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The Biologically Oriented Preparation Technique in Fixed Prosthodontics: A Comprehensive Narrative Review of Issues and Perspectives

Abstract

Objective: This review aims to evaluate the Biologically Oriented Preparation Technique (BOPT) and to analyze its effects on the periodontal environment, esthetics, and fracture resistance.

Overview: Gingival preparation consists of de-epithelialization of the sulcus without violating the biological space creating a blood clot that will be stabilized by the provisional prosthesis. BOPT technique also allows to obtain an increased gingival thickness and a better adaptation of the soft tissues to the shapes and profiles created by the prosthetic restoration

Conclusion: The data suggest that the BOPT resulted in improved soft tissue adaptation, enhanced esthetics, good clinical survival, and high patients' satisfaction. Moreover, the BOPT allowed the conservation of tooth structure and better fracture resistance when compared to conventional shoulder preparation. the BOPT seemed to result in less bone loss around dental implants when compared to bone level implants and stable peri-implant hard and soft tissue.

However, long term studies and suitable case selection are essential for achieving predictable, functional and esthetic results over time.

Clinical Significance: The BOPT Technique offers several advantages, yet successful outcomes require significant clinical skills and experience. Challenges remain, particularly regarding impression taking and accurate finishing line registration.

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Introduction

Tooth preparations in fixed prosthodontics, directly influence the durability, adaptation, and biological impact of restorations. Vertical preparations were historically widely used during the era of the predominance of metal alloys, as these materials allowed for minimal thickness.

Periodontal disease was the main indication for their use.¹ With the advent of ceramics, horizontal preparations (shoulder, chamfer) were found to be more suitable. Today, thanks to technological advances (CAD/CAM) and new biomimetic approaches, vertical preparations are experiencing a renewed interest. Indeed, they constitute a modern approach in restorative dentistry because they favor tissue conservation and simplification of clinical steps, while offering aesthetic and functional advantages.^{1,2}

Vertical preparations in fixed prosthodontics differ from horizontal preparations in that they lack a marked finishing line thus aiming to minimize tissue reduction while ensuring optimal adaptation of the prosthetic restoration. The Biologically Oriented Preparation Technique (BOPT) is a vertical tooth or feather-edge preparation method without a defined finish line. It is designed to promote gingival (gum) adaptation and health, allowing the soft tissues to shape naturally around the final restoration.² It encourages the natural reshaping of the gingiva around the restoration; thus, the provisional restoration plays a key role in shaping the soft tissue before the final restoration placement. Even though it is closely related to the conventional vertical preparation, a marked distinguishing feature of the BOPT technique is that it is biologically driven, focusing on gingival health and adaptation, and that the usage of provisional restoration is an essential part of the technique to shape and condition the soft tissue.

Gingival preparation consists of de-epithelialization of the sulcus without violating the biological space. This action will create a blood clot that will be stabilized by the provisional prosthesis allowing the neoformation of periodontal tissue adapted to the future prosthesis.³ The BOPT technique thus stimulates the regeneration of periodontal tissues and improve their progressive adaptation around the restoration.⁴ It allows to obtain an increased gingival thickness and a better adaptation of the soft tissues to the shapes and profiles created by the prosthetic restoration.⁵ Moreover, the absence of a visible finishing line promotes a smooth transition between the restoration and the gingival tissues, thus leading to an optimization of aesthetics.

However, their implementation requires technical mastery and rigorous selection of materials to guarantee an optimal fit and avoid periodontal complications.⁴ Moreover, the BOPT margins, being located at the dentin level or in a subgingival

position, raise the question of their influence on the inflammatory response on the long term and if the gingiva will be able to maintain a healthy and stable state.⁴ The absence of a clearly visible cervical finish can also make clinical control more complex and influence bacterial retention.

In this context, this review aims to analyze the biological effects of vertical preparations on the periodontal environment, to explore strategies to optimize their clinical integration, and to present future perspectives in prosthetic design.

Method

An electronic search was conducted on the PubMed/MEDLINE and Web of Science to identify relevant studies from 2019 to 2025. The search was performed using specific keywords: “BOPT” OR “Vertical preparation”. All the articles concerning the BOPT were selected after reading the title, the abstract, and then the full text. A first screening was carried out, during which the titles and abstracts were reviewed. The following were excluded as a result:

- Literature reviews,
- Studies related to immature permanent teeth.

