

SYSTEMATIC REVIEW

Evaluation of clinical and radiographic success and parental satisfaction of zirconia crowns compared to stainless steel crowns in primary mandibular molars requiring full-crown restoration: a systematic review

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Abstract

Background: This systematic review aimed to evaluate the clinical and radiographic success, along with parental satisfaction, associated with zirconia and stainless steel crowns (SSCs) in primary mandibular molars. **Methods:** A comprehensive search was conducted across multiple electronic databases, including the Cochrane Library, PubMed, the System for Information on Grey Literature in Europe (SIGLE), the Latin American and Caribbean Health Sciences Literature (LILACS), and Web of Science, to identify randomized clinical trials comparing zirconia and SSCs in primary mandibular molars. Studies meeting the predefined inclusion criteria were selected. Two independent reviewers selected the studies, extracted data, and assessed the risk of bias using the Cochrane risk of bias (RoB 2) tool. **Results:** A total of 245 studies were screened following the deletion of duplicate entries, with 239 having been excluded based on screening of titles and abstracts. Six studies were identified for full text analysis and all six had their eligibility analyzed. Five studies were identified as being eligible after one study did not meet the inclusion criteria. Zirconia crowns demonstrated clinical and radiographic outcomes comparable to those of SSCs, with potential advantages in gingival health and parental satisfaction. **Conclusions:** According to the current literature, zirconia crowns represent an acceptable choice to stainless steel crowns for the treatment of primary mandibular molars. The two types of crowns proved themselves to have similar performance; however, there were some benefits associated with zirconia crowns in terms of periodontal status and parents' satisfaction. Nonetheless, it should be remembered that the results need to be considered carefully because of the small number of available researches. **The PROSPERO Registration:** CRD42023458332.

Keywords

Zirconia; Systematic review; Parental satisfaction; Mandibular molars; Crowns; Stainless steel

1. Introduction

Oral health plays a fundamental role in overall health and well-being [1, 2]. As per the findings of Retnakumari and Cyriac (2012), Early Childhood Caries (ECC) is one of the most prevalent chronic conditions affecting young children [3]. ECC is characterized as "the occurrence of one or more tooth surfaces that are decayed, missing (as a result of cavities), or filled in any primary tooth of a child who is 71 months of age or younger" [4]. Clinically, ECC can progress rapidly, particularly in areas of enamel hypoplasia or demineralization. If left untreated, it may extend to the dental pulp, leading to infection and, in severe cases, fascial space involvement

[5, 6]. Such dental infections will need immediate attention and could require such dental measures as hospitalization, giving of antibiotics, and even removal of the tooth. Dentists need to give advice on the treatment measures that need to be taken on the children who are more vulnerable to getting ECC. According to Sheller, Williams, and Lombardi, pediatric dentists may employ behavior management techniques, protective stabilization, sedation, or general anesthesia when clinically indicated [7]. Stainless steel crowns (SSCs) have long been used to restore primary teeth affected by caries, developmental defects, and cervical decalcification. They are also employed when the potential loss of commonly used dental materials is more probable (e.g., in individuals who grind their teeth or

have interproximal cavities that extend beyond the corners). SSCs may also be used following pulpotomy or pulpectomy, for the restoration of primary teeth that serve as space maintainers, or as interim restorations for fractured teeth [8, 9].

When selecting SSCs, clinicians should consider patients at higher caries risk due to age, behavior, or underlying medical conditions. Therapeutic dental procedures for such patients are often performed under sedation or general anesthesia, as recommended in established clinical guidelines [10, 11]. Those individuals having problems either developmentally or medically that do not improve with time are more likely to suffer from soft tissue problems. The use of SSCs is also likely to decrease the instances where there is a need to sedate children and put them under anesthesia. But there are certain challenges faced when trying to get an aesthetically acceptable outcome for such pediatric cases. [12]. Over the past 50 years, the focus on providing proper care for the primary dentition has transitioned from extraction to restoration. In cases of extensively compromised dentition, the initial phase of rehabilitation may necessitate the use of SSCs [13]. These crowns were originally designed for posterior primary teeth, as noted in previous literature. Peethambar *et al.* [14] reported that primary molars, especially maxillary ones, often remain visible during smiling, making aesthetics a concern in young patients.

