

Photobiomodulation in Neonatal and Pediatric Healthcare: A Scoping Review*

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Theme: Healthcare technologies

Contributions to the field: The mapping of scientific evidence regarding photobiomodulation in the healthcare of neonates and children, through a scoping review, contributes to gathering references that enable understanding the benefits of applying the technique and its broad spectrum of action. It is a promising non-pharmacological treatment in healthcare, which is easy to apply and contributes to the practice of nurses and other healthcare professionals by assisting in pain management, injury prevention, and tissue repair.

Abstract

Introduction: Photobiomodulation is a noninvasive therapy used with neonates and children, with promising results due to its analgesic, anti-microbial, and reparative actions. **Objective:** To describe the available evidence on the use of photobiomodulation in nursing care for neonates and children. **Materials and Methods:** This is a structured scoping review based on the methodological guidelines of the Joanna Briggs Institute. The PCC mnemonic was applied, where P stands for population (neonates and children), C for concept (photobiomodulation), and C for context (healthcare). The databases searched were Web of Science, Science Direct, Embase, PubMed via MEDLINE, LILACS, BDEnf, WPRIM, and IBECs via the Virtual Health Library (VHL); in addition to the repositories: Preprints bioRxiv, Thesis and Dissertation Catalog, and OpenGrey. The results followed the guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist. **Results:** The final sample consisted of 11 studies, with a focus on diode laser application, all developed in the field of dentistry. It was evident that photobiomodulation is a promising and effective non-pharmacological method in nursing care for neonates and children. **Conclusions:** Photobiomodulation has a broad spectrum of action and is consolidating itself as a promising, safe, and easily applicable non-pharmacological treatment in child health care.

Keywords (Source: DeCS)

Laser therapy; low-level light therapy; child; newborn; child health.

4 Fotobiomodulación en la atención en salud de neonatos y niños: una revisión de alcance*

* El trabajo se realizó con el apoyo de la Fundação Araucária y el Programa Institucional de Bolsas de Iniciação Científica, a través del Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brasil.

Resumen

Introducción: la fotobiomodulación es una terapia no invasiva utilizada en neonatos y niños, con resultados prometedores debido a sus efectos analgésicos, antimicrobianos y reparadores. **Objetivo:** describir la evidencia disponible sobre el uso de la fotobiomodulación en los cuidados de enfermería dirigidos a recién nacidos y niños. **Materiales y métodos:** se realizó una revisión de alcance estructurada según las directrices metodológicas del Instituto Joanna Briggs. Se aplicó el mnemotécnico PCC, en el que P corresponde a la población (neonatos y niños); C, al concepto (fotobiomodulación); y C al contexto (atención en salud). Las bases de datos consultadas fueron: Web of Science, Science Direct, Embase, PubMed vía MEDLINE, LILACS, BDEnf, WPRIM e IBECs a través de la Biblioteca Virtual en Salud (BVS); además de los repositorios: preprints bioRxiv, Catálogo de Teses e Dissertações y OpenGrey. Los resultados se reportaron conforme a las recomendaciones de la lista de verificación Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). **Resultados:** la muestra final incluyó 11 estudios, con predominancia en la aplicación de láser de diodo, todos desarrollados en el área odontológica. Se evidenció que la fotobiomodulación es un método no farmacológico prometedor y eficaz en el cuidado de neonatos y niños. **Conclusiones:** la fotobiomodulación posee un amplio espectro de acción y se consolida como un tratamiento no farmacológico prometedor, seguro y de fácil aplicación en la atención en salud infantil.

Palabras clave (Fuente: DeCS)

Terapia con láser; terapia con luz de baja intensidad; niño; recién nacido; salud del niño.

Fotobiomodulação no cuidado à saúde de neonatos e crianças: revisão de escopo*

* Este trabalho foi realizado com o apoio da Fundação Araucária e do Programa Institucional de Bolsas de Iniciação Científica, por meio do Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brasil.

