

**Long term assessment of paediatric zirconia crowns – A systematic review**

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**Type of Publication:** Review Article

**Conflicts of Interest:** Nil

**Abstract**

**Background:** The purpose of this systematic review is to assess the long-term use of zirconia crown in pediatric dentistry.

**Methods:** A systematic search was performed through the electronic databases Medline via PubMed, EBSCOhost in English from 2012 till May 2022. Clinical trials, In-vivo studies using pediatric crowns in primary dentition in English language were included and In-vitro studies that were carried out in permanent were excluded from this review.

**Results:** This systematic review includes 9 clinical trials. A total of 862 primary teeth were restored with

zirconia crown and other crowns. Out of all the included studies, 3 studies evaluated the parental satisfaction, 3 studies assessed the oral hygiene and periodontal status restored with zirconia crown and pediatric crowns, 3 studies conducted comparative evaluation of clinical outcome of zirconia crown and other pediatric crowns.

**Discussion:** Zirconia crowns have shown to perform better comparing to other crowns in terms of esthetics, gingival and periodontal health and survival rate. However, zirconia crowns are reportedly more likely to require extensive tooth preparation and cause opposing tooth wear.

**Keywords:** Caries, Aesthetics, Paediatric, Primary teeth, Restoration, Zirconia crown

### **Introduction**

Dental caries is a debilitating disease that affects the population worldwide. Its high prevalence has become a major concern and countries all over the world are facing economic burden due to high cost of its management that is inflicted upon them.<sup>1</sup> Early Childhood Caries (ECC) is a form of caries that affect pediatric population. American Academy of Pediatric Dentistry define Early Childhood Caries (ECC) as the presence of one or more decayed, missing or filled tooth surfaces in any primary tooth in a child 71 months of age or younger.<sup>2</sup> Numerous children continue to be impacted by ECC on a global scale. 1.76 billion children with primary teeth experience it.<sup>3</sup> The unique and virulent features of ECC have been acknowledged by American Academy of Pediatric Dentistry (AAPD). It starts shortly after the eruption of the teeth, develops on smooth surfaces, and spreads quickly. ECC also cause more serious health problems than just dental problems, including difficulty in chewing, malnutrition, gastrointestinal issues, delayed or deficient growth (particularly in terms of height and/or weight gain), poor speech articulation, and low self-esteem.<sup>2</sup> ECC is primarily caused by a number of factors, including excessive sugar consumption, poor oral hygiene, poor fluoride exposure, and enamel deformities.<sup>4</sup> ECC is higher among those who are more socially isolated, especially for children who are migrants or refugees or whose parents are migrants or refugees.<sup>5</sup> This is a major oral health issue, particularly in underprivileged areas in both developing and developed nations where undernutrition is common. Choosing the best method of restoration is another important step to provide the best treatment results. There are many methods of restoration of primary

anterior teeth, materials like glass ionomer cement, composite resin, compomer or prefabricated pediatric crowns.<sup>6</sup> Full coverage restoration using crowns have gained more preference recently. Among which zirconia crown has outstanding qualities when compared to other crowns used in primary dentition like SSC, strip crown, preveenered SSCs due to its marked drawbacks.<sup>7-9</sup> This systematic review aims to explore, describe and summarize the evidence available in the literature that have assessed the clinical outcome of pediatric zirconia crowns over other crowns used in primary teeth.

### **Method**

#### **Protocol and registration**

The present review is reported according to the guideline described in The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Page MJ et al. 2020).<sup>10</sup>

#### **Search Strategy**

Search strategy and information sources

The PICO outline was followed:

P (participants): Primary teeth indicated for crown

I (Intervention): Zirconia crown

C (comparison): Stainless steel crown, strip crown, shell crown, acrylic crown

O(outcome): Occlusion, contour, esthetics, gingival health, survival rate, marginal integrity, occlusal wear, surface texture, discoloration, secondary caries.

A systematic search was performed through the electronic databases Medline via PubMed, EBSCO using broad MeSH terms and keywords to include publications in English till May 2022, by two investigators. To ensure literature saturation, the electronic search was complemented by a search through the reference lists of included studies. Grey literatures were also searched.

The PRISMA statement guidelines with predetermined search strategy were used (Figure 1).

