REVISTA DA FACULDADE DE ODONTOLOGIA DE PORTO ALEGRE
V. 65 (jan./dez. 2024) – REVISÃO DE LITERATURA
DOI: 10.22456/2177-0018.138031

EFFECT OF LOW-LEVEL LASER THERAPY IN TOOTH BLEACHING SENSITIVITY: A SYSTEMATIC REVIEW

Efeito da laserterapia de baixa potência na sensibilidade ao clareamento dental: uma revisão sistemática

Suéllen Gomes Siqueira[a]
Luana Carla Salvi[b]
Rodrigo Varella de Carvalho[a]
Luiz Alexandre Chisini[c]

[a] Federal University of Juiz de Fora, Department of Dentistry, Governador Valadares, Minas Gerais, Brazil
[b]Federal University of Pelotas, Technological Development Center, Pelotas, Rio Grande do Sul, Brazil
[c]Federal University of Pelotas, Department of Restorative Dentistry, Rio Grande do Sul, Brazil
Autor correspondente: Luiz Alexandre Chisini E-mail: alexandrechisini@gmail.com
Data de envio: 16/01/2024 **Data de aceite:** 14/05/2024

ABSTRACT

Aim: Tooth sensitivity is the principal side effect as a clinical consequence resulting from tooth bleaching. Therefore, several strategies have been proposed to control this adverse effect. The present study aimed to investigate the effect of low-level laser therapy on tooth bleaching sensitivity compared to the placebo group or no intervention group. **Literature Review**: A search was carried out in six databases (BVS, PubMed, Scopus, Web of Science, Scielo, Cochrane library) until April 2024. Only studies with a randomized clinical trial or split-mouth design that performed in-office tooth bleaching and evaluated the effect of low-level laser therapy on post-bleaching sensitivity were included. The search was not limited by language or time. Due to the great heterogeneity observed between studies, the data were analyzed qualitatively. **Results:** Of the 586 records found, 478 remained after removing duplicates. Thus, 21 articles were accessed in full and only ten met the eligibility criteria and were included in the present review. Most of the studies (n=6; 60%) were with split-mouth designs. Considering the ten studies included in the present review, only two studies did not find a significant reduction in sensitivity after tooth bleaching in at least one of the periods evaluated. The application of low-level laser therapy before or after in-office tooth bleaching does not seem to influence the results. **Conclusion:** we observed that low-level laser therapy appears to have a positive effect in preventing sensitivity after tooth bleaching. This effect seems to only be significant in the first few days after tooth bleaching.

Keywords: Tooth bleaching. Low-level light therapy. Dentin sensitivity. Laser therapy.

RESUMO

Objetivo: A sensibilidade dentária é o principal efeito colateral como consequência clínica resultante do clareamento dental. Portanto, diversas estratégias têm sido propostas para controlar esse efeito adverso. O presente estudo teve como objetivo investigar o efeito da terapia com laser de baixa potência na sensibilidade ao clareamento dental em comparação ao grupo placebo ou ao grupo sem intervenção. **Revisão de Literatura**: Foi realizada busca em seis bases de dados (BVS, PubMed, Scopus, Web of Science, Scielo, biblioteca Cochrane) até abril de 2024. Somente foram incluídos estudos com desenho de ensaio clínico randomizado ou desenho boca dividida que realizaram clareamento dental em consultório e avaliaram o efeito da terapia com laser de baixa potência na sensibilidade pós-clareamento. A pesquisa não foi limitada por idioma ou tempo. Devido à grande heterogeneidade observada entre os estudos, os dados foram analisados qualitativamente. **Resultados:** Dos 586 registros encontrados, 478 permaneceram após a remoção das duplicatas. Assim, foram acessados na íntegra 21 artigos e apenas dez atenderam aos critérios de elegibilidade e foram incluídos na presente revisão. A maioria dos estudos (n=6; 60%) foi com desenhos de boca dividida. Considerando os dez estudos incluídos na presente revisão, apenas dois estudos não encontraram redução significativa da sensibilidade após o clareamento dental em pelo menos um dos períodos avaliados. A forma de aplicação de laserterapia de baixa potência (antes ou após o clareamento dental de consultório) não parece influenciar os resultados. **Conclusão:** observamos que a laserterapia de baixa potência parece ter efeito positivo na prevenção da sensibilidade após o clareamento dental. Este efeito parece ser significativo apenas nos primeiros dias após o clareamento dental.

Palavras-chave: Clareamento dental. Terapia com luz de baixa intensidade. Sensibilidade da dentina. Terapia a laser.

INTRODUCTION

Tooth discoloration, a prevalent concern, stems from a variety of causes including pathological conditions or the natural aging process of teeth[1,2]. Although it does not directly affect one's health, it significantly impacts an individual's quality of life, given the crucial role of dental aesthetics in facial attractiveness[3-6]. Tooth bleaching has emerged as a conservative and popular aesthetic solution[7,8]. The process of tooth bleaching involves the degradation of the extracellular matrix and the oxidation of chromophores [9], breaking the double bonds of organic chemical dyes that stain teeth[10]. This oxidation transforms stain molecules into colorless, lighter-colored compounds[9]. The time required to reach the saturation point of tooth bleaching depends on the exposure time and the concentration of the bleaching compound [10,11].

Nevertheless, similar to any dental procedure, tooth bleaching poses risks that necessitate caution. Tooth sensitivity (TS) is the principal side effect as a clinical consequence resulting from tooth bleaching[2,9] performed with high levels of hydrogen peroxide (H_2O_2)[12]. This sensitivity typically occurs during treatment and may last for several days, often accompanied by mild gingival irritation[9]. The agents used for tooth bleaching have the potential to release substances that lead to alterations in cell metabolism leading to an inflammation of the dental pulp cells[13]. These cells can also release inflammatory mediators that can sensitize nociceptors and develop tooth sensitivity[9]. In this way, it is important to consider that the severity of tooth bleaching side effects is directly related to peroxide concentration, treatment duration, and product composition[9].