Resumo

Introdução: A fotobiomodulação é uma terapia não invasiva utilizada com neonatos e crianças, com resultados promissores devido às suas ações analgésica, antimicrobiana e reparadora. **Objetivo:** descrever as evidências disponíveis sobre o uso da fotobiomodulação na assistência de enfermagem a recém-nascidos e crianças. **Materiais e métodos:** Trata-se de uma revisão de escopo estruturada conforme orientações metodológicas do Instituto Joanna Briggs. Aplicou-se o mnemônico PCC, em que P se refere à população (neonatos e crianças); C, ao conceito (fotobiomodulação); e C, ao contexto (cuidado à saúde). As bases de dados consultadas foram: Web of Science, Science Direct, Embase, PubMed via MEDLINE, LILACS, BDEnf, WPRIM e IBECs via Biblioteca Virtual em Saúde (BVS); além dos repositórios: Preprints bioRxiv, Catálogo de Teses e Dissertações e OpenGrey. Os resultados seguiram as recomendações do checklist do Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). **Resultados:** A amostra final foi composta por 11 estudos, com predominância da aplicação do laser de diodo, todos desenvolvidos na área da odontologia. Evidenciou-se que a fotobiomodulação é um método não farmacológico promissor e eficaz na assistência de enfermagem a neonatos e crianças. **Conclusões:** A fotobiomodulação apresenta um amplo espectro de ação e vem se consolidando como um tratamento não farmacológico promissor, seguro e de fácil aplicabilidade na assistência à saúde infantil.

Palavras-chave (Fonte DeCS)

Terapia a laser; terapia com luz de baixa intensidade; criança; recém-nascido; saúde da criança.

Introduction

Photobiomodulation (PBM), also known as low-level laser therapy (LLLT) or light-emitting diode (LED) therapy, has gained interest in the health field for being a non-invasive tool (1) with satisfactory short-term results. Its applicability in vulnerable populations, such as neonates and children, has drawn attention due to the possibility of safe, painless, and well-tolerated interventions. Although the terms are often used interchangeably in the literature, in this study, the term “photobiomodulation” is adopted as the standard designation, as it is more comprehensive and current (2-4).

The first laser device was developed in 1959 to accelerate the regeneration of damaged tissue, promoting nerve response to restore the action potential threshold, and stimulating adjacent or contralateral neuromodulation to perform the role of the injured nerve (4).

It is a therapeutic approach capable of regulating numerous metabolic processes through biochemical and photophysical resources. PBM has the propensity to promote biological effects, such as pain relief (5). These characteristics make the technique appealing for use in children, as it avoids the side effects typical of conventional and invasive treatments. The ability to modulate the inflammatory process promotes the repair of injured tissue, stimulating the increase of growth factors, such as the stimulation of endothelial cells and fibroblasts, in addition to promoting the proliferation of keratinocytes (1, 6).

PBM consists of applying light to a biological system, relieving pain, promoting tissue regeneration, and reducing inflammation. Unlike other procedures that use lasers, LLLT has no ablative or thermal effects. Instead, it causes a photochemical effect, in which light is absorbed and results in a chemical reaction (2). It is classified as a low-level technique due to the low energy density used, and these ideal levels are not comparable to those of other laser therapy techniques used for cutting, thermal coagulation of tissues, and even ablation (7).

PBM has also been widely used in healthcare as it uses monochromatic radiation and has a wider spectral range. Laser waves allow for more precise collimation, while LED waves are incoherent, enabling the treatment of larger areas (8).

The intensity of the PBM effect is affected by wavelength, energy density (fluence), power density, lesion type, and photoreceptor absorption spectrum (9). However, the main difference between laser types is related to the wavelength spectrum (1, 6).

PBM emerged as a complementary alternative to conventional therapies and has presented several advantages, including being painless, providing rapid pain relief, being practical to use, cost-effective, and promoting good healing. It is also an appropriate alternative for pediatric patients, due to the low level of fear associated with the device and technique (2, 10).

PBM has the potential to alleviate pain and inflammation, promote healing, and facilitate tissue regeneration (11, 12). Due to its numerous benefits, it has been applied as an auxiliary treatment for various pathologies (11, 13, 14).

Since PBM is an innovative method that is increasingly present in healthcare practices, and there is a scarcity of systematic studies on the use of PBM in neonates and children, this study aims to describe the available evidence on the use of PBM in nursing care for neonates and children.