2. Materials and methods

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol was registered on PROSPERO (CRD42023458332). The PRISMA 2020 Checklist (Supplementary material 1) is included for this systematic review.

2.1 Research question

“Do zirconia crowns demonstrate superior clinical and radiographic success and parental satisfaction compared with SSCs in primary mandibular molars?”

2.2 Eligibility criteria

In order to find out the clinical outcomes associated with crown placement in children between 4 to 10 years of age, various types of studies were considered. This review includes various randomized studies regarding clinical and radiographic success and parental satisfaction associated with SSCs and zirconia crowns used in primary mandibular molar teeth. It is important to note that only English-language studies were considered to ensure a well-defined and interpretable body of evidence. Excluded studies were those that used adult populations, were case series studies, descriptive studies, *in vitro* studies, unpublished studies, and studies that used pre-veneered SSCs.

- Population: Children requiring full-crown restoration in primary mandibular molar teeth.
- Intervention: Zirconia crowns.
- Comparison: Stainless steel crowns.
- Outcome: Radiographic and clinical outcomes.

2.3 Research protocol

The recommendations of the Cochrane Handbook for Systematic Reviews were used to conduct this review.

2.4 Search strategy

The search strategy used a combination of Medical Subject Headings (MeSH) terms and appropriate free text words. This is because using a combination of MeSH terms and appropriate free text words is recommended. This ensures that the search is precise and comprehensive. Initially, the search strategy used a combination of free text words and MeSH terms according to guidelines. In this search strategy, the Boolean operator “OR” is used to combine words within each of the PICO (Population, Intervention, Comparison, and Outcomes). On the other hand, “AND” is used to combine the three elements. Additional databases that were searched were Web of Science, and Latin American and Caribbean Health Sciences Literature (LILACS). A comprehensive search of the grey literature was carried out using Google Scholar and the databases SIGLE (System for Information on Grey Literature in Europe).

Search terms used in this literature search were (((((((((((primary teeth) OR (primary tooth)) OR (deciduous teeth)) OR (deciduous tooth)) OR (milk tooth)) OR (milk teeth)))) OR (baby teeth)) OR (baby tooth)) OR (primary dentition)) OR (primary molars)) OR (lower molars)) OR (deciduous molars)) OR (mandibular molars) AND (((((((((((aesthetic crown) OR (primary aesthetic crown)) OR (tooth coloured crowns)) OR (teeth coloured crowns)) OR (zirconia crowns)) OR (keto zr crowns)) OR (keto zirconia crowns)) OR (numsmile)) OR (kinder zirconia crown)) OR (ez crown)) OR (cheng crown)) OR (zirkin crown)) OR (cerco crown)) AND (((((((stainless steel crown) OR (metal crown)) OR (pre formed metal crown)) OR (chrome steel crown)) OR (3m crown)) OR (kinder stainless steel crown)) OR (nickel chromium crown) AND (((((((crown fit assessment) OR (crown fit)) OR (marginal adaptation)) OR (marginal integrity)) OR (Secondary caries)) OR (recurrent caries)) OR (gingival health)) OR (gingival condition)) OR (gingival status)) OR (colour)) OR (staining)) OR (discolouration)) OR (crown marginal adaptation)) OR (crown marginal extension)) OR (periodontal status)) OR (oral health status).

Manual searches were performed to identify any additional relevant publications not captured in electronic searches. The articles that were included in the present study were those published from January 2000 to October 2023, as per the dental profession’s meticulous record-keeping and research standards.

2.5 Data collection and analysis

Two authors independently conducted the database searches, Guru Vishnu (GV) and Ganesh Jeevanandan (GJ). Titles were screened, and duplicates were removed. Duplicate records identified across databases were excluded. Disagreements were resolved through discussion, and when needed, by consultation with a third reviewer. The aim was to reach an agreement through discussion and mutual understanding. If the two main reviewers were unable to resolve, a third reviewer

with greater expertise was engaged. This reviewer offered an impartial assessment to assist in resolving the dispute. The abstracts of the studies were assessed when sufficient details about the groups and participants were not explicitly stated in the title. Two authors carefully evaluated the abstract, independently and with utmost care, to identify the final studies that meet the specific inclusion and exclusion criteria. Upon careful evaluation, it was observed that the full-text articles were assessed when abstracts failed to furnish sufficient details about the compared groups. The PRISMA flow diagram (Fig. 1) summarizes the study selection process. The final papers that were part of the discussion were carefully assessed for methodological quality according to the Cochrane Handbook's recommendations for systematic reviews.

