MedWave™

CLINICAL RESEARCH

Evidence Pack

A curated summary of peer-reviewed clinical research supporting the therapeutic applications of Photobiomodulation (PBM) across key medical indications.

SAHPRA	17	7
LICENSED	PEER-REVIEWED STUDIES	CLINICAL DOMAINS

ABOUT THIS RESEARCH PACK

The science behind the technology

This document compiles peer-reviewed, published clinical research on Photobiomodulation (PBM) therapy — the scientific foundation behind MedWave Group's photobiomodulation technology.

Each entry includes the study topic, a plain-language summary of findings, and a direct link to the original published paper. All research is independently conducted and published in peer-reviewed journals.

CONTENTS · 7 CLINICAL DOMAINS

This document summarises published research and provides direct links to source publications. All research cited is independently conducted and does not constitute a medical claim on behalf of MedWave Group.

01 Diabetes & Metabolic Health

1 STUDY

01 Diabetes in Spotlight: Current Knowledge and Perspectives of Photobiomodulation Utilization

Perrier Q, Moro C, Lablanche S · *Frontiers in Endocrinology* · 2024

KEY TOPICS

Diabetic neuropathy · Wound healing · Glycaemic control · Retinopathy · Periodontitis · Bone repair

This comprehensive review evaluated 87 clinical trials (5,837 patients) and 124 preclinical studies investigating PBM across all major diabetic complications. Key findings include pain reduction of 2–5 VAS points in diabetic neuropathy (77% of clinical studies); wound-closure improvements of 22–47.9% over controls in diabetic ulcer studies; a 37% reduction in post-meal blood glucose AUC and 16% faster postprandial glucose decay in a Type 2 diabetes RCT; and positive effects on bone repair, periodontitis, and glycaemic parameters. No adverse effects or hypoglycaemic risk were reported. The authors conclude PBM is a promising adjunctive therapy for diabetic neuropathy, wound healing, and glycaemic control.

ACCESS PAPER https://doi.org/10.3389/fendo.2024.1303638

10.3389/fendo.2024.1303638

02 Wound Healing

3 STUDIES

02 Photobiomodulation Therapy for Wound Care: A Potent, Noninvasive, Photoceutical Approach

Mosca RC, Ong AA, Albasha O, Bass K, Arany P · *Advances in Skin & Wound Care* · 2019

KEY TOPICS

Wound healing · Diabetic foot ulcers · Molecular mechanisms · PBM dosimetry · Chronic wounds · Clinical protocols

This CME-accredited clinical review examined the evidence for PBM therapy across multiple wound types including burn wounds, venous ulcers, pressure ulcers, and diabetic foot ulcers. Effective doses ranged from 0.1 to 10 J/cm² across wavelengths of 405–1,000 nm. In diabetic foot ulcer studies, PBM at 632.8–660 nm produced statistically significant reductions in wound size and pain scores. Three key molecular mechanisms are identified: mitochondrial cytochrome c oxidase activation; light-modulated cell-membrane ion channels; and extracellular activation of TGF-β1, a central wound-healing growth factor. The authors conclude PBM is a noninvasive, economical, multipurpose modality warranting standardised clinical protocols.

ACCESS PAPER https://doi.org/10.1097/01.ASW.0000553600.97554.5d

10.1097/01.ASW.0000553600.97554.5d

03

Wavelength-Dependent Effects of Photobiomodulation for Wound Care in Diabetic Wounds

Dungel P, Sutalo S, Slezak C, Keibl C, Schaedl B, et al. · *International Journal of Molecular Sciences* · 2023

KEY TOPICS

Wound healing · Wavelength selection · Angiogenesis · Diabetic wounds · LED therapy · Red vs green vs blue light

This preclinical study directly compared the wound-healing effects of three LED wavelengths — red (635 nm), green (540 nm), and blue (470 nm) — in a diabetic mouse excision-wound model. Red light achieved a 50% wound-size reduction 4.5 days faster than untreated controls, with green light also effective. Blood-vessel formation (angiogenesis) was significantly increased in the red and green groups versus controls. Blue light was ineffective. Wound perfusion increased significantly with red and green light as measured by laser Doppler imaging. The study concludes that pulsed LED therapy is an effective, low-cost, non-invasive option for diabetic wound management, with wavelength selection critical to outcome.

