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REVIEW ARTICLE

Effect of Propolis and other Commercially Available Agents in Reducing Dentine Hypersensitivity: A Systemic Review and Meta-Analysis

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ABSTRACT

Background: Dentin hypersensitivity (DH) is a widespread dental issue characterized by sharp pain from dentinal tubule exposure. Treatments include nerve-blocking and tubule-occluding agents, but no single method has been proven superior. This study investigates the efficacy of propolis, a natural substance with known biological properties, in reducing dentin hypersensitivity compared to commercially available agents.

Objectives: The study aims to assess the effectiveness of propolis-based products in reducing dentin hypersensitivity and to compare their efficacy with that of conventional commercially agents potassium nitrate, potassium oxalate, fluoride gels, and dentine bonding agents.

Material and Methods: A systematic review and meta-analysis were conducted following PRISMA guidelines, including Randomized Controlled Trials (RCTs) that assessed patients with dentin hypersensitivity treated with propolis-based products versus control agents. Data were pooled, and outcomes were evaluated using Visual Analog Scale (VAS) scores. High heterogeneity across studies was noted, attributed to variations in propolis concentrations, follow-up durations, and methodologies. Four RCTs were included, and study quality was evaluated using the modified Cochrane risk of bias tool.

Results: No significant difference in effectiveness between propolis and control products in reducing dentin hypersensitivity was found (SMD 0.04, 95% CI -2.23 to 2.32). Propolis showed prolonged effects, whereas other products provided immediate relief that diminished over time. A high level of heterogeneity (I2= 98%) was observed across the studies.

Conclusion: Propolis-based products appear to offer a natural alternative for managing dentin hypersensitivity. Although propolis showed potential for prolonged relief, the lack of significant differences between propolis-based and conventional products underscores the need for standardization and further research.

Keywords: Dentin hypersensitivity, Propolis, Desensitizing agents, Dentinal tubules, Toothache

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INTRODUCTION

Dental hypersensitivity (DH) is a sharp, transient pain triggered by thermal, chemical, and tactile stimuli due to exposed dentinal tubules. [1] This exposure can result from parafunctional habits, non-carious lesions, gastric regurgitation, and aggressive brushing.[2] The hydrodynamic theory by Brannstrom attributes the pain to fluid movement within dentinal tubules, activating nearby pressure receptors.[3] Dentine Hypersensitivity is seen to be more common in females than males with highest prevalence seen in individuals in age group 30-39 years. According to recent studies, the percentage of dental hypersensitivity cases is 8.2% when diagnosed clinically while self-reported cases are 13%. Most commonly affected teeth are first molars and lower front teeth.[4] in order to evaluate dentine hypersensitivity and its severity in clinical trials and dental practises, to detect it clinician uses dental explorers and gently run it across the tooth surface to stimulate dentinal tubules and provoke a response. The patient's feedback is then recorded.[5]

Current treatment for DH works in two ways. Either by blocking nerve impulses using potassium nitrate or by occluding exposed dentinal tubules through oxalates, strontium, etc[5]. Despite numerous studies, there is no consensus on a single best treatment approach. This has led to the exploration of natural alternatives, such as propolis, which shows unique properties that make it a potential solution for reducing DH.[6]

Propolis is a natural sticky substance collected by Honeybees from various plants sources, including flower resin and tree leaves. By mixing it with their saliva, bees create a versatile material used to fill gaps and cracks in their hive, smooth out surfaces and maintain a stable hive environment.[7,8] It constitutes 50-60% resins, 30-40% waxes, 5-10% essential oils, and 5% pollen, besides microelements like aluminum and calcium.[9] Given its unique composition antimicrobial, anti-inflammatory, and antioxidant properties propolis has emerged as a promising natural alternative for managing DH. This study aimed to access the potential benefits of propolis in reducing dentine hypersensitivity when compared with other commercially available products such as potassium nitrate, potassium oxalate, fluoride gels, and DBAs, and provide valuable insights for dental professionals and patients. With this analysis we aim to market propolis as a natural solution towards dentin hypersensitivity with minimal side effects. This study evaluates the potential of propolis, comparing its long-term efficacy with conventional desensitizing agents through a systematic review and meta-analysis.