Unlike other reviews, which address PBM in general clinical contexts or in other populations, this review focuses specifically on the pediatric and neonatal population, with an emphasis on the nursing practice. This delimitation aims to contribute to scientific production in this field and guide evidence-based clinical practices.

Materials and Methods

This is a scoping review, characterized as a systematic, exploratory review, which aims to explore the concepts of the theme in question, in addition to understanding the scope and nature of the studies, as well as mapping and highlighting existing gaps in the literature (15).

To formulate the research question, the PCC mnemonic strategy was used, where P stands for population (neonates and children), C stands for concept (PBM), and C stands for context (health care) (15). Given this, the following question was formulated: What scientific evidence is available on the use of PBM in the health care of neonates and children?

The search for materials was conducted by two independent researchers between January and February 2024. Studies whose population consisted of individuals aged 0 to 12 years were included, and the sample selection was guided by the following inclusion criteria: articles without language restrictions; with or without free access; studies with varying methodological designs; no time frame, and manuals, theses, dissertations, and legislation. The exclusion criteria included studies that used PBM in combination with other treatments (due to possible interference with the observed effects), studies without presentation of results, works with incomplete information that compromised the thematic analysis, as well as letters to the editor, abstracts, event proceedings, and documents not available in full, even after contacting the authors. The Rayyan® software was used to manage the references.

The study selection was conducted independently by two reviewers. Discrepancies in the inclusion or exclusion of studies were settled by consensus between the reviewers and, when neces-

sary, with the participation of a third reviewer. Data extraction was also performed independently by both reviewers, with cross-checking to ensure consistency of information.

The adapted Joanna Briggs Institute tool was used in the data extraction stage, covering aspects such as title, publication year, author(s), objective, methodological design, and main results. Although these categories guided the initial extraction, the process was conducted iteratively, allowing for adjustments as the data were analyzed, in line with the exploratory nature of the scoping review (15).

The descriptors were defined after searching the following electronic databases: Web of Science and PubMed via MEDLINE, to identify key terms related to the topic under study and, based on them, select controlled descriptors using the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH) tools: *terapia a laser/laser therapy*; *terapia com luz de baixa intensidade/low-level light therapy*; *criança/child*; *saúde da criança/child health*; *cuidado da criança/child care*; *recém-nascido/infant newborn*. As uncontrolled descriptors, the following were used: *fotobiomodulação/photobiomodulation*; and *neonato/neonate*.

The research sources were Web of Science, Science Direct, Embase, PubMed via MEDLINE, LILACS, BDEnf, WPRIM, IBECs via the Virtual Health Library (VHL); in addition to the repositories: Preprints bioRxiv, Thesis and Dissertation Catalog of the Coordination for the Improvement of Higher Education Personnel (Capes) and Open-Grey. The references of the selected articles were analyzed to identify other studies.

The following search operators were used to develop the search engine: (“Laser Therapy” OR “Low-Level Light Therapy” OR “photobiomodulation”) AND (“Child” OR “Child Health” OR “Child Care” OR “Infant Newborn” OR “neonate”), as shown in Table 1.

Table 1. Search Strategies in Databases and Repositories

Database	Strategy	No.
LILACS, BDEnf, WPRIM, IBECs via BVS	((“laser therapy” OR “low-level light therapy” OR “photobiomodulation”) AND (“child” OR “child health” OR “child care” OR “infant newborn” OR “neonate”)) AND (db:(“WPRIM” OR “LILACS” OR “IBECs” OR “BDEnf”))	385
PubMed via MEDLINE	(“Laser Therapy”[All Fields] OR “Low-Level Light Therapy”[All Fields] OR “photobiomodulation”[All Fields]) AND (“Child”[All Fields] OR “Child Health”[All Fields] OR “Child Care”[All Fields] OR “Infant Newborn”[All Fields] OR “neonate”[All Fields])	4147
Web of Science	ALL= (((“Laser Therapy” OR “Low-Level Light Therapy” OR “photobiomodulation”) AND (“Child” OR “Child Health” OR “Child Care” OR “Infant Newborn” OR “neonate”)))	266
Science Direct	ALL= (((“Laser Therapy” OR “Low-Level Light Therapy” OR “photobiomodulation”) AND (“Child” OR “Child Health” OR “Child Care” OR “Infant Newborn” OR “neonate”)))	3933