2.6 Risk of bias

The risk of bias in the included randomized trials was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool. Two reviewers independently performed the risk-of-bias assessment. The RoB 2 tool evaluates five domains: bias arising from the randomization process; bias due to deviations from intended interventions; bias due to missing outcome data; bias in measurement of the outcome; and bias in selection of the reported result. Each study was judged as having a "low risk of bias", "some concerns", or a "high risk of bias" according to the RoB 2 guidance.

3. Results

A thorough search of the electronic databases yielded a total number of 257 citations: 37 from PubMed, 53 from the Cochrane Library, and 167 from Web of Science. Further searches in Google Scholar, LILACS, SIGLE, and through manual searches did not yield any extra records. In total, 12 duplicated records were eliminated, and 245 records remained for title and abstract selection, of which 239 records were excluded since they did not satisfy the inclusion criteria. Six records were selected for retrieving, and all were retrieved and evaluated for eligibility. In one report, the full text was read, and it was excluded due to its failure to satisfy the inclusion criteria. (Fig. 1).

3.1 Study characteristics

Abuelniel *et al.* [15] (2018) evaluated the clinical and radiographic outcomes of zirconia and SSCs in young patients. They reported that zirconia crowns showed satisfactory clinical and radiographic outcomes, comparable to SSCs. Additionally, zirconia crowns offered improved aesthetics [15].

Mathew *et al.* [16] (2020) assessed clinical success and both parental and child satisfaction for zirconia and SSCs. The findings revealed that both crowns exhibited identical rates of clinical success. Zirconia crowns showed a significantly lower tendency for plaque accumulation compared with SSCs ($p = 0.047$). Both crowns were observed to yield high levels of parental satisfaction. Both parents and children reported high level of satisfaction with the colour of zirconia crowns compared to SSCs [16].

In a study conducted by Donly *et al.* [17] in 2018, the

clinical and radiological outcomes of children who received zirconia and SSCs restoration were evaluated. No clinically significant differences were found between the two crown types regarding gingival health, restoration success, wear on opposing teeth, anatomic form, marginal integrity, or proximal contacts. However, parental satisfaction was significantly higher for zirconia crowns. Fig. 2 (Ref. [15–19]) and Fig. 3 summarize the risk-of-bias assessments for the included studies.

Taran PK *et al.* [18] (2018) evaluated the clinical and radiographic success of stainless steel and zirconia crowns placed on mandibular primary molars. They reported reduced plaque accumulation and improved gingival health around zirconia crowns compared with SSCs. Both zirconia and SSCs demonstrated favorable clinical outcomes in primary teeth. It is important to note that a small percentage of zirconia crowns may experience minimal discolouration or occasional fractures [18].

Donly *et al.* [19] (2020) evaluated the clinical and radiographic success of stainless steel and zirconia crowns. Their findings demonstrated continued clinical success for both zirconia and SSCs over a three-year follow-up period. No clinical failures were reported for either crown type after three years of follow-up [19].

All the included studies are explained in detail in **Supplementary material 2**.

3.2 Risk of bias assessment

According to the RoB 2 evaluation, it was found that out of the five studies included in this study, three were considered to possess high overall risk of bias, while the other two had a low overall risk of bias. (Figs. 2,3).

4. Discussion

Children's general development depends on the maintenance of a healthy primary dentition [20]. Pediatric dentists find it particularly challenging to treat children who have severe ECC [21, 22]. Parental satisfaction, the longevity and strength of the restoration, and preservation of tooth structure are the three critical factors to consider [23]. Advances in pediatric dental materials require ongoing evaluation of new restorative options [12]. Several new techniques have been introduced for full-coverage restoration of primary teeth [12]. Since 1950, SSCs have emerged as the most widely used full-coverage restoration for children's primary and posterior teeth [24, 25]. The effectiveness of SSCs in maintaining pulpotomized or severely decayed primary molars has been documented in the literature. While SSCs require minimal maintenance, their metallic appearance is often a concern for parents. In pediatric dentistry, aesthetic outcomes have become increasingly important alongside durability [26]. Parents and children frequently express dissatisfaction with the metallic appearance of SSCs [27, 28]. Prefabricated zirconia crowns provide an aesthetic alternative that offers improved cosmetic outcomes. While zirconia has long been known for its use as a restorative material in permanent teeth, its use in primary teeth is comparatively recent. Zirconia crowns cannot be crimped or molded, but