As a result, several strategies have been proposed to control this adverse effect. Among these approaches is low-level laser therapy, which can be used alone or in combination with other desensitizing agents[14-17]. In contact with the tissue, low-level laser therapy can stimulate the synthesis, release, and metabolism of endorphins and bradykinin[18,19]. It can alter cell membrane permeability and affect the pain threshold, potentially reducing tissue damage and inflammation by stimulating cellular function[18,19]. Therefore, low-level laser therapy has presented potential analgesic, anti-inflammatory, and biostimulant effects, which could minimize the damage and inflammation caused in pulp tissue by bleaching agents[12]. The potential reduction in tooth sensitivity through low-level laser therapy could significantly enhance patient comfort during treatment. Achieving success in this regard would not only represent a

valuable advancement in improving comfort during tooth-bleaching procedures but also has the potential to boost patient satisfaction and promote wider adoption of the treatment. Therefore, our objective was to investigate the effect of low-level laser therapy alone or in combination with other desensitizing agents on tooth bleaching sensitivity compared to the placebo group or no intervention group.

LITERATURE REVIEW

The present review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline[20].

Research Question

The research question for this review, 'Is low-level laser therapy effective on tooth bleaching sensitivity?' was structured based on the P.I.C.O model, where:

Population: Individuals (>18 years old) who underwent in-office bleaching

Intervention: low-level laser therapy

Comparison: Placebo or no intervention group

Outcome: Post-bleaching sensitivity (immediate, 24 hours, 48 hours, and 7 days) measured using the Visual Analog Scale, Modified Visual Analog Scale, or Verbal Rating Scale (VRS).

Search Strategy

The search strategy was conducted using relevant keywords and MeSH terms. The syntax was organized while respecting and considering the structure of each database. The complete search strategy is detailed in (**Table 1**). Six databases (BVS, PubMed, Scopus, Web of Science, Scielo, Cochrane Library) were searched up to April 2024. Gray literature was investigated on Google Scholar using the combination of the words: “low-level laser therapy” AND “tooth bleaching” AND “tooth sensitivity”. The 100 first documents were analyzed. All records found were added to the EndNoteTM software (Thomson Reuters, Rochester, New York, NY, USA). This way, a virtual library was constructed, and duplicate records were electronically excluded using the software. Two authors (SGS and LAC) initially read all titles and abstracts of the documents, adhering to predefined inclusion and exclusion criteria. Studies that

did not fit within the inclusion criteria were excluded at this stage. Subsequently, the same authors independently conducted a thorough reading of the articles. In case of discrepancies during this process, the authors discussed until a consensus was reached.

Inclusion and Exclusion Criteria

Only studies with a randomized clinical trial or split-mouth design that performed in-office bleaching on sound teeth/patients, evaluated post-bleaching sensitivity and utilized low-level laser therapy were included. Observational studies, non-randomized clinical trials, in vitro studies, editorials, reviews, and case reports were excluded. The study did not impose restrictions on period or language.

Data Collection

Data extraction was independently conducted by two reviewers (SGS and LAC) using a predefined and tested electronic spreadsheet. The following data were extracted: author; year; country; study design; study objective; type of laser; type of bleaching gel; laser configuration (mode, power, time); timing of laser application; outcome scale; other desensitizing agents used; scale measurement; total number of individuals who completed the studies per group; immediate sensitivity, 24 hours, 7 days after treatment; statistical difference between groups.

Data Analysis

Due to the substantial heterogeneity among the included studies, a meta-analysis could not be performed. Thus, the data from this study were analyzed descriptively.

RESULTS

The search yielded 586 records. After removing duplicates, 478 records remained. During the title and abstract screening, 357 records were excluded, leaving 21 for full-text reading. Out of these, 11 articles[15,21-30] were subsequently excluded based on the pre-defined eligibility criteria due to the following reasons: Comment of study[21]; Review[15,25]; Register of Clinical Trial[22,26-29]; Letter to Editor[23]; No placebo[24,30]. Therefore, 10 studies (**Figure 1**) were included in the systematic review[14,16,18,31-37].

Study characteristics

Table 2 presents the main characteristics of the included studies. It can be observed that the design of the majority of the studies was a split-mouth randomized clinical trial (n=6; 60%)[16,18,31-33,35], while the minority were solely randomized clinical trials (n=4; 30%)[14,34,36,37]. The studies were predominantly conducted in Brazil (n=8; 80.0%)[14,16,18,31-33,35,36]. Almost all studies used 35% hydrogen peroxide (n=7; 70%)[14,16,18,31,32,35,36]. One study[33] used 25% hydrogen peroxide and 35% hydrogen peroxide, another[37] used 38% hydrogen peroxide, and another[34] used 40% hydrogen peroxide. The majority of the studies applied the laser after the bleaching procedure (n=5; 50%)[18, 33-36], followed by the application before the treatment (n=3; 30%)[31,32,37], at both times (n=1; 10.0%)[14], and during the bleaching (n=1; 10.0%)[16]. The majority of the studies utilized other desensitizing agents (n=6; 60%)[16,18,31,33-35], and only four did not use any complementary desensitizing agents (n=4; 40%)[14,32,36,37]. In total, 409 individuals were evaluated.

Effect of low-level laser therapy on sensitivity

Table 3 presents weekly results of dental sensitivity after in-office bleaching according to different groups. Considering the ten studies included in this review, only two studies[14,36] did not find a significant reduction in sensitivity after tooth bleaching.

Low-level laser therapy performed before tooth bleaching

Four studies evaluated the effect of laser low-level laser therapy after in-office tooth bleaching and compared to a placebo group[18,34,35]. In all studies, a significant decrease in dental sensitivity was observed in the groups that used low-level laser therapy in at least one of the evaluation periods compared to the placebo group[18,34,35,37]. No statistical difference was observed in one study at baseline, although the infrared laser group showed less sensitivity after 24 hours, and the red and infrared laser groups had a lower level of pain after 48 hours[34]. On the other hand, Alencar, De Paula[31], and Pompeu, de Paula[35] observed a gradual reduction in sensitivity from the first day after treatment, with the laser group showing the highest sensitivity.