ACCESS PAPER https://doi.org/10.3390/ijms24065895

10.3390/ijms24065895

04

Photobiomodulation Therapy for Wound Healing: A Narrative Review

Sukeri SF, Azlina A, Zainal SA · *International Medical Journal Malaysia (IMJM)* · 2025

KEY TOPICS

Wound healing · Wavelength optimisation · Biphasic dose response · Diabetic wounds · Narrative review · Clinical protocols

This 2025 narrative review synthesised 37 full-text studies to evaluate PBM efficacy in wound healing. Optimal wavelengths are identified as 635–670 nm (red) and 810–960 nm (near-infrared), with an optimal fluence range of 1–16 J/cm². Superficial wounds respond best to 500–700 nm, while deeper wounds such as diabetic ulcers respond to 800–1,000 nm. Combining wavelengths such as 625, 660, and 890 nm together showed synergistic effects, improving neovascularisation and blood flow. The Arndt–Schultz biphasic dose-response law is highlighted as a foundational dosing principle.

ACCESS PAPER https://doi.org/10.31436/imjm.v24i01.2545

10.31436/imjm.v24i01.2545

03 PBM Science & Mechanisms

2 STUDIES

05

The Photobiological Basics Behind Light-Emitting Diode (LED) Phototherapy

Calderhead RG · *Laser Therapy* · 2007

KEY TOPICS

LED photobiology · Wavelength science · Wound-healing mechanisms · 633 nm red light · 830 nm near-infrared · Fibroblast activation

This foundational review establishes the core photobiological principles underpinning PBM and LED therapy. Three key wavelengths are examined: 415 nm (blue) for acne; 633 nm (red) for fibroblast activation, collagen synthesis, and wound healing; and 830 nm (near-infrared) for anti-inflammatory effects and activation of macrophages, mast cells, and neutrophils. Wavelength is identified as the single most important variable, determining both the cellular target and penetration depth. LED arrays — through beam interference — achieve photon intensities comparable to lasers at significantly lower cost, enabling large-area, hands-off treatment.

ACCESS PAPER https://doi.org/10.5978/islsm.16.97

10.5978/islsm.16.97

06

Mechanisms and Applications of the Anti-Inflammatory Effects of Photobiomodulation

Hamblin MR · *AIMS Biophysics* · 2017

KEY TOPICS

Anti-inflammation · Cytochrome c oxidase · NF-κB signalling · Macrophage M1/M2 · Arthritis · Neuropathic pain · Biphasic dose response

This landmark review by Harvard's Prof. Michael Hamblin provides a definitive account of how PBM produces its anti-inflammatory effects. Primary chromophores are cytochrome c oxidase in mitochondria and calcium ion channels. PBM raises ROS in healthy cells but lowers ROS in oxidatively stressed tissue. It reduces pro-inflammatory cytokines (TNF-α, IL-1β, IL-6, PGE2) and shifts macrophage phenotype from pro-inflammatory M1 to healing-promoting M2. Anti-inflammatory effects are demonstrated across arthritis, muscle injury, neuropathic pain, traumatic brain injury, spinal cord injury, autoimmune thyroiditis, and psoriasis, with a Cochrane systematic review finding strong evidence in rheumatoid arthritis.