A second screening of the articles was then performed. The following studies were excluded:

- Articles unrelated,
- Articles not focusing on BOPT,
- Articles published before 2019.

Results

The result of the electronic search revealed three main types of articles; clinical studies, in vitro studies, and clinical reports. Even though the outcomes obtained by the clinical reports included in this review, could not be used as verified scientific results, yet they reveal the functionality of the BOPT technique, and its usefulness in variable situations.

The results of the electronic search are demonstrated in figure 1, and tables 1, 2, and 3.

I- Impact on gingival and periodontal tissues

Considerable number of studies assessed the impact of vertical preparations on periodontal health.^{43,44} Factors such as the patient's gingival biotype, iatrogenic preparation, chronic inflammation, and poor marginal fit seem to play a major role in the outcomes. Accordingly, poor prosthetic adaptation can lead to apical migration of gingival tissues and cause gingival recession. The overall assessment however, revealed better outcomes for the BOPT technique.

Paniz G et al. showed increased recession around teeth prepared with a horizontal finishing line compared to teeth prepared with a vertical finishing

line (25% vs 5.1 %) on an average period of 5 years follow up.⁴³ The author also recalls that horizontal preparations present eight times more risk of recession than vertical preparations and conclude that intrasulcular margin favors soft tissue stability and reduced gingival recession.⁴³ Along the same lines, Serra-Pastor et al. recorded only 2.9 % recession over a period of 6 years.⁴⁵

On the other hand, several studies indicated that vertical preparations seemed to provoke greater bleeding on probing (BOP) compared to horizontal preparations.^{43,46} Cagidiaco et al. recorded higher tendency for bleeding on probing for Feather-Edge Finish Lines, after 4 years follow up period.⁴⁶

Conversely, Galli et al. found only 3.2 % bleeding on probing for prosthetic crowns in a longer retrospective study of 9 years average period.¹³ While, Rinaldi et al. Demonstrated improvement in this index using the BOPT technique in their clinical case study.³⁹ These later studies seem to provide more relevant findings, since the previous two studies implicated Feather-Edge Finish Lines, implying vague resemblance to the vertical preparation technique, perhaps without fulfilling all its required criteria.

Good outcomes for gingival tissue surrounding BOPT was found, with less pocket depth and inflammation for zirconia-based when compared to porcelain-fused-to-metal crowns at 5 years evaluation time.^{14,47} Likewise Agustín-Panadero et al. recorded more than double increase in Pocket depth for horizontal chamfer control group when compared to BOPT group for the same follow up period.⁷

The BOPT technique seems to favor an overall marginal stability and evolution of the healing process in the long run, whether concerning the probing depth or gingival inflammation¹⁷; for example, Agustín-Panadero et al. reported marginal stability for full coverage restorations with BOPT technique after 10 years follow up period, though they also observed increase in the periodontal index.⁶ Other studies reported similar healing patterns for the supra-crestal soft tissue when compared with non-prepared teeth.²⁷

Finally, Agustín-Panadero et al. conducted a histological examination of the gingival and periodontal tissues for BOPT technique restoration after a 16 weeks healing time, they found the periodontal apparatus both histologically normal and free from inflammation.²⁰

II- Impact on esthetics

One of the advantages of BOPT technique is that it depends on the resilience of the gingival tissue and periodontal structures to achieve a healthy and esthetic emergence profile for the final prosthesis or restoration.^{14,31} Moreover, another perceived benefit

is the significant increase in the gingival thickness obtained around the preparation margin with this technique.¹⁹ In the anterior region where esthetics represent the main concern, Serra-Pastor et al. demonstrated that stable gingival margin, good clinical survival, and high patients' satisfaction levels were obtained by the BOPT technique over 6 years period.⁴⁸

III- Fracture resistance

Gavara et al. demonstrated in their in vitro study, comparable fracture resistance for Zirconia restorations using the BOPT technique, when compared to heavy chamfer finishing line.²⁴ Similarly, Sichi et al. analyzed the stress distribution at the margin of endodontically treated anterior teeth using finite element analysis, and found slightly better stress configuration for the BOPT preparation.²⁶