Database	Strategy	No.
Embase	((("Laser Therapy" OR "Low-Level Light Therapy" OR "photobiomodulation") AND ("Child" OR "Child Health" OR "Child Care" OR "Infant Newborn" OR "neonate")))(('laser therapy' OR 'low-level light therapy' OR 'photobiomodulation') AND ('child' OR 'child health' OR 'child care' OR 'infant newborn' OR 'neonate'))	2732
OpenGrey	((("Laser Therapy" OR "Low-Level Light Therapy" OR "photobiomodulation") AND ("Child" OR "Child Health" OR "Child Care" OR "Infant Newborn" OR "neonate")))	292
Preprints bioRxiv	Laser Therapy OR Low-Level Light Therapy OR photobiomodulation AND Child OR Child Health OR Child Care OR Infant Newborn	3
Capes Catalog of Theses and Dissertations	((("Laser Therapy" OR "Low-Level Light Therapy" OR "photobiomodulation") AND ("Child" OR "Child Health" OR "Child Care" OR "Infant Newborn" OR "neonate")))	68

Source: Prepared by the authors.

Following this, a thematic analysis was conducted to identify the potentialities and gaps in the theme. The summary of the results is presented in tables with the main findings, which are discussed narratively. Finally, the study presents the results following the suggestions of the PRISMA-ScR (16) checklist, as shown in Figure 1. The review protocol is registered in the Open Science Framework, under number 10.17605/OSF.IO/WAZUM.

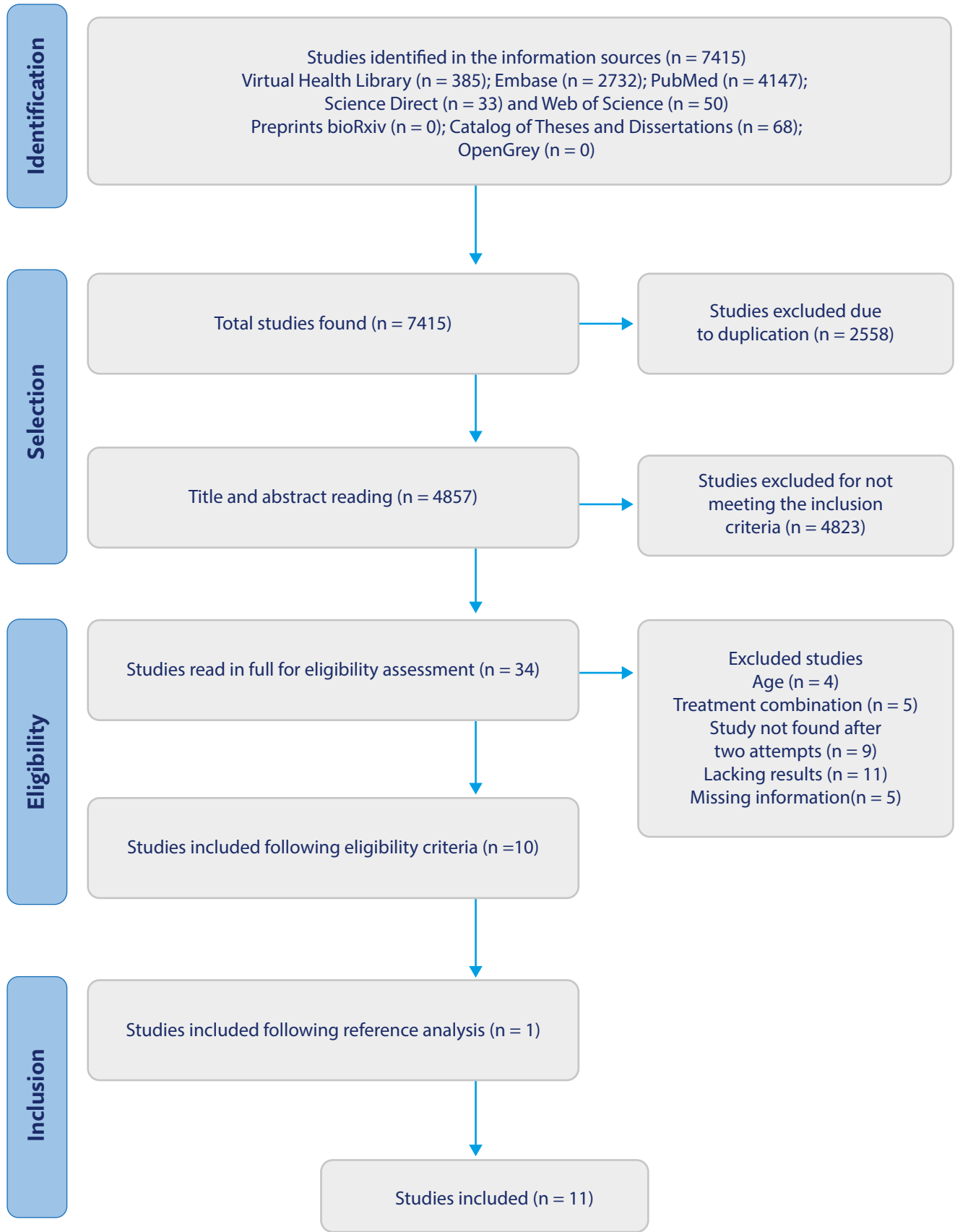
Key: Combination treatment — studies that combined PBM with a clinical protocol, a combination of low- and high-intensity lasers, medications, analgesics, or therapy; No results — these are proposals for studies that have not yet been completed and, therefore, the results have not been described; Missing information — these are studies that did not provide necessary information, such as the age and type of laser used.