ACCESS PAPER https://doi.org/10.3934/biophy.2017.3.337

10.3934/biophy.2017.3.337

04 Sport & Physical Performance

1 STUDY

07

The Evolution of Red and Infrared Light Therapy in Modern Times

Gonzalez JA et al. · *NSCA Coach* · 2024

KEY TOPICS

Sport performance · Muscle recovery · Pre-conditioning · Creatine kinase · DOMS · Fatigue delay · Athletic training

This strength-and-conditioning practitioner-focused article from the NSCA reviews the evidence for PBM in sport and athletic recovery. PBM applied before exercise (muscular pre-conditioning) increases ATP production, delays fatigue, and reduces creatine kinase (a muscle-damage marker) and delayed-onset muscle soreness. Applied after exercise, it accelerates recovery by reducing oxidative stress and inflammation in muscle tissue. Studies across elite runners, volleyball players, and rugby players demonstrate consistent improvements in performance metrics and recovery time. The article also covers transcranial PBM for cognitive and emotional performance benefits.

ACCESS PAPER https://www.nsca.com/education/articles/nsca-coach/evolution-of-red-and-infrared-light-the… NSCA Coach

05 Neurological & Brain Health

3 STUDIES

08

The Beneficial Role of Photobiomodulation in Neurodegenerative Diseases

Abijo A, Lee CY, Huang CY, Ho PC, Tsai KJ · *Biomedicines* · 2023

KEY TOPICS

Alzheimer’s disease · Parkinson’s disease · Neurogenesis · Neuroinflammation · Mitochondrial homeostasis · Cerebral blood flow

This review examines PBM as a therapeutic approach for neurodegenerative diseases, where conventional pharmacological treatments provide only symptomatic relief with significant side effects. PBM using red and near-infrared light has shown efficacy in animal studies for Alzheimer’s disease, Parkinson’s disease, and other neurodegenerative conditions. Key mechanisms include improving neuronal survival, promoting neurogenesis, reducing cerebral inflammation, enhancing cerebral blood flow, and maintaining mitochondrial homeostasis. PBM modulates multiple biological signal-transduction and metabolic-regulation pathways in neurons.

ACCESS PAPER https://doi.org/10.3390/biomedicines11071828 10.3390/biomedicines11071828

09

Lights on for Autism: Exploring Photobiomodulation as an Effective Therapeutic Option

Hamilton C, Bhatt S, Bhatt D, Bhatt A, Hamblin MR · *Photonics* · 2022

KEY TOPICS

Autism spectrum disorder · Neurological connectivity · Neuroinflammation · Gut microbiome · Transcranial PBM · Paediatric therapy

This mini-review considers PBM as a potential treatment for autism spectrum disorder (ASD), a neurodevelopmental condition affecting approximately 1 in 160 people, for which very few effective treatments currently exist. Key neurological abnormalities in ASD include imbalanced functional connectivity, synaptic-transmission disruption, neuronal death, gliosis, and inflammation, along with an altered gut microbiome. PBM has been shown in other pathological conditions to improve neuronal functional connectivity and survival, reduce gliosis and inflammation, and beneficially alter microbiome composition. The review concludes PBM is a potentially ideal, non-pharmacological treatment option for autism.

ACCESS PAPER https://doi.org/10.3390/photonics14040071

10.3390/photonics14040071

10

Photobiomodulation Improves Depression Symptoms: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Ji Q, Yan S, Ding J, et al. · *Frontiers in Psychiatry* · 2024

KEY TOPICS

Depression · Transcranial PBM · Neuromodulation · Neurogenesis · Cerebral blood flow · Systematic review · Mental health

This systematic review and meta-analysis published in Frontiers in Psychiatry provides the strongest level of evidence that PBM is an effective treatment for depression. As a non-invasive neuromodulation technique, PBM targets upstream disease mechanisms including mitochondrial dysfunction, oxidative stress, and neuroinflammation. The review also found that transcranial PBM can improve regional cerebral blood flow, promote neurogenesis, and influence brain-network connectivity — mechanisms shared with antidepressants and neuromodulation techniques such as TMS. PBM demonstrates an almost complete lack of adverse effects compared with pharmacological interventions.