The following search terms were used for literature search. ("child"[All Fields] OR "children"[All Fields] OR "childrens"[All Fields] OR "preschool"[All Fields] OR "pediatric"[All Fields] OR "pediatric"[All Fields] OR "toddler"[All Fields] OR "pediatric patients"[All Fields] OR "pediatric patients"[All Fields] OR "pediatric patient"[All Fields] OR "pediatric patient"[All Fields] OR "primary teeth"[All Fields] OR "primary dentition"[All Fields] OR "primary incisor"[All Fields] OR "deciduous dentition"[All Fields] OR "deciduous teeth"[All Fields] OR "deciduous molar"[All Fields] OR "baby teeth"[All Fields]) AND ("zirconia crown"[All Fields] OR "zircon"[All Fields] OR "prefabricated zirconia crown"[All Fields] OR "NuSmile"[All Fields]) AND ("stainless steel crown"[All Fields] OR "strip crown"[All Fields] OR "acrylic crown"[All Fields] OR "shell crown"[All Fields]) AND ("occlusion"[All Fields] OR "contour"[All Fields] OR "esthetics"[All Fields] OR "esthetics"[All Fields] OR "gingival health"[All Fields] OR "survival rate"[All Fields] OR "occlusal wear"[All Fields] OR "durability"[All Fields] OR "strength"[All Fields] OR "marginal integrity"[All Fields])

### **Selection Criteria**

#### **Inclusion Criteria**

The inclusion criteria for selection of studies were Clinical trials, randomized control studies reporting on zirconia crowns in deciduous teeth; Articles that studied the acceptance and preference of esthetic crowns by dentists, parents, and children were also included in the review.

#### **Articles in English language.**

#### **Exclusion Criteria**

The exclusion criteria included the articles that are: In vitro studies and investigated the effectiveness of zirconia crowns on permanent teeth Studies that were unable to access the full text;

Studies involving samples with specific health conditions (hospitalized or disabled children)

#### **Screening and Selection**

The results obtained through the search of the databases, journals and grey literature were managed systematically using spreadsheets (Excel 2010, Microsoft®, CA, USA). Identified duplicate studies were removed. Title and abstract screening of identified studies were screened by two reviewers with any disagreement resolved by consensus, or discussion with one additional external reviewer.

Full texts were obtained for all titles that met these criteria. Two reviewers assessed the full texts against the inclusion/exclusion criteria independently, with any disagreement resolved by third reviewer.

#### **Data Extraction**

Data extraction was performed using spreadsheets (Excel 2010, Microsoft®, CA, USA) by two reviewers with any disagreement resolved following discussion with one additional external reviewer. A standardized data extraction form was used to record the following details: Author/year, Title, Study design, Duration of the study, Sample size, Age limit, Intervention, Outcome.

#### **Result**

##### **Study selection**

The initial searching of electronic databases yielded 18 articles; no relevant studies were identified in the grey literature. After exclusion of duplicates, 13 records were screened based on title/abstract and 10 of those had their full text retrieved for analysis. Lastly, according to the inclusion criteria, 9 studies were included in the present systematic review.

##### **Study characteristics**

**Participants :** A total of 862 primary teeth amongst the included in-vivo studies were treated with different pediatric crowns in children of the age group 3-9 years.

## Method

The characteristics of the 9 included studies in this systematic review are given in the results of the individual studies (Table 1). Among the 9 included trials, all were clinical trials. Out of all the included studies, 3 studies evaluated the parental satisfaction of pediatric crowns including zirconia, 3 studies assessed the oral hygiene and periodontal status of children restored with pediatric crowns including zirconia, 3 studies conducted comparative evaluation of clinical outcome of zirconia and few other pediatric crowns.

## Intervention and control

Pediatric Zirconia crowns were compared with the following pediatric crowns to check the clinical outcome and parental satisfaction: Stainless steel crown (SSC), Open-faced stainless-steel crown (OSSC), Veneered stainless-steel crown (VSSC), Pedo Pearls (PP) crown, Resin composite strip crowns, Luxa crown.