MATERIALS AND METHODS

This meta-analysis has been registered on Prospero with ID: CRD42024596617. This meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[10]

a. Inclusion criteria:

- **i.** Patients of all ages with dentin hypersensitivity.
- **ii.** Interventions using propolis-based oral care products (toothpaste, mouthwash, gel).
- **iii.** Randomized controlled trials (RCTs).
- **iv.** Outcomes measured via VAS or similar scales.

b. Exclusion Criteria:

- **i.** Non-RCT studies, in-vitro studies, or those lacking DH measurements.

Multiple databases were used to conduct a rigorous search (PubMed®, Research gate®) and locate recently relevant published items until July 2024. In addition, Google Scholar® was also explored. A special search was conducted on the annotated bibliographies of the selected studies. The articles retrieved from

the systematic search were exported to the Mendeley reference manager software where duplicates were screened and removed. The study selection process involved organizing the systematic search results, removing duplicates, division of the studies into two groups: screening and intervention and having two reviewers independently assess the articles for relevance. The full articles were then reviewed to confirm eligibility, and any discrepancies were resolved by other two reviewers. The finalized trials yielded reduction in dentin hypersensitivity which was measured on base line day and follow up day via Visual Analogue Scale (VAS). To ensure the quality of the included studies, the modified Cochrane risk of bias tool was used for randomized controlled trials, evaluating the risk of bias and ensuring transparency and accuracy in the review. In one of the included studies, interquartile range and percentage values were given which was then converted into standard deviation and mean respectively by using an online tool. As we had multiple interventions and multiple control groups therefore their outcomes i.e., mean and standard deviation were combined separately by using a formula from Cochrane Handbook for Systematic Reviews of Interventions: Due to lack of sufficient data and up-to-date information, only 4 studies from last ten years were included. The key result measurement was standard mean deviation of their values. Meta-analysis was performed using Review Manager (RevMan)[5,4,1] pooling data via a random-effects model. Outcomes were summarized using standard mean differences (SMDs) with 95% confidence intervals. Forest plots were created, and heterogeneity was assessed using and chi-square tests. A sensitivity analysis was carried out to remove heterogeneity but there was no significant reason found. However, a closer examination of the study methods suggested that the small sample sizes and limited data availability with only four studies conducted on this topic to date likely contributed to the observed heterogeneity. A p-value ≤ 0.05 was considered significant.

RESULTS

Electronic searches yielded a total of 120 studies identification from databases, with no records from registers. After removing 106 duplicate studies and 1 for other reasons, 13 studies remained for screening. Following screening, 6 of them were excluded, leaving 7 studies sought for retrieval, all of which were successfully retrieved. After assessing eligibility, 3 studies were excluded for reasons such as being non-RCTs, preliminary reports, or lacking outcomes of interest. Ultimately, 4 studies[11-14] were included in the final review. Figure 1.

This study included four randomized controlled trials (RCTs) investigated the effectiveness of propolis-based desensitizing agents compared to conventional treatments for dentin hypersensitivity, utilizing different concentrations, control agents, follow-up durations, and evaluation criteria. The average follow-up period across studies was 52 days, with variations in sample sizes and methodologies. Askari et al [12] (2019) assessed the efficacy of 10% and 30% propolis against Single Bond DBA and distilled water in 120 participants over a 90-day period. The study measured dentin hypersensitivity reduction using Visual Analog Scale (VAS) scores following tactile stimuli, highlighting a significant improvement with propolis compared to distilled water. Maity et al [13] (2020) compared propolis with Admira Protect and sterile water in 72 participants over 60 days. VAS scores served as the primary evaluation tool to assess changes in sensitivity, with results indicating that both propolis and Admira Protect were effective in reducing hypersensitivity, while sterile water had minimal impact. Al Qahtani et al [14] (2023)