ACCESS PAPER https://doi.org/10.3389/fpsyt.2023.1267415

10.3389/fpsyt.2023.1267415

06 Skin Health & Aesthetics

2 STUDIES

11

Low-Level Laser (Light) Therapy (LLLT) in Skin: Stimulating, Healing, Restoring

Avci P, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, Hamblin MR · *Seminars in Cutaneous Medicine and Surgery* · 2013

KEY TOPICS

Acne · Skin rejuvenation · Collagen synthesis · Hair regrowth · Photoageing · Dermatology · Fibroblast stimulation

This widely cited review by Avci and Hamblin (Harvard) covers the broad clinical applications of PBM in dermatology. For acne vulgaris, blue light destroys P. acnes bacteria while red light addresses the inflammatory component, with clinical studies showing greater than 70% clearance in inflammatory acne. For skin rejuvenation and photoageing, red and near-infrared PBM stimulates fibroblasts to produce new collagen and elastin, reducing wrinkles and increasing dermal density. For hair loss, PBM stimulates follicular stem cells and prolongs the anagen growth phase. The paper establishes the foundational scientific rationale for PBM in aesthetic and dermatological applications.

ACCESS PAPER https://doi.org/10.12788/j.sder.0028

10.12788/j.sder.0028

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Red-Light Photons on Skin Cells and the Mechanism of Photobiomodulation

Herrera MA, Ribas AP, da Costa PE, Baptista MS · *Frontiers in Photonics* · 2024

KEY TOPICS

Red-light mechanisms · Skin-cell biology · Keratinocytes · Gene expression · Nitric oxide · Skin penetration

This 2024 mini-review from the University of São Paulo provides a detailed mechanistic account of how red light (600–700 nm) interacts with skin cells to produce PBM effects. Red light's unique advantage is that its photons are much less absorbed by endogenous photosensitizers (melanin, haemoglobin) than shorter wavelengths, meaning they penetrate deeper and generate far fewer damaging reactive oxidants. The paper reviews how red light influences gene expression, nitric-oxide production, metabolic pathways, and signalling cascades in keratinocytes, fibroblasts, and other skin-cell types, providing the molecular basis for PBM skin applications.

ACCESS PAPER https://doi.org/10.3389/fphot.2024.1460722

10.3389/fphot.2024.1460722

07 Body Contouring & Fat Reduction

5 STUDIES

13 Clinical Protocol Effects With LED Photobiomodulation for Reducing Adipose Tissue in the Abdomen Region

Nishioka MA, Brassolatti P, Alves ACA, et al. · *Journal of Cosmetic Dermatology* · 2024

KEY TOPICS

Abdominal fat · Lipolysis · Body contouring · LED therapy · Adipocyte · Cytochrome c oxidase

This randomised controlled trial of 90 patients evaluated LED PBM (red 630 nm and infrared 850 nm) for reducing abdominal adipose tissue. Key findings: significant reduction in umbilical perimetry, significant decrease in body-fat-layer depth confirmed by ultrasound, and histological improvements including increased collagen deposition. The mechanism involves cytochrome c oxidase activation increasing ATP and cAMP, stimulating cytoplasmic lipase to convert triglycerides into fatty acids. PBM-induced ROS also creates transient pores in adipocyte membranes allowing lipid release. The study demonstrates LED PBM is a safe, effective, non-invasive approach to abdominal fat reduction.

ACCESS PAPER https://doi.org/10.1111/jocd.16675

10.1111/jocd.16675

14 Low-Level Laser Therapy and Vibration Therapy for the Treatment of Localized Adiposity and Fibrous Cellulite

Savoia A, Landi S, Vannini F, Baldi A · *Dermatology and Therapy* · 2013

KEY TOPICS

Cellulite · Localized adiposity · Body contouring · Vibration therapy · 635 nm laser · Fat reduction

This clinical study of 33 patients evaluated the combination of 635 nm low-level laser therapy with vibration therapy for treating localized adiposity and fibrous cellulite. Results showed a statistically significant reduction in fat thickness versus pre-treatment measurements ($p < 0.0001$), confirmed across all evaluation methods including photographic, perimetric, ultrasound, histological, and subjective assessments. Triglycerides and VLDL levels were mildly reduced with no changes in liver-function markers. The study demonstrates the safety and efficacy of combining PBM with vibration therapy for non-invasive circumference reduction.