## Parameters assessed

Among 9 studies, the parameters assessed for clinical outcome were surface texture, anatomical form, marginal integrity, marginal discoloration, secondary caries, retention, opposing tooth wear, plaque accumulation, gingival inflammation, and proximal contact, surface roughness; staining on crown surface; color match in 3 studies. Parental satisfaction for crown's shape, size, color, durability and overall satisfaction were assessed in 3 studies. Oral hygiene and periodontal health were evaluated by checking changes in GCF (Gingival Crevicular Fluid) volume, the simplified oral hygiene index (OHI-S), the plaque index (PI), the gingival index (GI), and measurement of the probing pocket depth (PPD) to assess the extent of periodontal destruction.

## Discussion

The studies selected showed the varying levels of evidence regarding the performance and drawbacks of zirconia crown. Reviews have been done on the use zirconia crowns in permanent dentition; however, limited evidence exists in case of primary teeth. This review is based on evidence from nine clinical trials that assessed the long term use of zirconia crown in primary teeth.

Zirconium (Zr) is a metal with the atomic number 40. It was discovered in 1789 by chemist Martin Klaproth.<sup>20-22</sup> Zr does not exist in its pure form in nature. It is found in association with silicate oxide under the mineral name Zircon ( $ZrO_2 \cdot SiO_2$ ) or as a free oxide ( $ZrO_2$ ) under the mineral name Baddeleyite.<sup>23</sup> There are three types of zirconia: monoclinic, tetragonal, and cubic. Zirconia is used in dentistry in several forms, including Yttria-stabilized tetragonal polycrystal (Y-TZP), magnesia-partially stabilised zirconia, and zirconia-toughened alumina.<sup>24</sup> Zirconia has numerous key advantages. It has good esthetic qualities, is biocompatible, and has a high wear and corrosion resistance.<sup>24</sup> Zirconia has great flexural strength and fracture toughness because of a physical feature known as transformation toughening.<sup>25,26</sup> Prefabricated zirconium dioxide ceramic crowns have recently been employed in the treatment of deciduous teeth to give a more lasting and cosmetic option.<sup>27</sup> They are also an option for those who are allergic to or sensitive to Ni-Cr.

Assessment of zirconia crowns can be evaluated in terms of clinical outcome, periodontal health and oral hygiene and also the parental satisfaction after crown placement. Nischal M *et al*<sup>15</sup> conducted the study to compare three different full-coronal esthetic restorations on severely mutilated primary anterior teeth, i.e., resin strip crowns, zirconia crowns, and luxa crown. The modified USPHS

criteria were used to compare various parameters like surface texture, anatomical form, marginal integrity, marginal discolouration, and secondary caries after 3, 6, and 9 months intervals. After evaluation, it was observed that resin strip crowns have a low success rate and a significant occurrence of secondary caries. Luxa crowns overtook strip crowns in terms of performance due to its high fracture toughness, smooth glossy surface, reduced procedure sensitivity, and less of dependence on remaining tooth structure for retention as it is luted to the tooth. Zirconia crowns outperformed the other two categories in terms of longevity and mechanical performance. This is because of its higher corrosion resistance, high flexure strength, biocompatibility, smooth and glossy surface, and superior corrosion resistance. They also pointed out the limitation of zirconia crown that these crowns required greater amount of tooth reduction, limited shade selection, limited potential to alter the shape of the crown, and cost of the crown.

Two studies by **Murali G et al**<sup>18</sup> and **Donly KJ et al**<sup>14</sup> among the included nine studies evaluated crowns on primary posterior teeth. They compared stainless crown and zirconia crown after 3, 6, 9, 12 months and 6, 12, 24 months respectively. The parameters were occlusion; surface roughness; staining on the crown surface; color match; anatomic form; marginal discoloration; secondary caries at crown margin, retention, marginal integrity, opposing tooth wear, plaque accumulation, gingival inflammation, and proximal contact. **Murali G et al** suggested that both pediatric posterior zirconia crowns and stainless steel crowns maintained good proximal contact, marginal integrity with no opposing tooth wear. But crown retention, marginal integrity, accumulation of plaque, and gingival health were better with stainless steel crown compared to zirconia crowns.