Since this is a scoping review based on publicly available secondary data, it was not necessary to submit it to a research ethics committee, in compliance with national and international guidelines for research of this nature.

Results

The final sample consisted of 11 studies. Table 2 shows the articles included, according to general characteristics: authorship, publication year, country where the study was conducted, objective, study design, location, and participants' age, according to the methodological criteria proposed by the scoping review, highlighting the characteristics of contexts, populations, interventions, and outcomes observed.

Figure 1. PRISMA-ScR Flowchart for Identifying and Selecting Articles Included in the Scoping Review Using Information Sources. Maringá, Paraná, Brazil, 2024



Source: Adapted from PRISMA-ScR (16).

Table 2. Studies Included in the Review. Maringá, Paraná, Brazil, 2024

ID	Authorship/Year	Country	Objective	Study design	Location	Age	Funding
A1 (17)	McLoone E, O'Keefe M, McLoone S, Lanigan B/2006	Ireland	To evaluate the long-term functional and structural outcomes of premature neonates who underwent diode laser photocoagulation for retinopathy of prematurity.	Cohort study	Ophthalmology Clinic at the Children's Hospital	Average age of 11 years	Not declared
A2 (18)	Kuhn A, Porto FA, Miraglia P, Brunetto, AL/2008	Brazil	To determine whether LLLT can reduce the duration of chemotherapy-induced oral mucositis.	Controlled and randomized	Pediatric Oncology Service at Hospital de Clínicas	Average age of 8.2 years	Not declared
A3 (19)	Pinto FC, Chavantes MC, Pinto NC, Alho EJ, Yoshimura EM, Matushita H et al./2010	Brazil	To analyze the effect of LLLT on tissue repair following corrective surgical incision in neonates with myelomeningocele.	Prospective pilot study	Pediatric Nursery at the Hospital de Clínicas	Neonates	Not declared
A4 (20)	Cepera F, Torres FC, Scanavini MA, Paranhos LR, Capelozza L, Cardoso MA et al./2012	Brazil	To evaluate the effects of low-intensity laser on bone regeneration in rapid maxillary expansion procedures.	Comparative study, controlled and randomized trial	Orthodontic clinic	Ages 8 and 11	Not declared
A5 (21)	Cauwels R, Martens L, Van De Velde V, Benoit Y/2013	Belgium	To research the pain relief and wound healing capabilities of LLLT in chemotherapy-induced oral mucositis.	Pilot study	University Hospital	Average age of 9,4 years	Not declared
A6 (22)	Stein S, Korbmacher-Steiner H, Popovic N, Braun A/2015	Germany	Pain-reducing effect of low-intensity laser therapy in pediatric patients undergoing orthodontic separation.	Retrospective and randomized study	Orthodontic clinic	Average age of 8.05 years	Not declared
A7 (23)	Elbay M, Tak Ö, Şermet Elbay EUA, Kaya C, Eryılmaz K/2016	Turkey	To determine whether LLLT can reduce the gag reflex in children undergoing intraoral radiography of the maxilla.	Randomized, controlled, double-blind clinical trial	Pediatric Dentistry Center	Ages 6 to 12	Not declared
A8 (24)	Vieira KA, Bastos CM, Vitor MGC, Deana AM, Fernandes KPS, Rodrigues MFSD et al./2018	Brazil	To evaluate the effect of low-power laser on saliva in children aged 1 to 5 years with protein-energy malnutrition.	Cross-sectional experimental study	Educational and Nutritional Recovery Center	Ages 1 to 5	Not declared