ACCESS PAPER https://doi.org/10.1007/s13555-013-0026-x

10.1007/s13555-013-0026-x

15

Effect of 635 nm Low-Level Laser Therapy on Upper-Arm Circumference Reduction: A Double-Blind, Randomized, Sham-Controlled Trial

Nestor MS, Zarraga MB, Park H · *Journal of Clinical and Aesthetic Dermatology* · 2012

KEY TOPICS

Upper-arm contouring · Fat reduction · 635 nm laser · RCT evidence · Body contouring · Circumference reduction

This double-blind, randomised, sham-controlled trial of 40 healthy subjects tested 635 nm low-level laser therapy for upper-arm fat reduction. Subjects received three 20-minute treatments per week for two weeks. Significantly more LLLT-treated subjects achieved the primary endpoint (1.25 cm combined arm-circumference reduction) versus sham at all timepoints ($p < 0.0001$). Mean decrease in upper-arm circumference was significantly greater in the laser group at all time points. None of the LLLT-treated subjects reported any level of dissatisfaction. The study provides robust RCT evidence for 635 nm PBM in non-invasive body contouring.

ACCESS PAPER https://pubmed.ncbi.nlm.nih.gov/22468172/

PMID 22468172

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Photobiomodulation Therapy With Light-Emitting Diode in Stimulating Adipose Tissue Mitochondria

Modena DAO, Ferro AP, de Oliveira Guirro EC, Cazzo E, Chaim EA · *Lasers in Medical Science* · 2023

KEY TOPICS

Adipose-tissue mitochondria · Lipolysis mechanism · Mitochondrial stimulation · cAMP pathway · Obesity · Apoptosis

This clinical trial using a split-abdomen design in obese women (who subsequently underwent bariatric surgery) investigated whether PBM directly stimulates mitochondria in adipose-tissue cells. Treated adipose tissue showed highly significant positivity for mitochondrial markers including cAMP, DRP1, FAS, FIS1, MFN2, and OPA1 ($p < 0.001$), confirming direct mitochondrial stimulation in fat cells. This study provides the cellular-level mechanism for how PBM induces lipolysis and adipocyte apoptosis, establishing the scientific basis for PBM-based body-contouring treatments.

ACCESS PAPER https://doi.org/10.1007/s10103-023-03906-y

10.1007/s10103-023-03906-y

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Effects of LED PBM Therapy on the Subcutaneous Fatty Tissue of Obese Individuals: Histological and Immunohistochemical Analysis

Modena DAO, Soares CD, Martignago CCS, Almeida S, Cazzo E, Chaim EA · *Journal of Cosmetic and Laser Therapy* · 2022

KEY TOPICS

Subcutaneous fat · Lipolysis · Adipocyte apoptosis · Histological evidence · Hormone-sensitive lipase · Obesity treatment

This controlled comparative study examined the cellular-level effects of combined red (630 nm) and infrared (850 nm) LED PBM on subcutaneous fatty tissue in women with grade II obesity, using tissue collected at the time of bariatric surgery. Treated samples showed significant positivity across all markers ($p < 0.0001$ for most) compared with untreated control tissue. The study directly demonstrates that LED PBM promotes autophagic lipolysis induced by adipocyte apoptosis in subcutaneous tissue, confirming the mechanism by which PBM achieves fat reduction at a histological level.

ACCESS PAPER https://doi.org/10.1080/14764172.2022.2109677

10.1080/14764172.2022.2109677