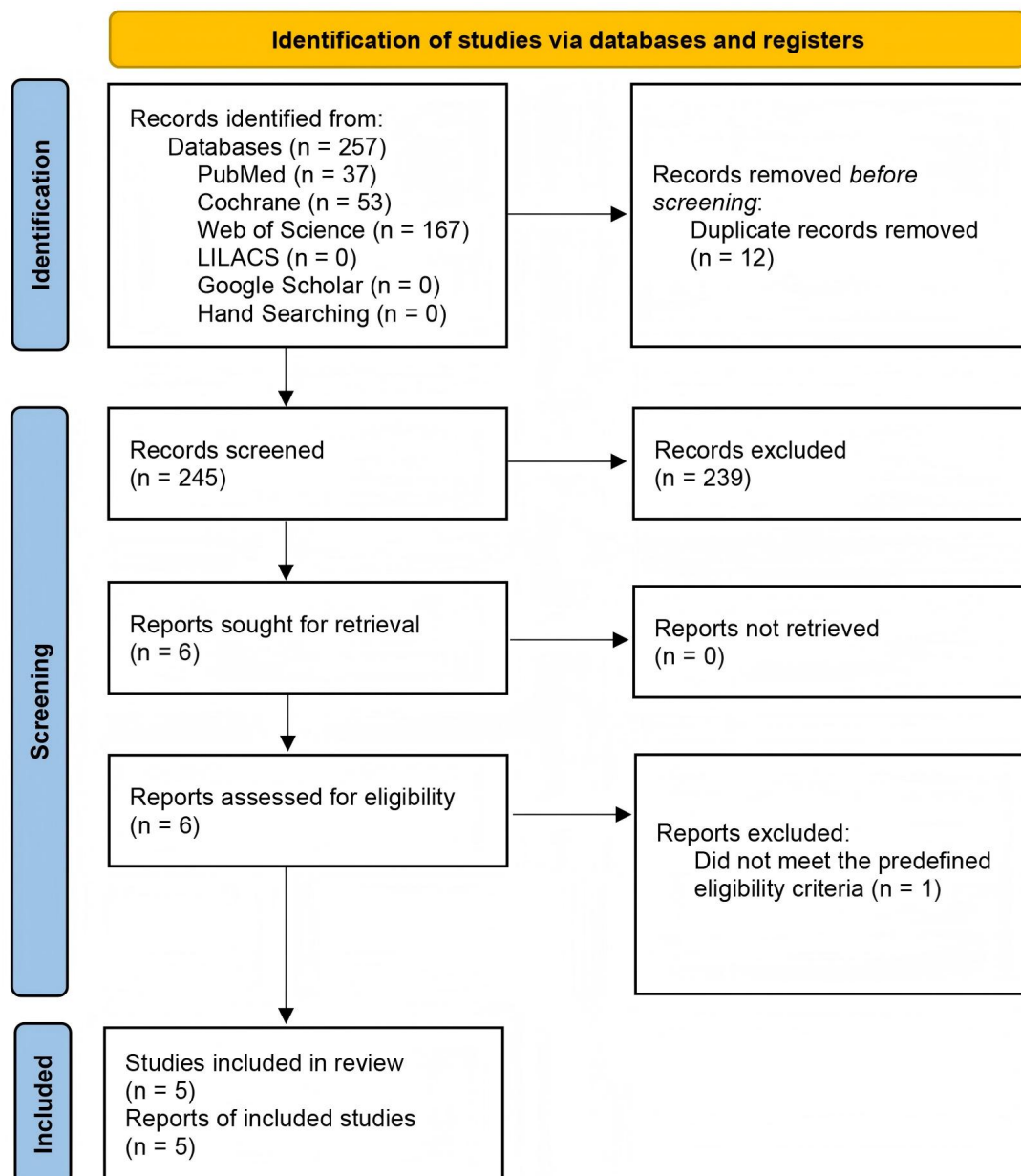


FIGURE 1. Preferred reporting items for systematic reviews and meta-analyses 2020 flow diagram. SIGLE: System for Information on Grey Literature in Europe; LILACS: Latin American and Caribbean Health Sciences Literature.