A9 (25)	Bardellini E, Veneri F, Amadori F, Conti G, Majorana A/2020	Italy	To evaluate the effectiveness of PBM in relieving pain and reducing lesions in children with recurrent aphthous stomatitis.	Controlled and randomized study	Orthodontic clinic	Ages 5 to 12	Not declared
A10 (26)	Oliveira AB, Ferrisse TM, Salomão KB, Miranda ML, Bufalino A, Brighent FL/2021	Brazil	To evaluate the effectiveness of PBM therapy for the treatment of xerostomia associated with hyposalivation.	Case report	Pediatric clinic	7 years	Capes
A11 (27)	Wu BY, Ou-Yang MC, Liu CT, Huang HC, Hu WL, Chen Illinois et al./2023	China	To research the analgesic effect of LLLT during heel pricking compared to breast milk in healthy term neonates.	Prospective, single-center, open-label, randomized, controlled study	Hospital Nursery	Neonates	Kaohsiung Chang Gung Memorial Hospital

Source: Prepared by the authors.

Table 3 presents the aspects of the included studies according to identification, type of PBM used, laser spot energy, laser wavelength, site where the laser was applied, and PBM outcome.

Table 3. Presentation of the studies included in the review. Maringá, Paraná, Brazil, 2024

ID	Type of PBM	Spot energy	Wavelength	Application site	Outcome
A1 (17)	Diode laser	-	-	Ocular retina	PBM showed long-term benefits, preserving distance and near vision in eyes with threshold retinopathy of prematurity.
A2 (18)	GaAlAs laser	100 mW	830 nm	Oral mucosa	Low-intensity laser therapy can reduce the duration of chemotherapy-induced oral mucositis.
A3 (19)	Diode laser	21 mW	685 nm	Surgical incision	There was a significant decline in surgical wound dehiscence in neonates undergoing PBM.
A4 (20)	Diode laser	40 mW	780 nm	Soft palate of the maxilla	The laser accelerated the bone regeneration process, improving tissue regeneration of the midpalatal suture opening.
A5 (21)	Diode laser	150 mW	830 nm	Oral mucosa	The diode laser reduces the severity and duration of oral mucositis, significantly alleviating the pain symptom.
A6 (22)	Diode laser	100 mW	660 nm	Mesial interproximal space of molars	Pain reduction was significant on the first day, demonstrating the effectiveness of immediate symptom relief.
A7 (23)	Diode laser	300 mW	810 nm	Acupuncture points PC 6 (located on the underside of the wrist)	Laser therapy has proven to be a useful technique in controlling the gag reflex, enabling children to tolerate the maxillary radiography procedure.
A8 (24)	Diode laser	100 mW	808 nm	Parotid glands bilaterally	PBM stimulated increased salivary production, as well as the source needed for increased protein energy.
A9 (25)	Diode laser	100 mW	645 nm	Oral mucosa	The laser significantly reduced wound size and pain compared to the placebo group.
A10 (26)	Red and infrared laser	100 mW	660 nm or 808 nm	Sublingual glands	PBM increased salivary flow, alleviating xerostomia and improving chewing and swallowing.
A11 (27)	Red and infrared laser	150 mW	810 nm	Yintang Acupoint (EX-HN3) (midpoint between the medial ends of the eyebrows)	The group in which PBM was applied had a shorter crying interval, associated with a shorter period of pain during heel pricking.