The retention ability could be attributed to lack of tooth structure to achieve subgingival preparation, due to inadequate moisture control while cementing, or due to loss of cement. On contrary to this, study by **Donly K J et al**, observed 100% success and retention of zirconia was as high as SSCs. They compared color match of the crown, where zirconia crown showed high color matching as it is tooth colored full coverage restoration unless like SSCs which has got metallic appearance affecting esthetics. The gingival health, staining of the crown, marginal integrity, opposing tooth wear all seems to be satisfactory on both the groups after the follow up period. Anatomic form was observed deteriorating after six months as it could be due to the changing dentition from primary to mixed (3-7years). Both studies concluded stating when clinical performance is considered, zirconia and stainless steel crowns are both outstanding options for posterior primary teeth. But when esthetics are of primary concern, zirconia crowns may be the best postendodontic restoration option.

Dental professionals treating children often experience parental influence in selection of restorations and the parents are getting keenly involved in clinical decision-making than ever before. There are three studies included in this review, checking the parental satisfaction of pediatric crowns. **Sharma M et al**<sup>16</sup> compared the parental satisfaction and clinical performance of pediatric zirconia crown and composite strip crowns after one year of interval. Parents were instructed to fill a questionnaire, based on their satisfaction about the crown's shape, size, color, durability, and overall satisfaction using a 5-point Likert-type scale. Parents were also asked about the level of pain and discomfort of their child with restoration over 1 year using the Visual Analog Scale (VAS). Almost equal number of parents were "satisfied" for

both the strip crowns and zirconia crowns. When the durability, retention, shape and size of crown was assessed for parental satisfaction, zirconia crown was highly chosen over strip crowns. Color of restoration and overall dissatisfaction for zirconia crowns were seen in this study as there was only one shade of crown used, whereas there are multiple shades of composite materials available which exactly match with the hue and chroma of natural enamel and dentin, for strip crowns. Postoperative pain and discomfort were seen in both crowns but was higher for strip crowns and this may be attributed to the dislodgment of the restoration itself. Considering the overall satisfaction of the parents for the restorations, it was found more for the zirconia crowns than that of resin composite strip crowns at 1-year follow-up. **Vaghela L L et al<sup>17</sup>** compared parental satisfaction and clinical performance of zirconia crown and composite strip crown. The crowns were evaluated clinically with various criteria like—color match, crown retention, gingival health, crown contour, opposing tooth wear, marginal integrity, and recurrent caries. The samples were also evaluated for parental satisfaction based on 5-point Likert scale and child liking was also recorded with Smiley face Likert scale at baseline, 3 and 9 months. Zirconia crowns showed better color match, crown retention, crown contour, and gingival health. Strip crowns showed more discoloration and chipping of material over a period of time. Study showed no opposing tooth wear, open margins, and recurrent caries in strip crown and zirconia crown group. Parents were asked to pay attention on parameters like appearance, color, size, restoration durability of crowns as well as their overall satisfaction. High parental satisfaction was seen with zirconia crown in all the parameters, while parents were dissatisfied due to gradual discoloration of some of strip crowns and its durability at 9 months

follow-up. Overall parents and children both were highly satisfied with zirconia crowns. Another study which assessed the parental satisfaction on pediatric crown was by **Salami A., Walia T., Bashiri R.**<sup>12</sup> They compared the parental satisfaction between resin composite strip crown, pre veneered stainless steel crown (PVSSC) and pre-fabricated primary zirconia crown for restoring maxillary primary incisors. Parents were asked to rate parameters such as the crown's shape, size, color, durability, and their overall satisfaction using a 5-point Likert-type scale. Parents were also asked to define the level of pain and discomfort their child ever complained during one year of the crown placement by using a visual analogue scale (VAS). The questionnaire was given soon after the placement of crowns and after 1 year post treatment. Parents rated size, color, shape and durability with primary zirconia crowns as very high. Parents were least satisfied with durability of resin composite strip crowns and color of pre-veneered stainless steel crowns. Parental overall satisfaction was highest for zirconia primary crowns followed by resin composite strip crowns and lowest satisfaction was observed for pre-veneered SSCs.