		Risk of bias domains					
		D1	D2	D3	D4	D5	Overall
Study	Abuelniel G. et al. [15]	⊗	⊕	⊕	⊕	⊕	⊗
	Mathew M.G. et al. [16]	⊗	⊕	⊕	⊕	⊖	⊗
	Donly K.J. et al. [17]	⊕	⊕	⊕	⊕	⊕	⊕
	Taran P.K. et al. [18]	⊕	⊕	⊕	⊕	⊕	⊕
	Donly K.J. et al. [19]	⊕	⊕	⊕	⊕	⊗	⊗

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
⊗ High
⊖ Some concerns
⊕ Low

FIGURE 2. Risk of bias assessment per study across five domains.

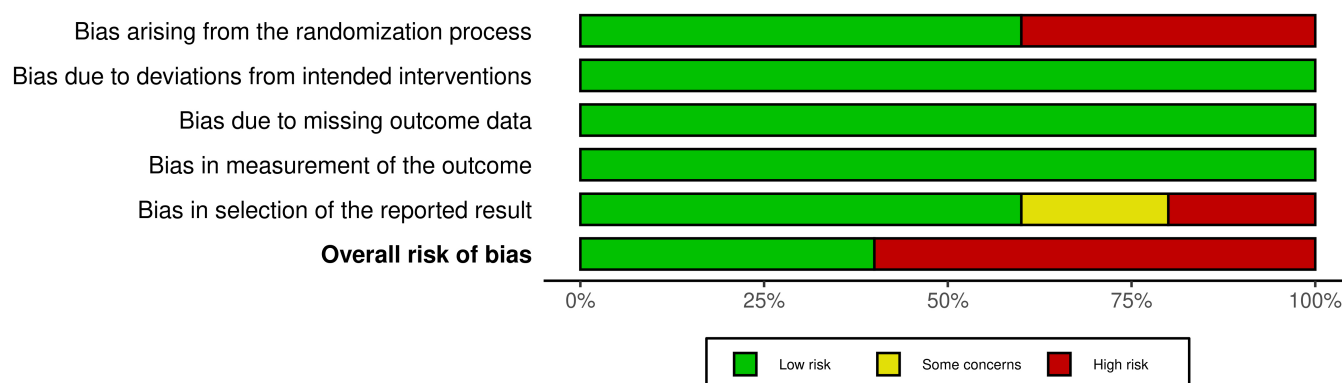


FIGURE 3. Summary proportion of risk of bias judgements across all domains.

they are mechanically comparable to metal crowns, requiring significant tooth reduction [29].

With the creation of novel restorative alternatives, clinical success has remained a topic of discussion. Few randomized clinical trials have directly compared zirconia crowns with SSCs, considered the standard of care for primary molars. Therefore, this review aimed to synthesize available evidence comparing the outcomes of the two crown types.

Donly *et al.* [17] reported better gingival health around zirconia crowns at six months, although by two years, gingival conditions were similar between zirconia and SSCs. These findings are consistent with the overall results of the present review. According to Taran PK *et al.* [18], zirconia crowns outperformed SSCs in primary mandibular molars in terms of periodontal index and gingival index scores. At three and six months of follow-up, teeth repaired with zirconia crowns showed greater gingival health than those treated with SSCs; nevertheless, at twelve months, both groups had healthy gingiva. These findings may be attributed to zirconia's high biocompatibility and smooth surface, which reduces plaque accumulation and gingival irritation. Mathew *et al.* [16] also reported significantly less plaque accumulation with zirconia crowns ($p = 0.047$) and significantly higher parental colour satisfaction ($p < 0.001$) compared with SSCs. The two groups showed similar results in terms of shape, size, durability, and retention, with a clinical success rate of 100% for both zirconia and SSC crowns [16]. Sharaf *et al.* [30] (2004) reported that SSC crowns exhibited signs of gingivitis and difficulties with marginal adaptation. However, changes in the marginal extension of the crowns and their appropriateness, as evaluated radiographically, did not impact on gingival health [30]. Checchio *et al.* [31] similarly reported higher rates of gingivitis around poorly adapted crowns, largely due to plaque retention [31]. Myers *et al.* [32] emphasized that proper SSC fitting is essential to prevent mechanical irritation of gingival tissues. However, Webber (1974) did not discover a connection between improved SSCs and gingival health [33].