Low-level laser therapy performed after tooth bleaching

Four studies evaluated the effect of laser application before tooth bleaching and compared to a placebo group[31-33]. A significant decrease in dental sensitivity was observed in the three studies[31-33] compared to the placebo group. Sensitivity was highest on the days of bleaching gel application and gradually decreased in the subsequent days[31-33].

Low-level laser therapy performed during tooth bleaching

The effectiveness of a hybrid light source (LED/laser) in controlling sensitivity caused by in-office bleaching when applied during the bleaching treatment was analyzed in one study[16]. There was no statistical difference between the groups at baseline, however, after 48 hours, a reduction in sensitivity was observed[16].

Low-level laser therapy performed at multiple time points

A single study analyzed the effect of low-level laser therapy in preventing sensitivity after in-office tooth bleaching by applying the laser at three moments: before, after, and at both moments. Within the studied parameters, there was no statistical difference between the groups and placebo[14].

DISCUSSION

In this systematic review, it was observed that most studies demonstrated a positive effect of low-level laser therapy in reducing sensitivity after tooth bleaching. This reduction was noted at various time points, varying among the included studies. We could observe that after the fourth day of post-in-office bleaching, study participants tended to report no sensitivity, even in the placebo group. This indicates that the effects of the laser are most prominent in the initial days following the treatment and that the effect of tooth sensitivity is self-limiting. Moreover, significant methodological heterogeneity was observed, hindering extensive comparisons and inferences.

The use of laser did not influence the whitening ability of tooth-bleaching agents[16,34]. Besides low-level laser therapy shown to effectively reduce post-bleaching sensitivity, they do not have a significant impact on bleaching efficacy. One potential explanation could be that while laser therapy presents a neural effect on dental pulp, it may not directly interact with the chemical processes involved in tooth whitening.

Tooth sensitivity is a common unwanted consequence of vital tooth bleaching[1]. Compared to at-home tray-based treatments, tooth sensitivity can be more frequently and intensely observed during and after in-office bleaching[38]. This can be attributed to the higher concentrations of peroxide used in the in-office technique[38]. Dental enamel, being a permeable tissue, allows hydrogen peroxide to penetrate its structure and break down pigment macromolecules[9]. However, this material can also diffuse through dentin and pulp, coming into contact with nerve endings, activating nociceptors, triggering an inflammatory reaction, and consequently, dentin hypersensitivity[9].

Various alternatives for managing sensitivity caused by bleaching agents have been proposed, and low-level laser therapy has shown promising results[34]. The first application of lasers in Dentistry emerged in the 1960s, becoming more common only 20 years later[39]. Lasers used in the field can be divided into two major groups: high-power lasers, or surgical lasers, and low-power lasers, or therapeutic lasers[39]. Low-power lasers generate rapid analgesia and anti-inflammatory effects through a photochemical process[12,18,19]. Molecularly, they can increase the potential of nerve cells, limiting the transmission of pain stimuli[12,18,19]. Furthermore, they can obliterate dentinal tubules by stimulating odontoblast activity, accelerating tertiary dentin production[39]. High-power lasers, on the other hand, employ photothermal effects, heating and melting the dentin surface, obliterating dentinal tubules[39]. They also significantly reduce the hydraulic conductance of dentin and lower the pain threshold[39]. However, they are more commonly used in cases of non-carious cervical lesions[39,40].

The present findings show an overall significant effect of the laser in most studies within the initial days. After the 4th day, there were no reports of pain resulting from the bleaching treatment. Additionally, it is important to mention that different laser configurations limit the possibility of interference. The majority of studies focused on infrared laser, but some utilized a combination of red laser or a hybrid light source. Moreover, other factors potentially interfering with the results of this review include the combination of low-level laser therapy with other desensitizing agents in most studies[16, 18,31,33,35] and the absence of comparison with a clear placebo group in study[16]. Fluoridated toothpaste (5000ppm) and a desensitizing gel composed of 2% sodium fluoride and 5% potassium nitrate were two types of desensitizers applied in all groups of two studies[31,33]. In this way, Alencar, De Paula[31] noted that laser combined with fluoride was more effective than using fluoride alone. However, no synergic effect was

observed when the laser was combined with 5% potassium nitrate to reduce the sensitivity after the bleaching[31]. Thus seems that the effect of laser combined with 5% potassium nitrate on post-bleaching tooth sensitivity is similar to their individual use alone. Similarly, teeth that underwent laser therapy along with the topical application of sodium fluoride (5000 ppm fluoride) during each bleaching session exhibited lower sensitivity in comparison to teeth treated solely with sodium fluoride[31].

Although the majority of studies investigated infrared laser, red laser was also studied in one of the trials[34]. However, it proved to be less efficient than an infrared laser in controlling sensitivity during the first 24 hours[34]. An explanation for this is that it acts on nociceptors in the more superficial layers of the tissue, not penetrating like infrared[39]. However, after this period, infrared and red laser were comparable to each other and both had a higher result in VAS sensitivity than placebo. Furthermore, a study used a 5% potassium nitrate gel for comparison with low-level laser therapy[18]. The results showed that both interventions were similar in reducing dental sensitivity, and no synergistic effect was observed between them[18].

This study has significant limitations that need to be discussed. The combination of laser with other desensitizers without evaluating the groups separately should be considered in interpreting the results. Therefore, an overestimation of results may have occurred, as there is a possibility of a synergistic effect between the different treatments. Outcome assessment was not standardized across the studies. While most studies assessed sensitivity using the Visual Analog Scale, others used a modified scale or the Verbal Category Scale. Different light sources were used by the included studies, which could introduce a significant bias in our interpretations. The use of different concentrations of bleaching gel could also be a limiting factor for this review. Although there are already two systematic reviews on the present topic, one of them focused on assessing the effects of low-level laser therapy on dentin hypersensitivity[40], while the other [15] investigated the effect of low-level laser therapy after in-office and at-home bleaching and also used other desensitization treatments as a comparison to group

Despite the mentioned limitations, this study has several strengths. Only randomized clinical trials were included during the search, resulting in greater result accuracy. Furthermore, publication date and language of the studies were not limited. Additionally, results from a large number of participants were included in this review.