Moreover, the BOPT was especially advantageous for damaged endodontically treated teeth, where the conservation of tooth structure led to higher fracture resistance when compared to conventional shoulder preparation.²² Likewise, Llaquet Pujol et al. demonstrated the feasibility of this technique for surgically extruded teeth to preserve the gingival tissue over a follow up period of 2 years.³⁵

Additionally, several case studies adopted this technique to overcome deficit in hard or soft tissue support. For example, Rinaldi et al. applied it in a periodontally compromised situation, and were able to achieve improvement of periodontal indexes and the marginal contour.³⁹ In another example, Pirc et al. combined it with Substance-Gain Extrusion Technique (SGET) for a case with significant loss of tooth structure, finally obtaining favorable esthetic and functional outcomes.³⁸ In another study, the BOPT technique was applied for non-carious cervical lesions using composite resins, and again demonstrated coronal gingival migration, and horizontal thickening of the gingiva.⁴⁸ The BOPT technique was equally applied to No- Preparation Veneers, with similarly excellent outcomes for the gingival and periodontal tissues.^{32,40}

Moreover, the BOPT seem also to provide an out of the box solution in certain extreme cases, as has been highlighted through the study of Ferrando Cascales. et al. where the BOPT technique was coupled with forced orthodontic extrusion to maintain the tooth and the surrounding structures.²⁹

IV- Marginal misfit

The complexity of the BOPT, coupled with inadequate training, remain as the main challenges hindering its implementation on wider scale in the dental practice.⁴⁹ For example, some authors claim that minimal removal of tooth structure would necessarily lead to over contouring.⁵⁰

Likewise, García-González et al. found larger

marginal misfit with this technique when compared to Shoulder-margin on screw retained implants, even though the differences were not statistically significant. On the other hand, in their in vitro study they demonstrated higher fatigue resistance for preparation limits using the BOPT technique.²³

Several techniques have been suggested to facilitate the information transfer to the prosthetic laboratory with the absence of predetermined margins,²⁸ whether through specialized digital impressions as suggested by García-Gil et al. or Morini et al.^{30,36}, or through printing 3D prototypes as proposed by Andrea et al.⁵¹ On the other hand, Cabanes-Gumbaut et al. used a specified CAD software after digital scanning,⁵² while Castelo-Baz et al. inserted polytetrafluoroethylene (PTFE) tape into the sulcus at the moment of impression taking to obtain clear impressions.⁵³ Likewise, Li et al. suggested gel deposition technique for Zirconia restorations to obtain better marginal quality.⁴²

It has been shown that the interim restoration plays an important role in forming the gingival architecture with the BOPT technique, Llansana et al. therefore used this concept to transfer the restoration limits to the definitive cast.³⁴

V- Optimization Techniques and Strategies

Several strategies have been proposed to ensure the success of vertical preparations. These advocate the use of lasers to improve access to prosthetic margins. Accordingly, the photo-thermal, photochemical and photo-dynamic effects of laser technology were found to enhance immediate hemostasis, the acceleration of healing and the improvement of post-operative outcomes.^{54,55}

Moreover, gingival deflection using lasers has allowed the widening of gingival grooves, led to less post-treatment gingival recession, less inflammation and less pain than other methods.⁵⁴ Also, the use of digital technologies for impression taking and the manufacture of prostheses by CAD/CAM (Computer Aided Design and Manufacturing) makes it possible to improve the precision of restorations and reduce periodontal complications. Finally, the choice of biocompatible materials will promote gingival stability by limiting inflammation.

VI- Implantology

The technique BOPT has moreover been successfully implemented with dental implants, to the point of treating peri-implantitis issues, by apical positioning of the restoration limits.⁵⁶

For example, Canullo et al. demonstrated that the BOPT seemed to result in less bone loss around dental implants when compared to bone level implants. It should be noted that in their study they

used feather edge margins, but referred to it as the principle of the BOPT,⁹ likewise Casula et al. found similar outcomes in their study.⁵⁷ Others still demonstrated that the BOPT are able to stabilize peri-implant tissue around resorbed alveolar tissue.⁴¹ Moreover, Mandillo-Alonso et al. reported stable peri-implant hard and soft tissue, with less probing depth and less bone loss over a 2 year follow up period.^{15,16}