Source: Prepared by the authors.

Discussion

In the studies included in the summary table, there are indications that the use of PBM may have therapeutic effects in reducing pain in invasive and surgical treatments (22, 27), in enhancing tissue repair (20, 28), and improving and regenerating wounds (19, 22, 27), as well as its application as a non-pharmacological treatment that can help manage recurrent aphthous stomatitis and oral mucositis in pediatric cancer patients (18, 21, 25), in preserving vision in children with retinopathy of prematurity (17), in the energy-protein effect of laser therapy in malnourished children, and in inhibiting the gag reflex through laser acupuncture (23, 24).

Experimental studies were the most recurrent in this study, highlighting the researchers' interest in proving the effectiveness of therapeutic interventions associated with the use of PBM in pediatric patients. The results suggest that this non-pharmacological technique has shown promise, with satisfactory effects in certain contexts, although further studies are still needed for its validation (29–31).

In line with this finding, it is noted that, among the health sciences, dentistry was the field that invested the most in PBM research, while no studies were identified in the field of nursing. It should be noted, however, that nursing has been known to use PBM in wound treatment, analgesia, increased microcirculation, and acceleration of the tissue repair process, among other recently explored applications (32).

It is believed that PBM is an innovative practice in nursing (32), unlike dentistry, which has been using it for some years in clinical procedures (31). Therefore, it is necessary to produce further robust evidence to support current knowledge on the theme to avoid gaps and expand the dissemination of the technique in all fields of healthcare (33).

Pain is an important factor that can compromise a child's well-being, since, in more severe cases, it interferes with patients' eating, hydration, movement, and speech (34). Pain relief has been one of the focuses of pediatric treatment, as it contributes to reducing anxiety and fear. In this context, PBM, as a non-pharmacological method, has been explored for its potential to improve children's ability to cope with painful experiences, although the evidence is still preliminary (34).

Therefore, the analgesic effect of PBM is related to the increased release of serotonin, β -endorphin, and enkephalins (natural endogenous opioid neuropeptides), acting on the release of substance P (neuropeptide) and the secretions of histamine, bradykinin, and prostaglandin E₂, leading to inhibition of pain afferent fibers (11) and reversibly altering membrane permeability. Thus, therapeutically applied photons activate cell proliferation and reduce the activity of delta C and A fibers (35, 36).

In addition, PBM modifies nerve conduction and excitation in peripheral neurons due to its action on the Na⁺/K⁺ pump channel, reducing noxious stimuli through its effects on the transient receptor potential cation channel subfamily V member 1 (TRPV1) and nerve growth factor (NGF), consequently decreasing their expressions (blocking inflammatory thermal hyperalgesia [37]). A study conducted in India identified that PBM is an effective way to better manage procedures that some patients find painful, without the need for prescription medications, which often have various side effects (38).

Light can have positive or negative effects on living cells and tissues, depending on wavelength, coherence, and dose or intensity (39). The wavelength (energy range) between 600 and 700 nm, in the red light spectrum, has been shown to be effective in inducing cell proliferation and differentiation, as it promotes greater biostimulation (40).

The prevalence of studies with children can be justified by the fact that they find it easier to communicate and express their pain, allowing the use of visual, audible, and tactile methods that lead them to understand the procedure performed and the importance of the proposed treatment, leading to greater closeness with the professional and contributing to greater adherence to their treatment (41). This reality is not perceived in neonates due to their inability to verbalize pain. In these cases, the painful sensation can be perceived through facial expressions, crying, and changes in physiological parameters (42).

