



# The Importance of Regular Multimodal Exercise Interventions on Sleep Quality via Embodied Consciousness



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## Abstract

Although sleep quality links to multiple cognitive, mental, physical, and physiological benefits, about 60% of US adults do not get enough sleep. First-line treatments for insomnia include pharmacotherapy and cognitive behavioral therapy. Given the limitations of pharmacotherapy, including cost, side effects, tolerance, and dependency, researchers have recently focused on non-pharmacological approaches, such as the linkage between exercise and sleep quality. Grounded in Merleau-Ponty's concept of embodied consciousness (body-mind unison), the purpose of this conceptual paper was to examine the multidimensional mechanisms related to the positive effects of multimodal exercise training programs on sleep quality. It was shown how regular endurance training and body-mind interventions like Tai Chi, Yoga, and Qigong constitute strong embodied consciousness or a shapely body schema, which is our motor habit or the way our body is habituated to the world. In this way, multiple physiological and psychological mechanisms can work synergistically to improve sleep quality. Regular exercise can lead to a balanced body schema, linking the in-itself (neurophysiological) and for-itself (psychological) body structures for improved sleep quality. Examples include increased slow-wave sleep; decreased Rapid Eye Movement (REM) sleep and sympathetic activity; enhanced modulation of the hypothalamic-pituitary-adrenal axis and circadian rhythms; increased human growth hormone; improved insulin resistance, and decreased stress and depression.

**Keywords:** Endurance exercise training; Body-mind movement programs; Psychophysiological mechanisms; Body schema; Merleau-Ponty; Improved sleep

## Introduction

According to the National Sleep Foundation's (NSF) 2025 Sleep in America (SIA) Poll, 60% of US adults do not get enough sleep [1]. Quality sleep is associated with flourishing characteristics, including happiness, work-home productivity, goal achievement, and fulfilling quality of life [1]. Sleep quality, which is more important than sleep quantity, is characterized by feeling rested and obtaining sufficient deep sleep. Poor sleep quality is associated with health problems, including cardiovascular disorders, obesity, decreased immunity and hormonal regulation, and mental and cognitive health issues [2-4]. Based on the European Insomnia Guidelines, first-line treatments for insomnia include pharmacotherapy (e.g., benzodiazepine-type drugs) and cognitive behavioral therapy [5]. Given the limitations of pharmacotherapy, including cost, side effects, tolerance, and dependency [6], researchers have recently focused on non-pharmacological approaches, such as the linkage between exercise and sleep quality [7].

Drawing on Merleau-Ponty's *Phenomenology of Perception* and the concept of embodiment (body-mind unison) [8], the purpose of this conceptual paper is to examine the multidimensional mechanisms related to the positive effects of multimodal exercise training programs on sleep quality. It will be shown below how regular endurance training and body-mind interventions like Tai Chi, Yoga, and Qigong constitute strong embodied consciousness or a shapely body schema, which is our motor habit or the way our body is habituated to the world. In this way, multiple physiological and psychological mechanisms can work synergistically to improve sleep quality.

## A balanced body schema via regular exercise and holistic health

Contrary to ultra-cognitive and brain-oriented interventions (e.g., pharmacotherapy) for improving sleep quality, this paper emphasizes how strong embodied consciousness (body-mind

unison) through regular exercise can link the various mechanisms underlying sleep quality. The philosophical underpinnings of this paper are based on Merleau-Ponty's *Phenomenology of Perception* to understand sleep architecture. Contrary to Cartesian mind-body dualism, Merleau-Ponty showed that the body and mind are inextricably linked and work in unison via one's actions towards and within the world. A key aspect in strengthening the link between the body and mind is motricity [8]. The body throws itself into meaningful movement significations, such as exercise, leading to improved perception, movement skills, homeostasis, and health [9-12]. Instead of viewing the body as an object or a measurable statistic that subserviently obeys the mind as in Cartesian theorizing, Merleau-Ponty elevated its essence to a subject, the *Lived Body*, that has consciousness and acts: walks, runs, climbs, dances, and expresses [8-15].