Follow up periods using this technique with tissue level implants, reported successful outcomes over three years and five years follow ups with stronger connective tissue seal and less crestal bone resorption.^{8,9} Moreover, Galli et al. demonstrated excellent medium-term results for implant rehabilitation using this technique.¹² In fact, several results reported increase bone width and thickness using the BOPT when compared to conventional groups.¹¹ Other potential advantages of this technique with dental implants, is its implementation in special cases to replace complex surgical procedures, especially in compromised situations,³⁷ or to reduce the number of clinical appointments, and to allow for immediate temporization in the posterior region, thus preserving the gingival tissues and increasing the patient comfort.³³

VII- Conclusions and perspectives

The Biologically Oriented Preparation Technique (BOPT) involves a vertical, or feather-edge, preparation without a defined finish line. And while it offers several advantages like improved soft tissue adaptation and esthetics, yet some precautions should be taken in consideration.

The BOPT technique requires clinical skills and experience to be executed properly, since inappropriate tissue management can damage the gingival and periodontal structures.⁴⁹

Moreover, issues regarding over contouring and difficulties of impression taking and accurate finishing line registration are among the difficulties concerning its application.¹⁷

Appropriate temporization is a necessary step that should be executed with care to avoid compromising the final results, the acquisition of the required skills, for both the dental practitioner and technician are prime requisites for satisfactory results.⁸

Finally, long term studies and the proper case selection of indicated cases is a key to long term functional and esthetic satisfactory outcomes on the long run.

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Table.1

Reference	Number of patients/sites	Duration	Parameters	Key results	Main limitations
Agustín-Panadero et al., 2025 ⁶	33 patients 91 abutment single-unit crowns FPD fixed partial dentures	10 years	PI, GI, PD, margin stability (MS). Mechanical behavior Patient satisfaction	Stable gingival margin, pocket depth. Slight increase in PI, GI,	Not double-blind
Agustín-Panadero et al., 2021 ⁷	40 patients 3-unit zirconia, FPD fixed partial dentures	5 years	PI, GI, PD, marginal stability (MS). Mechanical behavior	Better PI, GI, PD with BOPT, stability OK	Modest, not double-blind
Canullo et al., 2020 ⁸	15 patients 16 implants	3-year period	Bone resorption pink esthetic score (PES)	mean PES was 8.5 mean bone-level change was 0.071 mm	NO control group patient selection not randomized, limited follow-up time
Canullo et al., 2022 ⁹	85 patients (133 implants, 66 single crowns, and 28 FDPs)	Average 4.98 years	Marginal OS, complications,	Survival TL < BL in OS, survival >97%	Retrospective, heterogeneous
Canullo et al., 2022 ¹⁰	43 participants (48 implants)	4.5 years	Bone resorption, pink esthetic score (PES), and white esthetic score (WES)	Better outcomes for Tissue level implants	Retrospective, not randomized
Crespi et al., 2024 ¹¹	50 patients (23 test 27 control)	3 years	Soft tissue, papillae, mucositis ↑dimensional, papillae	BOPT > control	Retrospective, small numbers
Galli et al., 2020 ¹²	189 patients 502 implants	Average 5.11 years	GI, bleeding, recessions,	Survival 97% recession-free, Survival 99.6%	Retrospective, not control
Galli et al., 2024 ¹³	58 patients 220 crowns	Average 9.3 years,	Recessions, pockets, bleeding	Survival <3% recessions, Survival 99.6%	Retrospective, single-center
González Bonilla et al., 2024 ¹⁴	34 patients 50 crowns	Mean 5.6 years	California Dental Association (CDA) Quality Criteria GI, PD, recessions	100% zirconia vs 85.7% porcelain- fused-to-metal PFM, ZR less inflammatory	Retrospective, modest size
Mandillo-Alonso et al., 2021 ¹⁵	17 patients 26 implants	3 years	Hard and soft tissues,	SLT significant increase of ~1.5 mm in tissue thickness increase soft tissue with BOPT	Ambispective design, heterogeneity
Mandillo-Alonso V et al., 2022 ¹⁶	21 patients 32 implants.	3 years	PD, mucosal thickness, bone, plaque, bleeding.	Excellent bone stability. Stable and protective peri- implant mucosa seal and bone level	Small sample size, short follow-up, no histological analysis
Mohammad et al., 2023 ¹⁷	100 patients (split-mouth)	2 years	PI, GI, PD, CAL,	Satisfaction with BOPT BOPT good periodontal behavior and stability compared to the SHPT	Follow-up < long term, vague scale