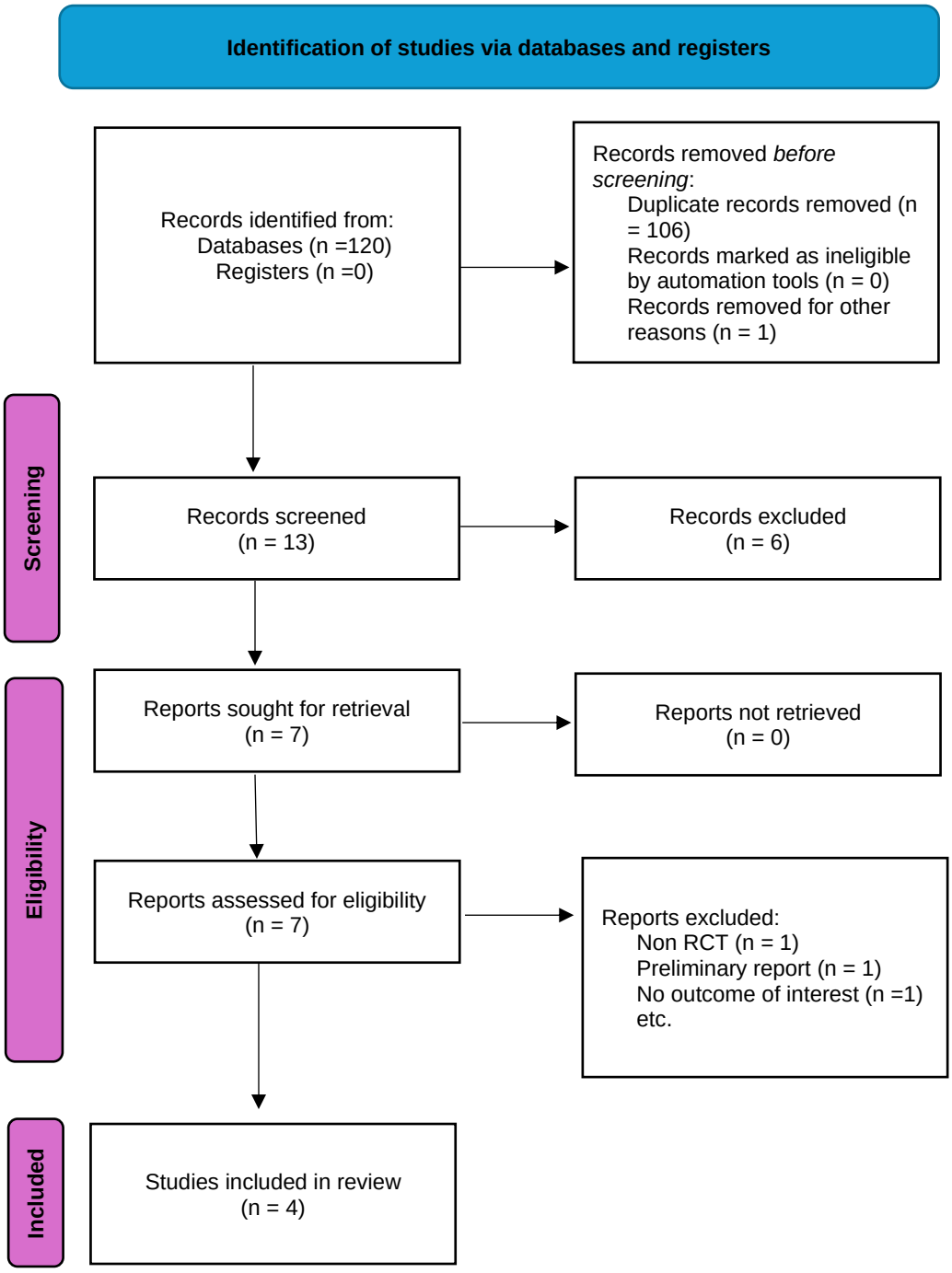

Figure 1: PRISMA[10] flow diagram of the study

investigated the effects of 10% propolis Hydrogel compared to 2% sodium fluoride (NaF) and 1.23% acidulated phosphate fluoride (APF) in 75 participants over a 28-day period. This study utilized multiple evaluation criteria, including VAS scores, tactile stimuli, and air blast responses, providing a comprehensive assessment of changes in dentin hypersensitivity. The findings suggested that 10% propolis hydrogel was comparable in effectiveness to NaF and APF. Shah et al [11] (2024) examined the use of propolis versus Gluma desensitizer in 80 participants over 30 days. The study incorporated VAS scores, Schiff's sensitivity scale, and air blast stimuli to assess hypersensitivity reduction, demonstrating that propolis showed significant improvement in reducing dentin hypersensitivity, like Gluma desensitizer. Across all studies, participants were adults suffering from dentin hypersensitivity, including both males and females. The four studies primarily relied on VAS scores and responses to tactile and air blast stimuli for evaluation, with Schiff's sensitivity scale additionally used in Shah et al [11] (2024). The variation in follow-up periods, evaluation criteria, and control agents provides a broad perspective on the potential of propolis as a natural desensitizing agent. These studies collectively demonstrate that propolis exhibits significant effectiveness in reducing dentin hypersensitivity, making it a promising alternative to conventional treatments such as fluoride-based agents and commercial desensitizers. (Table 1).

Qualitative analysis of the included studies

The quality assessment of the studies [11-14] indicates a generally low risk of bias across key domains. All studies exhibited low risk in the randomization process, ensuring that the sample selection was unbiased. Most studies also showed low risk regarding deviations from the intended interventions, with one study[11] raising some concerns. Additionally, all studies[11-14] had low risk of bias due to missing outcome data, ensuring the completeness of data for analysis. The measurement process was consistent and unbiased across all studies, further strengthening the reliability of the findings. Moreover, there were no concerns regarding the selection of reported results, suggesting the transparency of the reporting process. Overall, all studies were deemed to have a low risk of bias, indicating their high quality and reliability in providing meaningful insights. (Table 2).