When a crown is placed on a tooth in a healthy periodontal environment, the maintenance of good periodontal health depends on marginal integrity of the crown, the crown's contour, the patient's oral hygiene, and the patient's intrinsic resistance to disease. Three studies are included in this review focusing on the oral hygiene and periodontal health after placing pediatric crowns. The study conducted by **Beldüz Kara N, Yilmaz Y**<sup>11</sup> assessed oral hygiene and periodontal health around posterior primary molars after their restoration with five different crowns Traditional SSC, OSSC, VSSC, NuSmile (NS) pediatric crown, Pedo Pearls (PP) crown. 264 crowns were given to different group and

evaluated after 3, 6, 9, 12, 15, 18 months interval. They assessed periodontal health and oral hygiene by recording, changes in GCF(Gingival Crevicular Fluid) volume, the simplified oral hygiene index (OHI-S), the plaque index (PI), the gingival index (GI), and measurement of the probing pocket depth (PPD) to assess the extent of periodontal destruction. Among all the placed crowns, we found that the teeth that were restored with a PP crown have the highest PI and GI scores, the greatest PPD, and the biggest GCF volumes. The teeth that were restored with an SSC or an NS crown have the lowest PI score, and the teeth that were restored with an OSSC have the lowest GI score and the smallest PPD and GCF volumes. This finding suggests that a SSC, an OSSC, or a NS pediatric crown should be the preferred crown types for restoring posterior primary teeth.

Two studies conducted by PK Taran, MS Kaya<sup>13</sup> and Aggarwal, P. et al<sup>19</sup> compared Zirconia Crown and Stainless Steel Crown(SSC) over a period of one year. The results showed, PI and GI scores of SSCs higher than those of ZCs after baseline, the gingival health of ZCs was also better than that of SSCs. The surface roughness of the crown material is also an important consideration. Marginal contacts, well-adapted seating, and the absence of cement remnants in the sulcus are some factors relating to plaque accumulation which further is directly proportional to long-term periodontal health around full coverage restorations. Aggarwal, P. et al also checked for the effect of different crown materials on the interleukin one beta (IL-1 $\beta$ ) content of the gingival crevicular fluid. Interleukin-1 beta (IL-1 beta) is a pro-inflammatory cytokine that has a role in gingival inflammation and immune modulation with bone resorption in periodontitis. Porphyromonas gingivalis and Aggregatibacter are the most frequent

periodontal pathogens. When compared to other groups, the SSCs group had the highest IL-1 beta levels. This might be due to the makeup of SSC, which includes nickel and chromium, which when leached into the gingival border releases immune response mediating molecules (cytokines) within 24 hours and causes inflammation. When compared to healthy teeth and SSCs, the ZC group had the lowest amount of IL-1 beta. Prefabricated ZCs require major removal of enamel and dentin substance during tooth preparation to accommodate their rigid structure and seat them passively. It may also lead to pulp exposure and the postoperative problems of pulpal inflammation. Furthermore, this level of preparation, particularly at the gingival finishing line, causes difficulties in isolating gingival bleeding. It can be concluded that zirconia crowns have a considerable advantage over stainless steel crowns due to their esthetic appearance, high durability, successful clinical outcomes.

### **Conclusion**

Currently, dentistry is more concerned about the idea of esthetics. In the past, the importance of esthetics was discounted in favour of concepts such as function, structure and biology.

However, the effects of esthetics be taken into account in every treatment plan because it is so important in a child's overall physical and mental wellbeing. There are many esthetic crowns available right now that help us in achieving parental acceptance in esthetic terms. One among them is Zirconia Crown, due to excellent esthetic properties, the acceptance is increasing among children as well as parents. It is evident from this literature review that zirconia crown can be chosen as the best full coverage restoration than other pediatric crowns. Though it has got the disadvantages of more tooth material reduction which causes pain and discomfort in children

and minimal opposing tooth wear, the clinical outcome and overall satisfaction is highest for zirconia crown. This in turn changed the quality of life of the children and parents.