Serra Pastor et al., 2021 ¹⁸	34 patients Single crowns 75 teeth	6 years	IP, GI, gingival thickness, satisfaction.	Survival rate of 97.2%. Increased gingival thickness, Stable gingival margins Patient satisfaction	Overlap with same patients.
Serra-Pastor et al., 2023 ¹⁹	24 patients 70 teeth	6 years,	PI, GI, PD, mechanical complications Patient satisfaction	Satisfaction 100% Survival, Stability, ↑gingival thickness	Small series, no control

Table.2

Study	Type Sample	Parameters	Comparative Results	Limitations
Agustín-Panadero et al. 2020 ²⁰	Digital 2 teeth/2 patients	Gingival design	Error reduction	Agustín-Panadero et al. 2020 ²¹
Jagdish et al. 2024 ²²	ETT 45 teeth	Fracture resistance	Fracture modes BOPT ≈ chamfer > shoulder In vitro	Limited applicability
García-González et al. 2022 ²³	Implant 45 cobalt-chromium metal frameworks	Mechanical test Marginal fit	Fatigue limit: Feather edge > Chamfer > shoulder Mean marginal fit (µm) Shoulder +++ In vitro	Limited fatigue simulation
Gavara et al. 2023 ²⁴	Zirconia 30 epoxy resin casts Finish line	Fracture resistance	Fracture resistance None ≥ chamfer > shoulder In vitro	Limited sample No artificial aging
Serrano-Belmonte et al. 2022 ²⁵	Provisional 60 resin samples Modulus	Premium flexure > Structur3	Thickness affects modulus of provisional materials	Clinically limited
Sichi et al. 2021 ²⁶	3D model Virtual models	Stress concentration of endodontically treated upper central incisors	Concentration stress BOPT viable but marginal stress > FEA model	Non-clinical
Palombo et al. 2023 ²⁷	Animal experiment 24 teeth (dog)	Hard and soft tissues healing	Soft tissues and bone Stable healing	Animal model

Table.3

Study	Technique	Results
Di Felice et al. 2022 ²⁸	Technique illustration for the clinical and laboratory steps for the BOPT	Aesthetic improvement via adapted profiles
Ferrando Cascales et al. 2024 ²⁹	Forced orthodontic extrusion combined with the BOPT to manage compromised teeth	Post-extrusion management orthodontic eruption may be less invasive than prosthetic restoration after extraction.
García-Gil et al., 2020 ³⁰	Digital impression with the BOPT technique.	Trios most accurate in terms of trueness
Granell-Ruiz M et al. 2024 ³¹	Gingival margin stabilization using the BOPT technique	Gingival level stability observed
Granell-Ruiz M et al. 2023 ³²	Gingival margin stabilization using the BOPT technique around veneers	Stability of the gingival tissues around veneers No unwanted recession
Laguna-Martos M et al. 2024 ³³	BOPT with the complete digital workflow for immediate posterior implant	Reduced number of clinical appointments and abutment-implant disconnections, Increases patient comfort
Llansana et al. 2022 ³⁴	Method of transferring the position of the interim finish line	Exact reproduction of the subgingival morphology.
Llaquet Pujol et al. 2021 ³⁵	Combining Surgical extrusion with BOPT for teeth with no ferrule	Improved gingival architecture Soft-tissue stability with the extruded teeth
Morini et al. 2025 ³⁶	Digital method described addressing the clinical challenges of impression making and emergence profile with BOPT	Accurate scanning and esthetically pleasant outcomes were obtained
Morón-Conejo et al. 2025 ³⁷	Retreatment of anterior fixed dental prosthesis using BOPT and Digital Workflow	Stable clinical and esthetic outcomes at the 2 years
Pirc et al. 2025 ³⁸	Combining the substance-gain extrusion technique (SGET) with BOPT for restoring deep subgingival fractures	The combination of SGET and BOPT was minimally invasive and cost-effective Excellent soft tissue integration and patient satisfaction.
Rinaldiet al. 2023 ³⁹	The Full Digital Workflow with BOPT to obtain good periodontal healing around fixed restorations	Validating the BOPT technique combined with full digital workflow for the correction and remodeling of gingival architecture
Alawa et al. 2024 ⁴⁰	BOPT for No-Preparation Veneers	Good gingival stability at 1 year No chippings or marginal discoloration Good patient satisfaction
Jeong et al. 2025 ⁴¹	Esthetic reconstruction of a localized severely resorbed anterior maxilla associated with peri-implantitis.	BOPT improved the health and stability of the peri-implant tissues. Excellent esthetic and functional outcomes.
Li et al. 2023 ⁴²	Compare the morphology, and margin quality of 3 types of zirconia crowns with knife-edge margins.	3D gel deposition forms a smoother and more homogeneous surface than soft milling. Knife-edged crowns had good dimensional accuracy and margin quality

