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Mini Review

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Meditation Enhances Immune Function by Positively Regulating the Neuroendocrine System

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Abstract

Meditation positively regulates emotions and mental states, influencing the nervous and endocrine systems, thereby creating a healthier and more balanced internal environment for the immune system and ultimately enhancing immune function. This article elaborates on how this chain is connected and exerts influence. It explores the direct physiological and psychological pathways through which meditation influences immunity. Primarily, meditation directly regulates the autonomic nervous system, activating the parasympathetic "rest-and-digest" response to lower heart rate and blood pressure, while dampening the sympathetic stress response. It also modulates the Hypothalamic-Pituitary-Adrenal (HPA) axis, reducing chronic cortisol secretion. Psychologically, mindfulness practice fosters non-judgmental awareness, decreasing emotional reactivity and alleviating stress, anxiety, and depression. These emotional shifts further stabilize neuroendocrine activity. Collectively, these changes create an optimal internal environment for immune function: reducing pro-inflammatory cytokines, enhancing antibody response post-vaccination, and increasing the activity of key immune cells like natural killer cells. Thus, meditation does not directly boost immunity but supports the body's inherent self-healing capacity by resolving chronic stress and promoting systemic balance.

Keywords: Meditation, Neuroendocrine, Immune function, Neuroimmune interaction

Introduction

The burgeoning field of Psychoneuroimmunology (PNI) posits a dynamic, bidirectional communication network linking the mind, the nervous system, and the immune system. Within this conceptual framework, chronic psychological stress has been consistently implicated as a disruptive force, capable of dysregulating key physiological pathways-such as the autonomic nervous system and the Hypothalamic-Pituitary-Adrenal (HPA) axis-thereby promoting a pro-inflammatory state and suppressing adaptive immune function [1]. Consequently, interventions that effectively mitigate stress hold significant promise for restoring immunological homeostasis and improving health outcomes. Meditation, and mindfulness-based practices in particular, have emerged as potent, non-pharmacological modalities for modulating this intricate interplay [2]. This mini-review synthesizes current evidence elucidating the mechanisms through which meditation influences immunity, tracing the pathway from the cultivation of mindful awareness and emotional regulation to subsequent downstream effects on neuroendocrine signaling and, ultimately, immune competence.

How Does Meditation Directly Affect the Physiological System?

Meditation (especially mindfulness meditation) is not a passive "thinking of nothing", but an active training of the brain and body. It mainly affects physiology directly through two major systems. First of all, the autonomic nervous system such as stress response (dominated by the sympathetic nerve): When we feel stressed, anxious or scared, the body enters a "fight or flight" mode, the sympathetic nerve becomes excited, and adrenaline and cortisol are released. Such as relaxation response (dominated by the parasympathetic nervous system): Meditation, especially meditation focused on breathing, can directly activate the parasympathetic nervous system and trigger the body's "rest and digestion" mode. This is manifested as a slowed heart rate, decreased blood pressure and smooth breathing. Regular meditation is like constantly practicing this "relaxation switch",

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enabling you to recover from a stressful state more quickly [3]. The other one is the neuroendocrine system (hypothalamic-pituitary-adrenal axis, HPA axis), which is the core axis for the body to cope with stress. Long-term chronic stress can lead to overactivity of the HPA axis, continuously releasing cortisol [4]. High levels of cortisol can suppress the immune system. It is a powerful anti-inflammatory hormone that works in the short term, but if it is too high for a long time, it will "shut down" the immune response, making us more prone to infection and slowing down wound healing [5]. Meditation has been proven to lower basal cortisol levels and make the HPA axis respond more flexibly and moderately to stress, avoiding prolonged high levels [6].

How Can Emotions and Psychology Be Embedded in This Chain? Emotion-psychology-neuro-immune link）

This is the core area of "psychoneuroimmunology" research. Your thoughts and emotions will directly transform into chemical signals that affect your entire body. When you experience continuous stress, anxiety, and depression (negative emotions), the amygdala (the fear center) in the brain becomes more active, while the function of the prefrontal cortex (responsible for rational thinking and emotional regulation) weakens. This pattern of brain activity intensifies the stress response [7]. The autonomic nervous system has direct nerve fibers connected to immune organs (such as the spleen, thymus, and lymph nodes), which can directly affect the activity of immune cells. The autonomic nervous system has direct nerve fibers connected to immune organs (such as the spleen, thymus, and lymph nodes), which can directly affect the activity of immune cells [8]. Stress chemicals (cortisol, norepinephrine): They "command" immune cells to reduce activity or change their function. Positive chemical substances (endorphins, oxytocin) can enhance the patrol and combat capabilities of immune cells [9].

A Complete Closed Loop of Meditation - Emotion - Nerve – Immunity

You began to practice meditation regularly. Psychological and emotional changes: Through meditation, you develop mindfulness - the ability to observe your current thoughts and emotions without judgment. This reduces your reactivity to stressors. You will no longer be easily swept away by negative thoughts or experience secondary anxiety about anxiety. The result is that symptoms of stress, anxiety and depression are alleviated. Positive emotions, a sense of calmness and happiness have been enhanced. This improved emotional state leads to enhanced parasympathetic nerve activity and weakened HPA axis activity. When cortisol levels decline, the levels of other neurochemicals related to relaxation and pleasure, such as GABA and endorphins, may rise [10]. In a lower-stress and more balanced neurochemical environment, the immune system can function more effectively. Scientific research has found that long-term meditators or those who take meditation courses show: reduced inflammation levels: a decrease in pro-inflammatory cytokines (such as interleukin-6) in the blood. Chronic inflammation is the root cause of many modern diseases, from heart disease to depression itself [11]. Enhance immune defense: Increase antibody response: Some studies have shown that meditation practitioners produce more antibodies after getting the flu vaccine. Improve cellular immunity: The activity of CD4+ T helper cells (the commander of the immune system) is enhanced, and the number and activity of natural killer cells (NK cells, which can recognize and destroy cancerous or virus-infected cells) increase [12]. Enhanced telomerase activity: Telomeres are the "protective caps" at the ends of chromosomes and are related to cellular senescence and lifespan. Stress can shorten telomeres, and meditation may protect telomere length by reducing stress [13].

Conclusion

Imagine your body as a country, the immune system is the army and the medical force. The brain and nervous system are the central government. Emotions and mental states are the governance concepts of the central government. When the central government (the brain) remains in a "panic and war readiness" mode for a long time (chronic stress, anxiety), it will constantly order the military (the immune system) to remain on high alert and even indiscriminately consume resources, eventually leading to the military being exhausted (immunosuppression) or mistakenly injuring civilians (autoimmune diseases). Meanwhile, the country's infrastructure and restoration (daily health maintenance, wound healing) have been neglected. And meditation is like replacing the central government with a wiser and calmer leader. This leader can assess threats more accurately and no longer issue national alerts easily. It enables the military (immune system) to fully rest and train in peacetime, and to respond promptly, accurately and effectively when actually encountering external enemies (viruses, bacteria) or internal strife (cancer cells). Therefore, meditation is not a magical "immune enhancer", but a fundamental method that creates the best conditions for the body's inherent powerful self-healing ability and immunity to function by reshaping the inner environment.

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Conflict of Interest

None.

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