We suggest that future studies employ the Visual Analog Scale to measure the outcome and use standard concentrations of hydrogen peroxide (35%). Moreover, it is important for studies to include low-power infrared laser as the standard/control light source and avoid combinations with other desensitizers, especially if these are used in all study groups, and have a placebo group as a comparison.

CONCLUSION

It was observed that laser low-level laser therapy appears to have a positive effect on sensitivity after tooth bleaching. This effect seems to only occur in the first few days after applying the gel. More randomized clinical trials with good and standardized designs should be conducted to confirm these observations.

FUNDING

The work was supported by the CNPq - Brazil.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. de Geus JL, Wambier LM, Kossatz S, Loguercio AD, Reis A. At-home vs In-office Bleaching: A Systematic Review and Meta-analysis. Oper Dent. 2016;41(4):341-56.

2. Donassollo SH, Donassollo TA, Coser S, Wilde S, Uehara JLS, Chisini LA, et al. Triple-blinded randomized clinical trial comparing efficacy and tooth sensitivity of in-office and at-home bleaching techniques. J Appl Oral Sci. 2021;29:e20200794.

3. Bersezio C, Martin J, Mayer C, Rivera O, Estay J, Vernal R, et al. Quality of life and stability of tooth color change at three months after dental bleaching. Qual Life Res. 2018;27(12):3199-207.

4. Dong JK, Jin TH, Cho HW, Oh SC. The esthetics of the smile: a review of some recent studies. Int J Prosthodont. 1999;12(1):9-19.

5. Chisini LA, Cademartori MG, Collares K, Pires ALC, Azevedo MS, Correa MB, et al. Desire of university students for esthetic treatment and tooth bleaching: a cross-sectional study. Brazilian Journal of Oral Sciences. 2019;18:e191648.

6. Chisini LA, Boeira GF, Correa MB, Salas MMS, Maciel FV, Passos D, et al. Effect of weight satisfaction on adolescent facial and dental satisfaction. Eur Arch Paediatr Dent. 2024.

7. Silva FBD, Chisini LA, Demarco FF, Horta BL, Correa MB. Desire for tooth bleaching and treatment performed in Brazilian adults: findings from a birth cohort. Braz Oral Res. 2018;32:e12.

8. Cólon VEV, Márquez MOC, Carrillo-Cotto RA, Demarco FF, Chisini LA. Dentist's preferences on vital and nonvital tooth bleaching: findings from a Guatemalan survey. Brazilian Journal of Oral Sciences. 2021;20:e211711.

9. Kwon SR, Wertz PW. Review of the Mechanism of Tooth Whitening. J Esthet Restor Dent. 2015;27(5):240-57.

10. Carey CM. Tooth whitening: what we now know. J Evid Based Dent Pract. 2014;14 Suppl:70-6.

11. Chisini LA, Conde MCM, Meireles SS, Dantas RVF, Sarmento HR, Della Bona A, et al. Effect of temperature and storage time on dental bleaching effectiveness. J Esthet Restor Dent. 2019;31(1):93-7.

12. Reddy GK. Photobiological basis and clinical role of low-intensity lasers in biology and medicine. J Clin Laser Med Surg. 2004;22(2):141-50.

13. Dantas CM, Vivan CL, Ferreira LS, Freitas PM, Marques MM. In vitro effect of low intensity laser on the cytotoxicity produced by substances released by bleaching gel. Braz Oral Res. 2010;24(4):460-6.

14. Calheiros APC, Moreira MS, Goncalves F, Aranha ACC, Cunha SR, Steiner-Oliveira C, et al. Photobiomodulation in the Prevention of Tooth Sensitivity Caused by In-Office Dental Bleaching. A Randomized Placebo Preliminary Study. Photomed Laser Surg. 2017;35(8):415-20.

15. Carneiro AMP, Barros APO, de Oliveira RP, de Paula BLF, Silva AM, de Melo Alencar C, et al. The effect of photobiomodulation using low-level

laser therapy on tooth sensitivity after dental bleaching: a systematic review. Lasers Med Sci. 2022;37(7):2791-804.

16. de Almeida Farhat PB, Santos FA, Gomes JC, Gomes OM. Evaluation of the efficacy of LED-laser treatment and control of tooth sensitivity during in-office bleaching procedures. Photomed Laser Surg. 2014;32(7):422-6.

17. de Barros Silva PG, Filho ELC, Nigri FMN, Dantas TS, de Miranda Candeiro GT, Neri JR. Photobiomodulation Reduces Pain-Related Symptoms Without Interfering in the Efficacy of In-Office Tooth Bleaching: A Systematic Review and Meta-Analysis of Placebo-Controlled Clinical Trials. Photobiomodul Photomed Laser Surg. 2022;40(3):163-77.

18. de Paula B, Alencar C, Ortiz M, Couto R, Araujo J, Silva C. Effect of photobiomodulation with low-level laser therapy combined with potassium nitrate on controlling post-bleaching tooth sensitivity: clinical, randomized, controlled, double-blind, and split-mouth study. Clin Oral Investig. 2019;23(6):2723-32.

19. Tabibzadeh Z, Fekrazad R, Esmaeelnejad A, Shadkar MM, Khalili Sadrabad Z, Ghojazadeh M. Effect of combined application of high- and low-intensity lasers on dentin hypersensitivity: A randomized clinical trial. J Dent Res Dent Clin Dent Prospects. 2018;12(1):49-55.

20. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. PLoS Med. 2021;18(3):e1003583.