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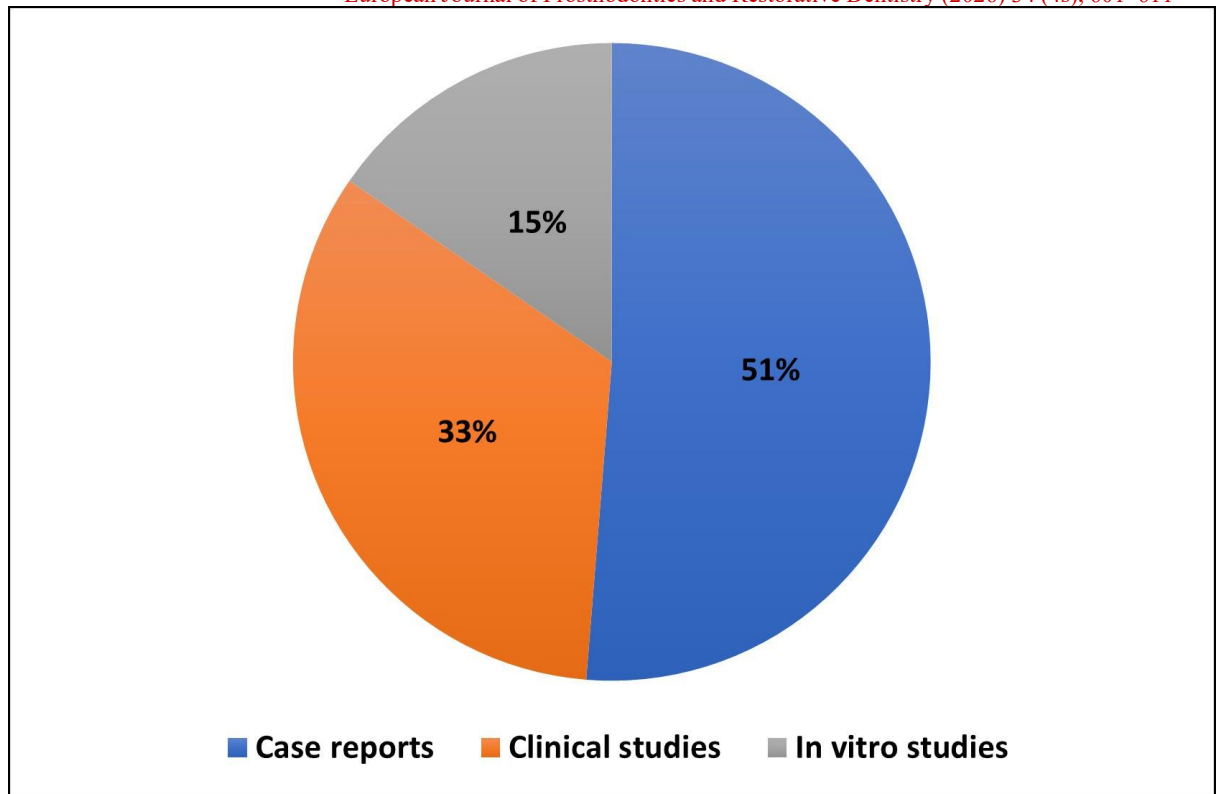


Figure 1. Percentages and types of studies included