

The Effects of Meditation and Mindfulness on Telomere Length and Telomerase

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Purpose

The research question asked was: What are the effects of meditation on cellular aging, i.e. telomere length and telomerase activity?

Abstract

This review explored studies on the effects of meditation practices on telomere length (TL) and telomerase activity (TA). Methods: Four randomized, controlled studies were reviewed, having a total of 174 participants. Types of meditation studied included mindful breathing, Loving-Kindness, Kirtan Kriya, and Soto Zen. Two studies compared TL of either long-term practitioners of Loving-Kindness meditation or Soto Zen meditation with controls who had no experience meditating. The other two studies included meditation training within the study protocol. One study included a 3-month retreat using mindful breathing and Loving-Kindness Meditation, and the other study included eight weeks of Kirtan Kriya practice. Telomere length and TA was examined in peripheral blood mononuclear cells (PBMC). Statistical significance was set between $p=0.05$ and 0.007 among the studies. Significantly greater TL or TA was found in all four studies, suggesting that meditation has positive effects on TL and TA, and therefore, stress-induced cellular aging.

Keywords: meditation; mindfulness; telomere length; telomerase; stress

Background

Telomeres are the protective end caps on chromosomes that prevent them from unravelling. Telomere length is associated with cellular aging and reduced TL is linked with chronic stress. Telomerase is a ribonucleoprotein reverse transcriptase cellular enzyme and is one factor that affects the rate of telomere shortening or lengthening. (Blackburn, 2000). It has the capacity to add nucleotide sequences to telomeres to lengthen them and counteract the shortening of them, which improve and preserve cell function.

Telomere length may be considered a psychobiometer that links stress with disease (Epel, 2009). Shortened telomere length and reduced telomerase may predict many health risks and diseases. Shorter telomeres are related to chronically elevated level of cortisol and epinephrine, suggesting a chronically elevated stress response. Shorter TL is linked to cardiovascular disease, heart attacks, vascular dementia, osteoarthritis, osteoporosis, diabetes, Alzheimer's disease, and stroke. Cognitive and emotional stress are related to shorter TL (Epel et al., 2004).

Telomere shortening and lengthening depends on a variety of factors, including the activity of the enzyme telomerase (Blackburn, 2000), which has the capability to add DNA sequences back onto the ends of telomeres, increasing their length and preserving healthy cell function (Kim et al., 2003).

Meditation training involves a variety of techniques focused on maintaining attention on a chosen thought, feeling, sensation, image, phrase, or posture. Mindfulness is one aspect of meditation that involves paying attention in the present moment non-judgmentally, with an attitude of curiosity, acceptance, kindness, compassion, and patience (Kabat-Zinn, 1994). Meditation and mindfulness can be described as psychological processes that act on specific parts of cognitive content and process, which disrupt the stress pathways and affect physiological arousal systems.

Background, cont.

Psychological stress cognitions, particularly perceptions of threat and ruminative thoughts, can lead to heightened and prolonged states of psychological and physical reactivity. Meditation and mindfulness are techniques that appear to reduce stress arousal states by shifting cognitive appraisals of threat to challenge and curiosity, and decrease ruminative thought. Meditation and mindfulness may also effectively increase positive arousal states.

A reference study (Epel et al., 2004) compared the lengths of telomeres of mothers of chronically ill children to TL of mothers of healthy children. The longer the mothers of chronically ill children were the primary caregivers, the shorter her telomeres were. Also, the more severe her psychological stress, the shorter her telomeres were. The reduction in TL was considered equivalent to a decade of aging.

Research suggests that TL and TA may be regulated by psychological stress and stress management (Epel, 2009, Ornish et al., 2008). Studies have also shown that certain health behaviors are associated with TL and TA, such as physical exercise, body mass index below $25\text{kg}/\text{m}^2$, non-smoking, healthy diet, and being married (Hoge, 2013; Ludlow et al., 2008).

Studies on meditation have shown that it can reduce the stress response, lower systolic and diastolic blood pressure, improve heart rate variability, lower basal cortisol, and enhance allostasis. Studies have shown that it can increase positive emotions, a sense of purpose in life, a sense of social support, and decreased illness symptoms such as headaches, sinus congestion, and weakness (Fredrickson et al., 2008).

Health implications of increased TL and TA may include decelerated cellular aging and age-related diseases, improved endocrine and immune balance, and reduced cardiac events and cancers.

Meditation training in these studies involved non-judgmental focused attention and self-awareness on breathing, thoughts of universal goodwill and compassion, and chants spoken out loud, whispered, and thought.

Results

Jacobs et al. (2010) compared participants in an isolated 3-month retreat using mindful breathing and Loving-Kindness practices for ~6 hours/day with controls who had no meditation experience. Meditators had significantly greater TA than controls, increasing by 30%.

Hoge et al. (2013) examined the TL of those with four or more years of daily practice in Loving-Kindness meditation with controls who had no experience with meditation or yoga. Telomere length of women meditation participants was significantly longer than the controls, 36% longer. There was no significant difference in the groups of men.

Lavretsky et al. (2013) studied the TA of those practicing Kirtan Kriya yoga meditation for 12 minutes a day for eight weeks compared with controls who practiced relaxation. The meditation group had 43% improvement in TA than the relaxation group, which had 3.7% increase in TA.