21. Brignardello-Petersen R. Low-level laser therapy may not provide any benefit in preventing and minimizing tooth sensitivity after dental bleaching. J Am Dent Assoc. 2017;148(12):e192.

22. Alencar GS. Online Effectiveness of Photobiomodulation in Sensitivity to tooth Whitening in adults: randomized clinical trial [Internet]. Registro Brasileiro de Ensaios Clínicos [updated 2020 Out 09; cited 2024 Jun 17]. Available from: https://ensaiosclinicos.gov.br/rg/RBR-3cbjq9.

23. Cho SB, Song BC, Lee SJ, Oh SH. Dental whitening using 532/ 1064-nm Q-switched Nd:YAG lasers. J Eur Acad Dermatol Venereol. 2009;23(9):1105-6.

24. Gurgan S, Cakir FY, Yazici E. Different light-activated in-office bleaching systems: a clinical evaluation. Lasers Med Sci. 2010;25(6):817-22.

25. Mohammadi Z, Palazzi F, Giardino L. Laser application in tooth bleaching: an update review. Minerva Stomatol. 2011;60(4):167-78.

26. Silva MC. Online Evaluation of the Effect of Fluoride and Laser Application on the Prevention of Sensitivity in Bleached Teeth [internet]. Clinical Trials [updated 2017 Mar 17; cited 2024 Jun 17]. Available from: https://clinicaltrials.gov/show/NCT03044171.

27. Silva MC. Online Effect of Low-level Laser Therapy on Post-bleaching Sensitivity and Color Change [internet]. Clinical Trials [updated 2018 May 02; cited 2024 Jun 17]. Available from: https://clinicaltrials.gov/show/NCT03514290.

28. Silva MC. Effect of Laser and Potassium Nitrate Application on the Sensitivity Control in Bleached Teeth [internet]. Clinical Trials [updated 2018 Feb 15; cited 2024 Jun 17]. Available from: https://clinicaltrials.gov/show/NCT03434782.

29. Silva MC. Effect of Low Power Laser and Glutaraldehyde-based Desensitizer in the Control of Tooth Sensitivity, Tooth Color and Its Impact on Post-whitening Quality of Life [internet]. Clinical Trials [updated 2023 Feb 28; cited 2024 Jun 17]. Available from: https://clinicaltrials.gov/show/NCT05309967.

30. Yahya G, AlAlwi A, Shurayji F, Baroom W, Rajeh M, AbdelAleem N. Effectiveness of sodium fluoride varnish and/or diode laser in decreasing post-bleaching hypersensitivity: A comparative study. Saudi Dent J. 2022;34(1):62-7.

31. Alencar CM, De Paula BLF, Araujo JLN, Alves EB, De Albuquerque Jasse FF, Silva CM. Effect of low-level laser therapy combined with 5000 parts per million fluoride dentifrice on postbleaching sensitivity: A clinical, randomized, and double-blind study. J Esthet Restor Dent. 2018;30(4):352-9.

32. Silva CC, Alencar CM, de Paula BLF, Jassé FDA, Araújo JLN, Silva CM. Photobiomodulation vs. Placebo on Post-Bleaching Sensitivity and Color Change: A Split-Mouth Clinical Study. The open Dentistry Journal. 2020;14(1):267-74.

33. Mondelli R, Rizzante F, Rosa ER, Borges A, Furuse AY, Bombonatti J. Effectiveness of LED/Laser Irradiation on In-Office Dental Bleaching after Three Years. Oper Dent. 2018;43(1):31-7.

34. Moosavi H, Arjmand N, Ahrari F, Zakeri M, Maleknejad F. Effect of low-level laser therapy on tooth sensitivity induced by in-office bleaching. Lasers Med Sci. 2016;31(4):713-9.

35. Pompeu DDS, de Paula BLF, Barros APO, Nunes SC, Carneiro AMP, Araujo JLN, et al. Combination of strontium chloride and photobiomodulation in the control of tooth sensitivity post-bleaching: A split-mouth randomized clinical trial. PLoS One. 2021;16(4):e0250501.

36. Vochikovski L, Favoreto MW, Rezende M, Terra RMO, Gumy FN, Loguercio AD, et al. Use of infrared photobiomodulation with low-level laser therapy for reduction of bleaching-induced tooth sensitivity after in-office bleaching: a double-blind, randomized controlled trial. Lasers Med Sci. 2022;38(1):18.

37. Femiano F, Femiano R, Scotti N, Nucci L, Lo Giudice A, Grassia V. The Use of Diode Low-Power Laser Therapy before In-Office Bleaching to Prevent Bleaching-Induced Tooth Sensitivity: A Clinical Double-Blind Randomized Study. Dent J (Basel). 2023;11(7).

38. Dahl JE, Pallesen U. Tooth bleaching--a critical review of the biological aspects. Crit Rev Oral Biol Med. 2003;14(4):292-304.

39. Rathod A, Jaiswal P, Bajaj P, Kale B, Masurkar D. Implementation of Low-Level Laser Therapy in Dentistry: A Review. Cureus. 2022;14(9):e28799.

40. Rezazadeh F, Dehghanian P, Jafarpour D. Laser Effects on the Prevention and Treatment of Dentinal Hypersensitivity: A Systematic Review. J Lasers Med Sci. 2019;10(1):1-11.