Taran PK *et al.* [18] also recommended regular oral hygiene reinforcement for children receiving crown restorations. The children may have been encouraged to maintain good oral hygiene throughout their research by this teaching and the many follow-up visits [18]. According to Sharaf A *et al.* [30] in 2004, children with poor oral hygiene had a greater fre-

quency of gingivitis, whereas those with adequate oral hygiene had healthy gingiva surrounding SSCs. These findings are consistent with Checchio *et al.* [31] and Taran PK *et al.* [18]. Checchio *et al.* [31] concluded that, regardless of the quality of SSCs, poor dental hygiene led to obvious tissue degeneration, and improperly shaped restorations increased gingival vulnerability to more severe inflammation. Previous studies have associated alveolar bone loss with poorly positioned SSCs and untreated proximal caries. SSCs deemed to be radiographically unsatisfactory were linked to alveolar bone loss. Importantly, well-adapted SSCs on primary molars did not contribute to marginal bone loss on adjacent permanent molars [34, 35].

Research informed by patient outcomes contributes to clinical practice, helping clinicians guide treatment pathways. Furthermore, such evidence supports more meaningful discussions about informed consent with patients and families. As data from different studies converge, as in meta-analyses, conclusions gain strength and reliability. The results of the current systematic review indicate that the results in these two crown varieties are essentially comparable.

5. Limitations of the study

We included a total of five studies with 600 teeth restored with zirconia or SSCs in the systematic review. However, as only five studies met the inclusion criteria, there is a need for a larger number of well-designed trials to augment the existing evidence base. The included studies were randomized clinical trials; however, they exhibited methodological limitations, including inadequate blinding, unclear allocation concealment, and small individual sample sizes. Major differences in methodology, sample sizes, follow-up periods, and outcome measurements occurred across the studies, making direct comparisons difficult. Another source of variation in the reported findings was that clinical and radiographic success were defined and evaluated differently across studies.

Moreover, limiting inclusion to English-language publications possibly led to the exclusion of relevant non-English studies, introducing language bias. Thus, the current evidence, which is primarily derived from randomized clinical trials with methodological limitations (e.g., risk of bias related to randomization and blinding), should be interpreted cautiously.

6. Conclusions

Within the constraints of this review and the available evidence, zirconia crowns represent a viable alternative to SSCs for restoring primary mandibular molars. Zirconia crowns demonstrated clinical performance comparable to that of SSCs, with potential advantages in gingival health and parental satisfaction. Nevertheless, the limited number of included studies and their methodological heterogeneity preclude definitive conclusions regarding the superiority of either crown type.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are available within the article. No additional data are available. Further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

GJ, GM—Conceptualization. GV, GJ—Data curation; Investigation; Methodology. GV—Formal analysis. RF, MC, GM—Project administration. MMM, MDB, GM—Resources. MDB, MC, GM—Supervision. MMM, MDB, MC, GM—Validation. RF, MMM—Visualization. RF, MMM, MDB—Writing—original draft. RF, MMM, MDB, MC, GM—Writing—review & editing. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study is a systematic review based on previously published data and does not involve any human participants, human data, human tissue, or animal subjects. Therefore, ethical approval and informed consent were not required. The review protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD42023458332.

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During the preparation of this manuscript, the authors used DeepL Translate for language checking/grammar correction. After its use, the authors thoroughly reviewed, verified, and revised all content to ensure accuracy and originality. The authors take full responsibility for the integrity and final content of the published article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Giuseppe Minervini was a member of the Editorial Board of this journal at the time of submission. We declare that Giuseppe Minervini had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to AS.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at <https://oss.jocpd.com/files/article/2095382619472445440/attachment/Supplementary%20material.zip>.

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