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**Legend Table and Figure**

**Table 1.** Descriptive characteristics of included studies

Author and year of publication	Title	Study design	Duration of study	Sample size	Age limit	Intervention	Outcome
Beldüz Kara N, Yilmaz Y. <sup>11</sup> (2014)	Assessment of oral hygiene and periodontal health around posterior primary molars after their restoration with various crown types	Randomized, non-blinded prospective controlled clinical trial	18 months	264	5-8 year	1) Stainless steel crown (SSC) 2) Open-faced stainless steel crown (OSSC) 3) Veneered stainless steel crown (VSSC) 4) NuSmile (NS) pediatric crown 5) Pedo Pearls (PP) crown	Oral hygiene and gingival health around a restored primary tooth deteriorate with time. Our results suggest that SSC, an open-faced SSC, or a NuSmile pediatric crown should be the preferred crown type for restoring posterior primary teeth.
Salami A.,Walia T., Bashiri R. <sup>12</sup> (2015)	Comparison of Parental Satisfaction with Three Tooth-Colored FullCoronal Restorations in Primary Maxillary Incisors	Prospective clinical study	1 year	129	3-5 year	1)Resin composite strip crowns 2) Pre-veneered stainless steel crowns 3) Pre-fabricated primary Zirconia	Parental overall satisfaction was highest for zirconia primary crowns followed by resin composite strip crowns and lowest satisfaction was reported for pre-veneered SSCs. Parents were least satisfied with

						crowns	durability of resin composite strip crowns and colour of pre-veneered stainless steel crowns.
PK Taran,MS Kaya <sup>13</sup> (2018)	A Comparison of Periodontal Health in Primary Molars Restored with Prefabricated Stainless Steel and Zirconia Crowns	Randomized controlled trial	1 year	52	6-9 year	1)Stainless steel crown 2)Preformed zirconia crown	The gingival health and plaque accumulation performance of zirconia crowns were better than those of stainless steel crowns and controls.
Donly, K. J. et al <sup>14</sup> (2018)	Prospective Randomized Clinical Trial of Primary Molar Crowns: 24-Month Results	Randomized controlled trial	2 years	100	3-7 year	1)Stainless steel crown 2)Preformed zirconia crown	Current 24-month results indicate that zirconia primary molar crowns perform similarly to an established stainless steel crown for restoration of primary molar teeth
Nischal, et al. <sup>15</sup> (2020)	Clinical Comparison of Three Tooth-colored Full-coronal Restorations in Primary Maxillary Incisors	In vivo study	9 months	45		1) Resin composite strip crowns (Pedoform strip crowns, 3M, United States) 2)Prefabricated primary zirconia crowns (kids-e-crown, kids-e-Dental, India) 3) Luxa crown (DMG, Hamburg, Germany)	Zirconia crown performed best among the three full-coronal restorations. Luxa crown performed similar to zirconia crown. It can be used as an alternative economical esthetic full-coronal restoration for primary maxillary anterior incisors.
Sharma M, et al <sup>16</sup> (2021)	Comparison of parental satisfaction with strip crowns and primary anterior zirconia crowns in 3-5 years old children over 1 year	Randomized controlled trial	1 year	40	3-5 year	1)Strip crowns 2)Preformed zirconia crowns	Parental overall satisfaction was higher for preformed primary anterior zirconia crowns than strip crowns. Almost equal number of parents was satisfied with all other parameters except for durability, which was more for zirconia crowns.
Vaghela, L.L. et al <sup>17</sup> (2021)	Clinical Performance and Parental Satisfaction with Composite Strip Crown and Prefabricated Zirconia Crown for Primary Anterior Teeth: A Randomized Clinical Trial	Randomized controlled trial	9 months	102	3-6 year	1)Composite Strip Crown 2) Prefabricated Zirconia Crown	Clinically zirconia crowns showed higher success rate as compared to strip crowns and parental overall satisfaction was higher for zirconia crowns.
Murali G et al <sup>18</sup> (2022)	Clinical Evaluation of Pediatric Posterior Zirconia and Stainless Steel Crowns: A Comparative Study	Prospective clinical trial	1 year	70	3-9 year	1)Stainless steel crown 2)Preformed zirconia crown	Posterior preformed zirconia and stainless steel crowns showed good clinical performance. Preformed zirconia crowns can be an option for posterior full coronal restoration when esthetics is of prime concern for the parent and child.
Aggarwal, P. et al <sup>19</sup>	Effect of Stainless-Steel Crown and Preformed	In vivo split-mouth study	1 year	60	4-8 year	1)Stainless Steel Crown,	Preformed zirconia crown can be a relative replacement of SSC in primary

(2022)	Zirconia Crown on the Periodontal Health of Endodontically Treated Primary Molars Correlating with IL-1 $\beta$ : An In Vivo Study					2)Preformed zirconia crown,  3) Control group	molars as it causes comparatively less inflammation and with an advantage of esthetics.
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Figure 1: Flow diagram of literature search and selection criteria adapted from PRISMA