Alda et al. (2016) examined the TL of long-term, daily meditators of Soto Zen with controls with no meditation experience. Meditators had significantly longer LT and less short telomeres than controls.

Results, cont.

Table 1. Summary of studies and findings

Study	Meditation tradition	Meditators /Controls	Biomarkers studied	Results of meditators compared to controls
Jacobs et al. (2010)	3-month retreat: mindful breathing and Loving-Kindness practices.	30/30	Telomerase activity (TA)	Significantly greater TA in retreat group, a 30% increase (Fig 1).
Hoge et al. (2013)	Loving-Kindness	15/22	Telomere length (TL)	Women meditators had 36% longer RTL (Fig 2) than controls.
Lavretsky et al. (2013)	Kirtan Kriya	20/19	Telomerase activity	TA improved in meditation group by 43%. Relaxation group had 3.7% improvement.(Fig 3)
Alda et al. (2016)	Soto Zen	20/20	Telomere length	Meditators had significantly longer median LT and less short telomeres.

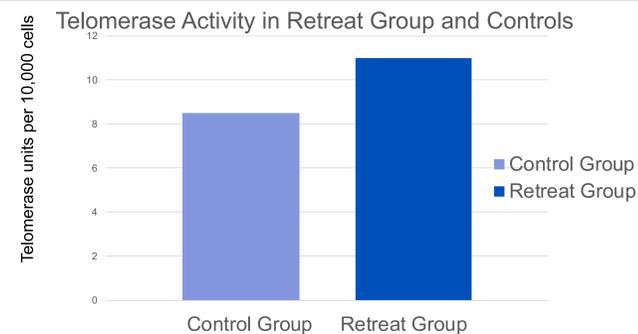


Fig 1: Telomerase activity in retreat and control groups (Jacobs et al., 2010)

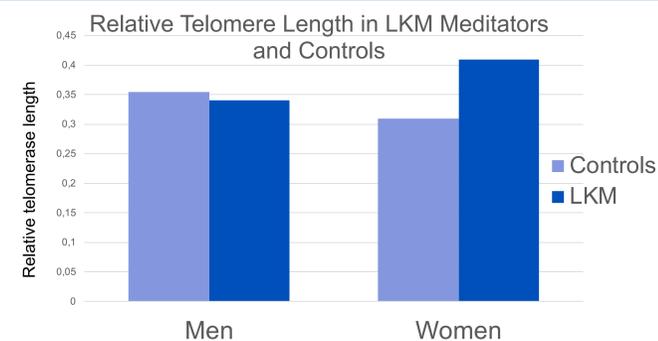


Fig 2. Relative telomere length in LKM Meditators and control groups (Hoge et al., 2013).

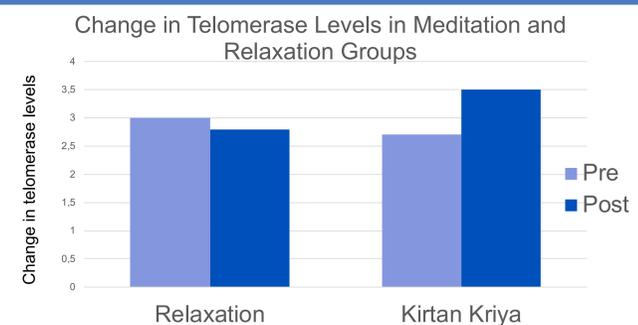


Fig 3. Changes in telomerase levels in meditation and control groups (Lavretsky et al., 2013).

Conclusion

Cellular mechanisms of mind-body interventions are only beginning to be understood. These study findings represent a growing body of literature showing longer telomeres and increased telomerase were related to the practice of meditation. The ability to affect telomere length through meditation even as short as eight weeks, 12 minutes a day, as well as long-term meditation, has many implications on health.

These studies indicate that mindfulness meditation that includes focused attention is a protective factor for telomeres, regardless of the tradition of meditation practiced.

A possible pathway between meditation and telomere length and increased telomerase appears to be that mindfulness meditation leads to decreased stress, anxiety, and depression, which are associated with cortisol level. Meditation has also been correlated with a reduction in inflammatory markers, chronic elevations of which are associated with poor health and increased mortality. Pace et al. (2013) and Pace et al. (2009) found that compassion meditation practice correlated with a reduction in C-reactive protein and interleukin-6 levels.

The reasons for the association between Loving-Kindness Meditation (LKM) and Relative Telomere Length in women is unknown. One contributing factor may have been that females spent longer time practicing LKM than men. Another possibility is that LKM leads to greater physiological and psychological benefits because women are better able to access empathetic tendencies. This capacity is supported by neuroimaging data showing increases in neural activation in women while engaging in empathy tasks, such as emotion recognition, interpersonal perspective awareness, and affective responsiveness (Derntl et al., 2010).

These studies were limited by low number of participants, and further research with greater participants may strengthen these findings. The opportunity to study the impact of this lifestyle choice on telomere biology may offer a valuable mind-body approach to many aspects of physical and emotional health.

Further research considerations include minimal and optimal meditation practice lengths per day, and assessment of participant perceptions of study instructors, as it is possible that differences in charisma between meditation and control group leaders may have influenced outcomes. It is also of interest to determine best meditation style based on the many variables that affect success with meditation, such as emotional and mental ability, and personal interest, as some meditation techniques are more challenging to beginners, leading to variations in compliance rates and long-term implementation.

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