This forest plot presents a total sample size consists of 149 participants in the Propolis group and 198 participants in the other agents group. The mean differences (MD) with 95% confidence intervals (CI) are presented for each study, along with their respective weights in the analysis. Notably, the individual study results vary considerably, with some favouring Propolis while others favour other agents, as reflected in their confidence intervals and mean difference values. Askari M et al [12] (2019) and Maity et al [13] (2020) reported negative mean differences of -2.85 [-3.69, -2.01] and -0.80 [-1.49, -0.11], respectively, indicating that other agents were more effective in these cases. In contrast, Al Qahtani S et al [14] (2023) and Shah M et al [11] (2024) reported positive mean differences of 0.76 [0.25, 1.27] and 3.00 [2.49, 3.51], respectively, suggesting Propolis was more beneficial in their studies. The substantial variability among these results is quantified by the heterogeneity statistic (I^2 = 98%), which indicates a high level of inconsistency between studies. This suggests that factors such as differences in study design, sample characteristics, outcome measurements, or interventions may contribute to the variation in findings.

The overall pooled mean difference is 0.04 [-2.23, 2.32], which crosses the zero threshold, indicating no statistically

Table 1: Characteristics of the included studies (n=4)

Author, Year	Study Type	Intervention Group	Comparison Group	Participants	Follow-Up Duration (Days)	Evaluation Criteria	Outcome
Shah et al[11] 2024	RCT	Propolis	Gluma desensitizer	80	30	VAS scores, Schiff's sensitivity scale, response to air blast stimuli	Propolis demonstrated significant reduction in hypersensitivity, comparable to Gluma desensitizer.
Askari et al[12] 2019	RCT	10% propolis, 30% propolis	Single Bond DBA, Distilled water	120	90	VAS scores following tactile stimuli	10% and 30% propolis showed significant reduction in dentin hypersensitivity compared to distilled water.
Maity et al[13] 2020	RCT	Propolis	Admira Protect, Sterile water	72	60	VAS scores following tactile stimuli	Propolis and Admira Protect were effective, with significant reduction in hypersensitivity compared to sterile water.
Al Qahtani et al[14] 2023	RCT	10% propolis hydrogel	2% Sodium Fluoride (NaF), 1.23% Acidulated Phosphate Fluoride (APF)	75	28	VAS scores, response to tactile and air blast stimuli	10% propolis hydrogel was as effective as NaF and APF in reducing dentin hypersensitivity.