Embodied consciousness constitutes the synergistic actions of body and mind during motricity, leading to the formation of body schema as a Gestalt or the way the body is habituated to the world [8-15]. Body schema is not cognitive knowledge, a mental representation, or a reflex. Rather, it is knowledge in hand or tacit knowledge, through which understanding of the world and mastery of movement skills are facilitated. This is accomplished via the pre-reflective (immediate awareness) integration of multiple senses, such as visual, tactile, olfactory, and kinesthetic, for the navigation and perception of the world [8-10,12-15]. Body schema can tie together the body's in-itself (physiological) elements (e.g., organs, cells, glands, and blood arteries) and for-itself (psychological) essence (e.g., perceptions, emotions, intentions) [8,9,14,15]. Regular exercise leads to a shapely body schema, strengthening the linkage between the body's in-itself (e.g., secretion and inhibition of cortisol and neurotransmitters) and for-itself (e.g., perceptions, emotions, and breathing regulation) structures. In this way, stress and inflammation are reduced while homeostasis and psychophysiological health are improved [8,9,14,15]. The importance of body schema, or the way the body is habituated to the world in bringing together psychophysiological structures, is also shown in the explanation of the phantom limb syndrome. When the body is congenitally habituated to a limb deficiency, it is less likely to exhibit the phantom limb syndrome than when experiencing a traumatic amputation later in life [8,9,12].

It is erroneous to attempt to understand sleep quality by examining only the brain and the signals it sends to the body. Brain-body connections for sleep regulation are not mechanistic feedback loops, but a multifaceted approach that incorporates genetic, environmental, social, behavioral, and climatic factors. For example, finding ways to minimize stress while staying physically active and maintaining a healthy diet can strengthen one's body schema for quality sleep patterns and overall health [9,15,16].

Therefore, in this conceptual paper, sleep regulation will be examined holistically by focusing on different types of exercise and their effects on sleep quality. Regular exercise and body-

mind movement programs constitute a strong body schema or embodied consciousness. In this way, neurophysiological regulations during sleep work synergistically to improve sleep architecture and overall health.

### Mechanisms for the Positive Effects of Regular Exercise on Sleep Quality

Based on a recent systematic review, regular moderate physical activity improves sleep quality and decreases insomnia. However, high-intensity exercise close to bedtime can decrease sleep quality [17,18]. Certain mechanisms related to the positive effects of regular mild-to-moderate exercise and holistic body-mind movement programs on sleep health include:

- a) hormonal regulation by increases in the production of melatonin and a decrease of stress hormones like cortisol
- b) temperature regulation whereby the increases in core temperature due to exercise lead to subsequent temperature decreases about 30-90 minutes post exercise, decreasing sleep onset latency
- c) improved mood [17,19-21].

Consistent exercise is better than acute exercise for permanent psychological and physiological adaptations, thus improving sleep quality [22]. Although acute exercise has temporary minimal effects on sleep parameters, regular exercise has significant and lasting benefits. Examples include increased Slow-Wave Sleep (SWS); decreased Rapid Eye Movement (REM) sleep and sympathetic activity; enhanced modulation of the Hypothalamic-Pituitary-Adrenal (HPA) axis and circadian rhythms; increased human growth hormone; improved insulin resistance and decreased stress and depression [9,22-24].

### Mechanisms for the positive effects of holistic mind-body exercises on sleep quality

In holistic mind-body exercises like Yoga, Tai Chi, and Qigong, the emphasis is on mindful, controlled, and gentle movement postures and regulatory breathing techniques. In this way, psychophysiological and neuroendocrine pathways are modulated, leading to physical and mental health [7,25]. Such practices improve sleep quality by reducing inflammation, increasing serotonin, and decreasing anxiety and depression [7,26].

In a recent randomized controlled trial [27], the Tai Chi group showed greater improvements in self-reported sleep quality among patients with advanced lung cancer than the aerobic exercise group, which also incorporated resistance training, and the information-based, self-managed control group. Additionally, the one-year survival rate was higher in the Tai Chi group than in the aerobic group. Possible reasons for these differences were attributed to the regulatory breathing techniques and mindful meditation of the Tai Chi exercises [27]. Similarly, mind-body

meditation-based interventions, such as Tai Chi, Yoga, and Qigong, tend to improve sleep quality among older adults, cancer patients, and people with chronic fatigue and post-COVID syndrome [28-30]. In a recent systematic review and meta-analysis comparing various exercise modalities for improved sleep quality and reduced insomnia severity, Yoga, Tai Chi, walking, and jogging were more effective than other exercises [31].

## Summary and Conclusion

The purpose of this conceptual paper was to examine the multidimensional mechanisms related to the positive effects of multimodal exercise training programs on sleep quality. Regular endurance training and holistic body-mind movement programs, such as Tai Chi, Yoga, and Qigong, constitute strong embodied consciousness or a shapely body schema. In this way, complex neurophysiological regulations during sleep work synergistically to improve sleep architecture and overall health. A balanced body schema can link the in-itself (neurophysiological) and for-itself (psychological) body structures related to improved sleep quality. Examples include increased Slow-Wave Sleep (SWS); decreased REM sleep and sympathetic activity; enhanced modulation of the HPA axis and circadian rhythms; increased human growth hormone; improved insulin resistance and decreased stress and depression.

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