Table 1 - Search strategy used in each database

Database	Key words
BVS	(“tooth sensitivity” OR "dentin sensitivity" OR "dentine hypersensitivity" OR "dentin sensitivit*" OR ("sensitivit*" AND "Tooth") OR ("hypersensitivit*" AND "Dentin") OR ("hypersensitivit*" AND "Dentine") OR "tooth bleaching" OR "bleaching tooth" OR "teeth whitening" OR "whitening teeth" OR "tooth whitening" OR "whitening tooth" OR "teeth bleaching" OR "bleaching teeth") AND ("low level light therapy" OR (("Light" OR "Light" OR "lighted" OR "lights" OR "lighting" OR "lighting" OR "lightings" OR "lightness" OR "lightnesses") AND "therapies low level") OR "light therapy low level" OR "low level light therapy" OR "low level light therapies" OR (("therapeutics" OR "therapeutics" OR "Therapies" OR "Therapy" OR "Therapy" OR "therapys") AND "low level light") OR "therapy low level light" OR "photobiomodulation therapy" OR "photobiomodulation therapies" OR "therapies photobiomodulation" OR "therapy photobiomodulation" OR "LLLT")
Pubmed	(“tooth sensitivity” [MeSH Terms] OR "dentin sensitivity"[MeSH Terms] OR "dentin hypersensitivit*"[Title/Abstract] OR "dentine hypersensitivit*"[Title/Abstract] OR "dentin sensitivit*"[Title/Abstract] OR ("sensitivit*"[All Fields] AND "Tooth"[Title/Abstract]) OR ("hypersensitivit*"[All Fields] AND "Dentin"[Title/Abstract]) OR ("hypersensitivit*"[All Fields] AND "Dentine"[Title/Abstract]) OR "tooth bleaching"[MeSH Terms] OR "bleaching tooth"[Title/Abstract] OR "teeth whitening"[Title/Abstract] OR "whitening teeth"[Title/Abstract] OR "tooth whitening"[Title/ Abstract] OR "whitening tooth"[Title/Abstract] OR "teeth bleaching"[Title/Abstract] OR "bleaching teeth"[Title/Abstract]) AND ("low level light therapy"[MeSH Terms] OR (("Light"[MeSH Terms] OR "Light"[All Fields] OR "lighted"[All Fields] OR "lights"[All Fields] OR "lighting"[MeSH Terms] OR "lighting"[All Fields] OR "lightings"[All Fields] OR "lightness"[All Fields] OR "lightnesses"[All Fields]) AND "therapies low level"[Title/Abstract]) OR "light therapy low level"[Title/Abstract] OR "low level light therapy"[Title/Abstract] OR "low level light therapies"[Title/Abstract] OR (("therapeutics"[MeSH Terms] OR "therapeutics"[All Fields] OR "Therapies"[All Fields] OR "Therapy"[MeSH Subheading] OR "Therapy"[All Fields] OR "therapy s"[All Fields] OR "therapys"[All Fields]) AND "low level light"[Title/Abstract]) OR "therapy low level light"[Title/Abstract] OR "photobiomodulation therapy"[Title/Abstract] OR "photobiomodulation therapies"[Title/Abstract] OR "therapies photobiomodulation"[Title/Abstract] OR "therapy photobiomodulation"[Title/Abstract] OR "LLLT"[Title/Abstract])

Scopus	(TITLE-ABS-KEY ((tooth sensitivity) OR (dentin sensitivity) OR (dentine hypersensitivity) OR (dentin sensitivit*) OR ((sensitivit*) AND (Tooth)) OR ((hypersensitivit*) AND (Dentin)) OR ((hypersensitivit*) AND (Dentine)) OR (tooth bleaching) OR (bleaching tooth) OR (teeth whitening) OR (whitening teeth) OR (tooth whitening) OR (whitening tooth) OR (teeth bleaching) OR (bleaching teeth)) AND ((low level light therapy) OR (((Light) OR (Light) OR (lighted) OR (lights) OR (lighting) OR (lighting) OR (lightings) OR (lightness) OR (lightnesses)) AND (therapies low level)) OR (light therapy low level) OR (low level light therapy) OR (low level light therapies) OR (((therapeutics) OR (therapeutics) OR (Therapies) OR (Therapy) OR (Therapy) OR (therapys)) AND (low level light)) OR (therapy low level light) OR (photobiomodulation therapy) OR (photobiomodulation therapies) OR (therapies photobiomodulation) OR (therapy photobiomodulation) OR (LLLT)))
Web of Science	Tópico: ((tooth sensitivity) OR (dentin sensitivity) OR (dentine hypersensitivity) OR (dentin sensitivit*) OR ((sensitivit*) AND (Tooth)) OR ((hypersensitivit*) AND (Dentin)) OR ((hypersensitivit*) AND (Dentine)) OR (tooth bleaching) OR (bleaching tooth) OR (teeth whitening) OR (whitening teeth) OR (tooth whitening) OR (whitening tooth) OR (teeth bleaching) OR (bleaching teeth)) AND ((low level light therapy) OR (((Light) OR (Light) OR (lighted) OR (lights) OR (lighting) OR (lighting) OR (lightings) OR (lightness) OR (lightnesses)) AND (therapies low level)) OR (light therapy low level) OR (low level light therapy) OR (low level light therapies) OR (((therapeutics) OR (therapeutics) OR (Therapies) OR (Therapy) OR (Therapy) OR (therapys)) AND (low level light)) OR (therapy low level light) OR (photobiomodulation therapy) OR (photobiomodulation therapies) OR (therapies photobiomodulation) OR (therapy photobiomodulation) OR (LLLT))