RCT; randomized controlled trial

Table 2: Quality assessment of the included studies

Author ID	Risk of bias due to randomisation process	Risk of bias due to deviations form intended interventions	Missing outcome data	Risk of bias in measurement process	Risk of bias in selection of reported result	Overall risk of bias
Shah et al [11]	Low risk	Some concerns	Low risk	Low risk	Low risk	Low risk
Askari et al [12]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Maity et al [13]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Al Qahtani et al [14]	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

significant difference between Propolis and Other agents in terms of effectiveness. Furthermore, the *p*-value of 0.97 confirms that the observed effect is not statistically significant. Graphically, the forest plot shows individual study estimates represented by green squares, with horizontal lines depicting their confidence intervals. The diamond at the bottom represents the overall pooled estimate, which is cantered near zero, reinforcing the lack of a clear advantage for either intervention. Given the high heterogeneity and non-significant overall effect, further research with standardized methodologies, larger sample sizes, and controlled study conditions is necessary to determine whether Propolis provides a meaningful clinical benefit compared to other agents. Figure 2.

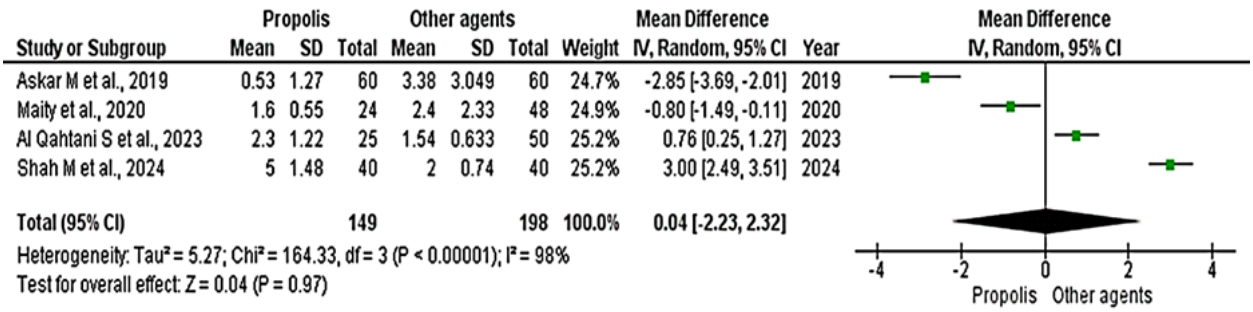

Figure 2: Forest plot of the study

DISCUSSION

Dentin hypersensitivity is a complex phenomenon that can be explained by the hydrodynamic theory, which suggests that the movement of fluid within the dentin tubules is the primary cause of pain. This pain is triggered by various stimuli, such as temperature changes, mechanical forces, or chemical substances, which set the fluid in motion and excite the nerve endings within the dentin. As a result, the nerve endings transmit these signals to the central nervous system, leading to the sensation of pain.[15] However, for dentin hypersensitivity to occur, the dentin must be exposed, which can happen due to a combination of factors. These include mechanical forces, such as improper brushing techniques, and chemical erosion caused by acidic substances.[16] Additionally, dental treatments like scaling and root planning, which are used to address periodontal diseases, can also lead to exposed dentin and subsequent hypersensitivity.[17]

The current treatments for dentin hypersensitivity primarily focus on either blocking the nerve impulses or occluding the exposed dentinal tubules. Potassium nitrate, for example, works by blocking the nerve impulses, while other treatments like oxalates, strontium, and fluoride gels aim to occlude the dentinal tubules. However, these treatments have limitations, such as requiring multiple applications and providing only temporary relief.

In this study, the potential benefits of propolis, a natural substance, in reducing dentin hypersensitivity is evaluated. By comparing propolis with commercially available products, the study seeks to provide valuable insights for dental professionals and patients, promoting propolis as a natural solution with minimal side effects. While propolis demonstrates prolonged effects in reducing DH, its efficacy compared to conventional treatments remains inconsistent. Variability in propolis concentration, follow-up duration, and outcome measures complicates drawing definitive conclusions.

