



Gender differences in photobiomodulation of lymphatic vessels of meninges and brain diseases

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Photobiomodulation (PBM) has emerged as a promising therapeutic approach for brain diseases, with growing evidence highlighting significant gender differences in its efficacy. This study explores the role of sex-specific variations in lymphatic function, hormonal influences, and ion channel activity in modulating PBM responses. Women exhibit higher lymphatic vessel density and estrogen-driven lymphangiogenesis, leading to enhanced PBM effects, particularly in conditions like lymphedema. In contrast, men show stronger inflammatory responses mediated by androgens, which may alter PBM outcomes. Additionally, gender differences in nitric oxide synthase (NOS) isoforms and ion channels (e.g., Kv1.2, Cav1.2) further contribute to divergent neuroprotective and metabolic responses to PBM. For instance, premenopausal women demonstrate elevated endothelial NOS (eNOS) activity, offering vascular protection, while men exhibit higher neuronal NOS (nNOS) expression in specific brain regions. Climacteric periods (menopause and andropause) also influence PBM responsiveness, with studies suggesting its potential to alleviate genitourinary symptoms in women and boost testosterone levels in men. These findings underscore the need for sex-tailored PBM protocols to optimize therapeutic outcomes. Further research is warranted to elucidate molecular mechanisms and validate clinical applications.

Keywords: photobiomodulation, gender differences, lymphatic system, nitric oxide synthase, ion channels, menopause, andropause

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