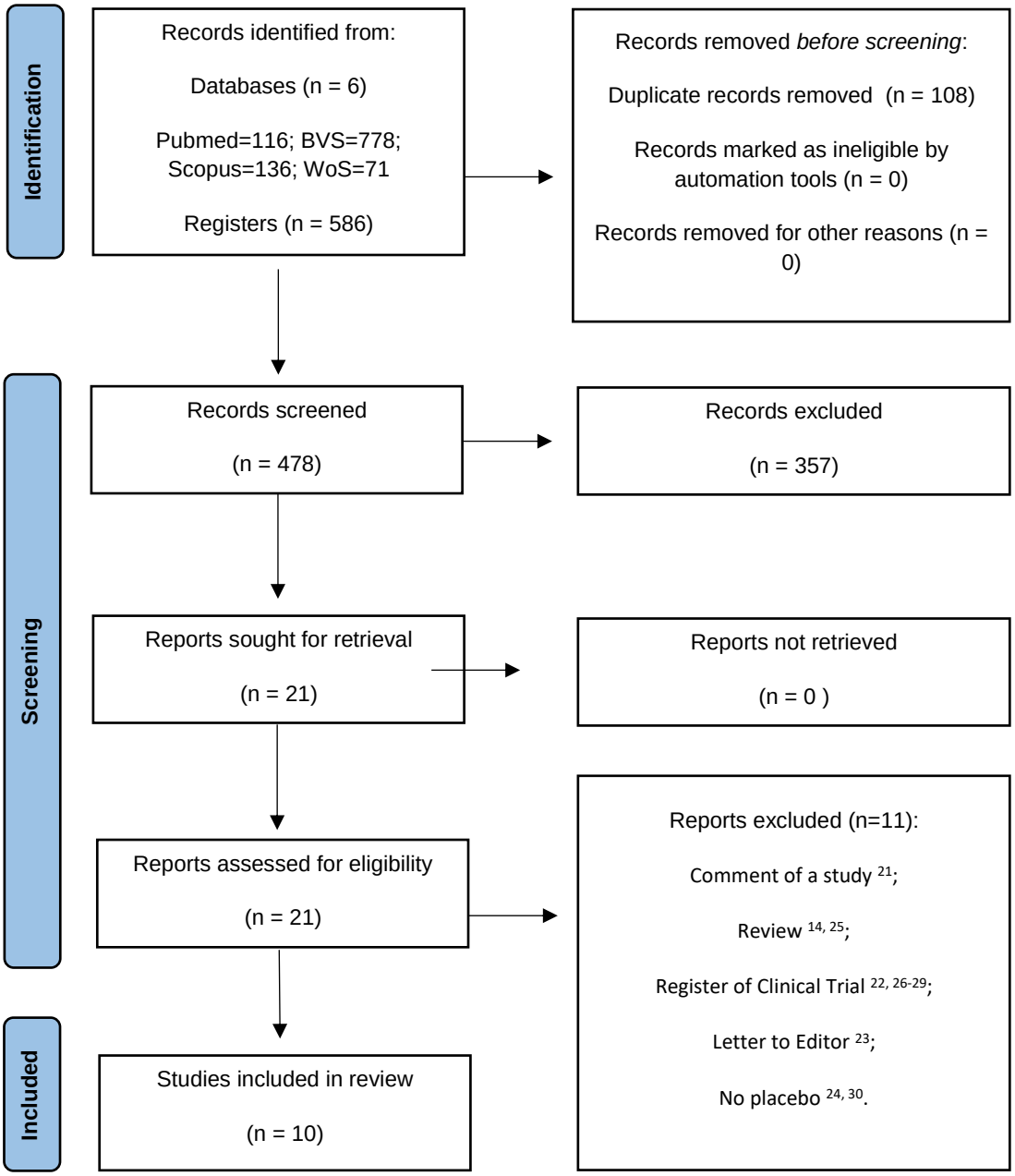

Figure 1 - Prisma Flow Diagram

Table 2 - Characteristics of the included studies

Author/ Ano	Country	Study Design	Laser Type	Bleaching Gel	Laser Configuration and gropus	Laser Application	Outcome Scale	Other Desensitizers	Outcome Scale	n	Significant Effect of laser low-level laser therapy
Alencar (2018)	Brazil	RCT/SM	Gallium Aluminum Arsenide Diode Laser (Infrared: 808 nm)	HP 35%	Continuous mode - 60J/cm² applied for 16 seconds at each point, with an irradiance of 3.75 W/cm²; Placebo + sodium fluoride/ Laser + sodium fluoride	Before	Modified VAS	5,000 ppm Sodium Fluoride	0 - 3	25	Yes
Calheiros (2017)	Brazil	RCT	Gallium Aluminum Arsenide Diode Laser (Infrared: 810nm)	HP 35%	780 nm, 40 mW, 10 J/cm², 0.4 J for 10s per point (2 points); Placebo/ Laser after bleaching/ Laser before and after bleaching	Before/ After/ Both	Modified VAS	-	0 - 3	50	No
Farhat (2014)	Brazil	RCT/SM	Hybrid Source (Whitening Lase II)	HP 35%	6 outputs of blue LEDs (425-480 nm) with 300 mW each and 3 infrared lasers (810 nm) with 200 mW power each; 300 mW/cm² per tooth (activated three times; 1 minute activation, interspersed by 2 min with gel at rest); Placebo + Led / Led + Laser	During	VRS	LED	0 - 4	16	Yes

Author/ Ano	Country	Study Design	Laser Type	Bleaching Gel	Laser Configuration and gropus	Laser Application	Outcome Scale	Other Desensitizers	Outcome Scale	n	Significant Effect of laser low-level laser therapy
Femiano (2023)	Italy	RCT	Diode laser	HP 38%	810 nm diode laser with 0.5 W for 30 s for an energy density of 15 J/cm2; Placebo / Laser	Before	VAS	-	0 - 10	30	Yes
Mondelli (2018)	Brazil	RCT/SM	Hybrid Source (Whitening Lase II)	HP 25% and 35%	6 blue LEDs (470 nm and 350 mW/cm2 each) and 3 therapeutic infrared diode lasers (810 nm and 200 mW/cm2) 25 J for 30 seconds; Laser + sodium fluoride + Potassium nitrate / No laser + sodium fluoride + Potassium nitrate	After	VAS	2% Sodium Fluoride and 5% Potassium Nitrate	0 - 10	20	Yes
Moosavi (2016)	Iran	RCT	Indium-Gallium-Aluminum-Phosphorus Diode Laser (Red: 660nm) and Gallium Aluminum Arsenide Diode Laser	HP 40%	Continuous mode; 200mW; IV: 3J energy with energy density of 12 J/cm² and power density of 800 mW/cm²; 15s; Laser (red)/ Laser (infrared)/ Placebo	After	VAS	-	0 - 100	66	Yes