PBM has beneficial effects on tissue regeneration and wound healing (10, 11, 43, 44), matrix deposition, and cell layer regeneration (39, 43). PBM has an anti-inflammatory effect on oral mucosal cells. Its mechanism of action occurs at the mitochondrial cellular level, related to the absorption of light by cytochrome C oxidase for cellular metabolism. Thus, it stimulates oxidative phosphorylation in mitochondria, reducing pain and accelerating wound healing. This increases adenosine triphosphate synthesis, produces inflammatory responses, and exhibits beneficial effects on inflammation and wound healing (9).

In addition, PBM controls secondary infections, as different wavelengths (energy ranges) induce different bacteria. Thus, at 830 nm, it controls infections at different stages since visible light reduces bacteria in infected wounds. However, it is necessary to check the type of bacterial infection before starting local irradiation (45).

A study conducted in Italy with pediatric patients found that PBM laser irradiation was effective in accelerating lesion resolution and increasing wound healing rates (34). In addition, it is considered a non-invasive and painless treatment, with high acceptance rates among pediatric patients. Given the positive results achieved, it is a viable therapy for the prevention and treatment of oral mucositis (46, 47).

The prevalence of diode laser application is due to its widespread use in orthodontics, as this type of laser has been widely used in dental practice. The diode laser is easier to handle, has an anti-inflammatory effect, accelerates healing, intensifies neovascularization, causes less temperature elevation in target tissues, and, when used adequately, according to manufacturing protocols, does not cause harmful effects (4, 48).

Treatment for oral mucositis is mainly palliative, using analgesics and anti-inflammatory medications, specific agents for the mucosa, and mouthwashes (49). The photochemical effect of the laser caus-

es the damaged tissue to absorb the laser radiation and transform it into energy, preventing the progression of the wound in a preventive manner and avoiding the development of ulcers in the oral cavity. As oral mucositis arises, laser therapy will act in a curative manner, allowing therapeutic action on painful symptoms and accelerating the healing of this condition. Thus, it can be used as a complement to other treatment methods (12).

Another possible use for lasers is in the treatment of hyposalivation, which can impact children's daily lives, due to discomfort and pain, and potentially lead to oral health problems. In this context, the use of PBM in pediatric patients with hyposalivation has shown an increase in the quality of saliva flow, as well as improved chewing and swallowing (26).

Stimulation using LLLT can prevent gagging and reduce the gag reflex in pediatric patients undergoing intraoral radiography of the maxilla. Therefore, dentists should consider managing the gag reflex based on the type of treatment, the severity of the gagging, and the patient's age (50). In addition, stimulation through PBM can significantly reduce the incidence of postoperative vomiting in children undergoing strabismus surgery (23, 50).

Study limitations

The methodological heterogeneity of the studies analyzed, both in terms of design and conduct of interventions, hindered a standardized analysis of the applicability and safety of PBM. This limitation compromises the generalization of results and hinders more robust conclusions regarding the technique's efficacy. In view of this, there is a need for efforts by the scientific community to develop study protocols that define specific parameters — such as wavelength, energy dose, application sites, and type of laser used — to ensure the reproducibility of studies and to obtain consistent and comparable results.

Conclusions

This scoping review mapped the available evidence on the use of PBM in neonatal and child healthcare. The studies found indicate that PBM has been used as a promising, safe, and easily applicable non-pharmacological method, with varying degrees of evidence and a range of protocols. This reinforces the need for training and adequate handling by healthcare professionals across the board, regardless of their field of expertise.

In addition, it contributes to the practice of healthcare professionals by providing resources on the use of PBM in neonatal and child health, highlighting its social and clinical relevance. However, due to the heterogeneity and limitations of the studies, it is not possible to conclusively state its clinical effectiveness.

Considered an easily applicable, painless, and non-invasive method, PBM tends to occupy an increasingly prominent place as a complementary therapy in the healthcare network for pain management, injury prevention, and tissue repair.

Given the relevance of this therapy, further primary studies are recommended, using distinct and rigorous methodologies, focused on the neonatal and pediatric population, especially in the field of nursing, to expand and consolidate knowledge on the use of PBM in varying clinical contexts, both in hospital and non-hospital settings.

Conflict of interest

There are no conflicts of interest.

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