The results of this meta-analysis suggest that propolis may be an effective natural alternative for reducing dentin hypersensitivity. However, other studies have reported conflicting results. For example, Shah M et al., 2024, found that both Gluma and propolis had a significant impact immediately after application, but the effectiveness of propolis decreased with time.[11] The optimal concentration of propolis for reducing dentin hypersensitivity remains unclear. Askari et al (2019) found that 20% propolis was more effective than 10% propolis,

suggesting that higher concentrations may be more effective.[12]

Long-term studies have also demonstrated the efficacy of propolis in reducing dentin hypersensitivity [17-20]. Maity et al (2020) found that propolis was effective in reducing dentin hypersensitivity for up to 6 months.[13] The meta-analysis revealed significant heterogeneity among the included studies. The observed heterogeneity in the meta-analysis may be attributed to several factors. One major contributor is the variation in propolis concentrations used across studies ranging from 10% to 30%. Additionally, study durations varied significantly, with follow-up periods spanning 28 to 90 days. Differences in outcome measures also played a role, as studies employed distinct scales to assess dentin hypersensitivity including visual analogue scale and Schiff's sensitivity scale. Furthermore, population characteristics differed across studies, with participants of varying ages, sexes, and oral health statuses. These differences in study design and population characteristics likely contributed to the substantial heterogeneity observed in the analysis.

The presence of substantial heterogeneity in this meta-analysis necessitates cautious interpretation of the results. Heterogeneity can attenuate precision, broaden confidence intervals, and hinder definitive conclusions regarding propolis efficacy. Moreover, the combination of studies with disparate methodologies may introduce bias, potentially compromising the validity of the findings.

The findings of this meta-analysis have significant clinical implications for the treatment of dentin hypersensitivity, clinicians should exercise caution when interpreting the results due to the high heterogeneity among studies. When considering propolis treatment, clinicians should consider individual patient characteristics, such as age, sex, and oral health status. Standardized treatment protocols, including propolis concentration and duration, are essential to minimize variability. Regular monitoring and follow-up are also crucial to assess treatment efficacy and potential adverse effects. The study highlights the need for standardized study protocols, including propolis concentration, study duration, and outcome measures. Future studies should investigate subgroup effects, such as age, sex, and oral health status, to better understand propolis efficacy Long-term studies are also necessary to assess the sustained efficacy and safety of propolis treatment. Additionally, comparative effectiveness research should be conducted to determine propolis relative efficacy compared to other treatments for dentin hypersensitivity.

To advance the field, future research should focus on dose-response studies to identify the optimal propolis concentration and duration for treating dentin hypersensitivity Comparative effectiveness research and mechanistic studies will also provide valuable insights into propolis desensitizing effects. Well-designed, randomized controlled trials are essential to confirm propolis efficacy and safety.

CONCLUSION

The study revealed that Propolis-based products hold promise as a natural, long-term solution for managing dentin hypersensitivity. The results obtained from the data provided by each of the 4 studies revealed no significant difference, indicating the need for further research on this product with multiple variables. Hence, high-quality, standardized trials are necessary to confirm efficacy, optimize dosage, and establish safety profiles. Therefore, the clinicians should cautiously consider propolis alongside conventional options based on individual patient needs.

Authors contribution

AUR: Conception and design of the study, drafting the manuscript, and collected data,

contributed data, performed analysis and contributed to writing the manuscript.
SSR: Supervised the study, reviewed and revised the manuscript and provided critical revision of the manuscript for important intellectual content and final approval of the version to be published.
EZ: Contributed in data analysis and contributed in writing the paper
HUA: Contributed in collecting the data and writing the manuscript.
LK: Contributed in providing the necessary tools needed for collecting data and analyzing it and contributed in writing the manuscript as well.
HR: Contributed in collecting data for the manuscript.

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Institutional ethical board approval

Not applicable.

Informed Consent
The written consent was obtained from all participants in this study.

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Availability of data and materials
The data supporting this study's findings are available from the corresponding author upon reasonable request.

Consent for publication
Not applicable.

Disclaimer of using AI tools
Not utilized. All ideas, arguments, and conclusions presented in the review, however, are entirely the authors' original work. The authors take full responsibility for the accuracy and integrity of the content.

Conflict of interest

No conflict of interest.

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