Author/ Ano	Country	Study Design	Laser Type	Bleaching Gel	Laser Configuration and gropus	Laser Application	Outcome Scale	Other Desensitizers	Outcome Scale	n	Significant Effect of laser low-level laser therapy
			(Infrared: 810nm)								
Paula (2019)	Brazil	RCT/SM	Gallium Aluminum Arsenide Diode Laser (Infrared: 808 nm)	HP 35%	Continuous mode; an energy of 1.7 J at a dose of 60 J/cm² was applied at each point for 16 s, with a point size of 0.028 cm²; Placebo + Potassium Nitrate/ Laser + Potassium Nitrate	After	Modified VAS	Potassium Nitrate	0 - 3	48	Yes
Pompeu (2021)	Brazil	RCT/SM	Gallium Aluminum Arsenide Diode Laser (Infrared: 808 nm)	HP 35%	Continuous mode, using 1.7 J of energy; a dose of 60 J/cm² at each point for 16s (light with 100mW power), with a point area of 0.028 cm²; Placebo + 10% Strontium Chloride/ Laser + 10% Strontium Chloride	After	Modified VAS	10% Strontium Chloride	0 - 3	50	Yes
Silva (2020)	Brazil	RCT/SM	Laser (Photon Laser III, DMC) Infrared (808nm)	HP 35%	Continuous mode; 1.7 J energy at a dose of 60 J/cm2 was applied at each point for 16 s, with a point size of 0.028 cm2; Placebo / Laser	Before	Modified VAS	-	0 - 3	21	Yes

Author/ Ano	Country	Study Design	Laser Type	Bleaching Gel	Laser Configuration and gropus	Laser Application	Outcome Scale	Other Desensitizers	Outcome Scale	n	Significant Effect of laser low-level laser therapy
Vochikovski (2022)	Brazil	RCT	Gallium Aluminum Arsenide Diode Laser (Infrared: 808 nm)	HP 35%	100 J/cm2 was applied for 30 s with 808 nm (100 mW of power) in the middle third of the crown; Placebo / Laser	After	VAS	-	0-10	83	No

Table 3 - Weekly results of tooth sensitivity after the use of in-office whitening according to the different groups

Author	Year	Placebo (for each assessment week)			Laser applied before bleaching (for each assessment week)			Laser applied after bleaching (for each assessment week)		
Evaluations		**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)
Alencar	2018	25	-	T1= 1(0.2) T2= 1(0.2) T3= 1.5(1) T4= 2(1)	T1=10(0) T2=0(0) T3=0(0) T4=0(0)	*25	-	T1=1(1) T2=1(1) T3=1(1) T4=1(1)	T1=0(0) T2=0(0) T3=0(0) T4=0(0)				
Calheiros	2017	10	T1=0.5(0.53) T2=0.7(0.67)	T1=0.2(0.42) T2=0.4(0.51)	T1=0(0) T2=0(0)	10	T1=0.6(0.51) T2=0,5(0.53)	T1=0.6(0.69) T2=0.8(1.03)	T1=0(0) T2=0(0)	10	T1=1(0.94) T2=0.9(0.32)	T1=0.5(0.72) T2=0.6(1.03)	T1=0(0) T2=0(0)
Femiano	2023	15	T1=4.8 (3.2)	T1=3.8 (2.5)		15	T1=2.9(1.9)	T1=2.4(1.4)					
Moosavi	2016	22	T1=21.11(18.19)	T1=51.94(20.80)	-					22	T1=26.11(19.59)	T1=24.58(15.72)	-
Paula	2019	24	-	T1=2(1)	T1=0(0)					*24	-	T1=1(1)	T1=0(0)

Author	Year	Placebo (for each assessment week)				Laser applied before bleaching (for each assessment week)				Laser applied after bleaching (for each assessment week)			
Evaluations		**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)
Pompeu	2021	25	-	T2=3(1) T3=3(0) T1=3(1) T2=3(1) T3=3(1)	T2=0(0) T3=0(0) T1=0(0) T2=0(0) T3=0(0)	25	-	T1=2(1) T2=2(1) T3=2(2)	T1=0(0) T2=0(0) T3=0(0)			T2=1(2) T3=1(2)	T2=0(0) T3=0(0)
Silva	2020	21	-	T1=2(1) T2=2(1) T3=3(1)	T1=0(0) T2=0(0) T3=0(0)	*21	-	T1=0(1) T2=1(1) T3=1(1)	T1=0(0) T2=0(0) T3=0(0)				
Vochikovski	2023	40	T1=3.2(3.0) T2=2.7(3.1)			43		T1=2.8(2.8) T2=2.7(2.6)					

		n	**Laser applied during bleaching** (for each assessment week)		
		n	**Immediate**	**24hs**	**7 days**

Author	Year	Placebo (for each assessment week)				Laser applied before bleaching (for each assessment week)				Laser applied after bleaching (for each assessment week)			
Evaluations		**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)	**n**	**Immediate** Mean (SD)	**24hs** Mean (SD)	**7 days** Mean (SD)
			Mean (SD)	Mean (SD)	Mean (SD)								
Farhat (2014)	2014	16	T1=0.61 (1.17)	T1=0.41 (0.62)									

Mean and standard deviation (SD) results are presented for each week of evaluation (T1= first week; second week, T3= third week; and T4= fourth week); N: number of group participants; *Data provided in the measure of central tendency (interquartile deviation). Mondelli 2018 did not present the gross results of the periods evaluated.

Supplemental material

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3/4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Table 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	-
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	-
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6

Section and Topic	Item #	Checklist item	Location where item is reported
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	-
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	-
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	-
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	-
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	-
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	-
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	-
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	Table 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	-
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table 3
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Table 3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	-
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	-
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	-
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	-
DISCUSSION			

Section and Topic	Item #	Checklist item	Location where item is reported
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	9
	23b	Discuss any limitations of the evidence included in the review.	10
	23c	Discuss any limitations of the review processes used.	10
	23d	Discuss implications of the results for practice, policy, and future research.	10
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	-
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	-
Competing interests	26	Declare any competing interests of review authors.	Title page
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	-

Fonte: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/.