International Journal of Clinical Trials
Divate S et al. Int J Clin Trials. 2022 Nov;9(4):274-278
http://www.ijclinicaltrials.com
pISSN 2349-3240 | eISSN 2349-3259

DOI: https://dx.doi.org/10.18203/2349-3259.ijct20222376

Protocol

A mapping review protocol for toothbrush design

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Received: 31 August 2022
Revised: 13 September 2022
Accepted: 14 September 2022

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ABSTRACT

Background: A universal method of dental home care regimen has been toothbrushing. It aids with dental biofilm and plaque removal in an attempt to prevent chronic oral diseases. Although many comparative studies have been conducted on toothbrushes and their efficacy in plaque removal, there has been no systematic mapping review focusing on toothbrush design, ease of use and safety. This mapping review aims to map key concepts, categorise existing themes and identify gaps in existing literature for future primary or scoping studies.
Methods: The protocol for this mapping review has been designed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) and the Joanna Briggs Institute (JBI) guidelines. Primary and secondary studies, guidelines, and reports about the design, ease of use and safety of toothbrushes will be considered for inclusion in this mapping review. Four databases (Dentistry and Oral Sciences Source, CINAHL, MEDLINE, and Scopus) and three sources of unpublished literature (Cochrane Library, Google, and Google Scholar) will be searched using the JBI proposed three-stage search strategy by reviewers independently. A PRISMA-ScR flowchart will be utilised to document the numbers of identified, screened, and excluded sources. Data will be extracted using a data extraction table designed by the reviewers. Extracted data will be summarised and presented in diagrammatic and tabular forms, accompanied by a narrative explanation.
Conclusions: Examining the existing literature on toothbrush design is fundamental to guide future research, design innovations, and improve oral health.

Keywords: Comfort, Ergonomics, Oral hygiene products, Toothbrush, Toothbrush design, Safety

INTRODUCTION

Oral health is crucial for an individual's general well-being. Oral diseases can have various impacts, the largest being psychosocial and economic. Compromised oral health can often lead to pain and discomfort, diminishing the quality of life, and can lead to missed hours of productivity for both adults (work) and children (school).[1] In 2010, costs of approximately US 422 billion dollars were incurred worldwide due to direct and indirect expenditure relating to oral diseases.[2]

Dental caries and periodontal diseases are the most common conditions affecting nearly 3.5 billion people worldwide.[3] One of the most significant contributors to dental caries is the ineffective removal of dental biofilm. The aggregated bacterial cells attached to tooth surface for prolonged periods produce acids that demineralise tooth structure, promoting dysbiosis, which results in dental caries.[4] Furthermore, the accumulation of these bacterial cells at or below gingival margin can manifest as gingivitis and periodontitis due to formation and build-up of dental plaque.[5] Hence, effective removal of dental biofilm and plaque is vital in preventing oral diseases.

Manual toothbrushes are the most preferred and universal home care method used to remove bacteria, debris and plaque from the teeth and surrounding oral tissues.[6] Despite the universality of toothbrushes, other factors such as an individual's oral health knowledge, determination, skills, physical abilities and attitudes also

determine the outcomes of toothbrushing (effective removal of dental plaque and biofilm). This may differ from person to person or from one population to another. To improve efficacy in plaque removal and improved oral health, toothbrush design has been constantly refined. As a result, numerous types with varying sizes and shapes of head, handle, and filaments/bristles have been researched and are available commercially to the public for use.[7]

Preliminary searches for existing literature and ongoing mapping, scoping, and systemic reviews on toothbrush design have been conducted on the following databases: Open Science Framework; Campbell Library; allied and Complementary Medicine; PROSPERO; Dentistry and Oral Sciences Source; CINHAL; JBI Systemic Review; JBI Evidence Synthesis Journal; MEDLINE; TRIP; Scopus; PubMed; and Google Scholar. However, to best of our knowledge, no systematic, rigorous mapping or scoping review that provides a broad overview, and summarises literature on toothbrush design, has carried out to date.

Many studies have been published since 1946 regarding various toothbrush designs and their effectiveness in removing dental plaque and preventing dental caries. Unfortunately, no study to date has provided a broad overview to map all evidence available; and development of design over time concerning toothbrushes.

The authors believe that a broad overview mapping the key elements/aspects of toothbrush design noted in the existing literature is required to detect gaps in current research and navigate future studies on toothbrush design. The authors have chosen a mapping review as the most appropriate research methodology for this study as the main aim of a mapping review is to provide a broad mapping overview of the existing literature and establish gaps in research.[8]

METHODS

This mapping review will be conducted by using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) and Joanna Briggs Institute (JBI) Manual for Evidence Synthesis guidelines.[9,10]

Review question

The aim is to answer a broad, overarching question: 'What is known from existing literature about toothbrush design?' In addition, we will also address the following sub-questions: What categories of key concepts/themes are present in the existing literature; and what research gaps exist concerning toothbrush design, and what aspects require further investigation?

Eligibility criteria

The population, concept, and context (PCC) framework, as recommended by JBI, was used to determine the eligibility criteria for this mapping review.[11] Studies evaluating the design features, ease of use and safety of toothbrushes will be included in this mapping review.

Inclusion criteria

Population

This element of the PCC framework is not relevant for this mapping review, as the authors aim to provide a broad overview of existing literature on toothbrush design.

Concept

This review will consider any research on toothbrush design, comfort and safety.

Context

No geographical/setting limitations will be placed for inclusion to provide a broad overview of existing literature.

Types of evidence source

Published and unpublished primary and secondary studies, guidelines, and reports published before December 2021 will be included. As resources for translation are not available for this mapping review, only studies in English will be included. Studies focusing on manual toothbrushes/ design features adaptable to manual toothbrushes, ease of use/comfort and safety features of toothbrushes will be considered for inclusion in this review.

Exclusion criteria

Letters, narratives, opinion papers, commentaries, and historic reviews will not be considered for inclusion. In addition, studies focusing on electric or sonic toothbrushes with design features not adaptable to the manual toothbrushes will be excluded from this review study.

Information sources

We will search electronic databases EBSCOhost (Dentistry and Oral Sciences Source, CINAHL and MEDLINE), Scopus, Google Scholar and Google. The first 100 items on Google, and the first one hundred articles on Google Scholar, will be screened for eligible studies.

Search strategy

A three-step search strategy proposed by the JBI has been utilised for this mapping review.[11] An initial, limited search of the Dentistry and Oral Sciences Source, CINAHL, MEDLINE, and Scopus databases was

conducted, followed by an analysis of relevant articles for text words and index terms. This helped in the development of an entire search strategy.

With the assistance of an experienced health sciences librarian, a complete search strategy was developed and later adapted for each of the databases we intend to search. A complete search strategy for MEDLINE is presented in Table 1.

Table 1: Search strategy for MEDLINE (via EBSCOhost).

S. no.	Keywords search
1.	(Toothbrush*) N7 (design* or ergonomic* or evaluation or comfort* or efficacy or safe* or "patient satisfaction*" or bristle*)

Search in each database will be conducted in one step. The search will include all studies up to the 1st of December 2021. The number of identified and selected sources will be presented in a PRISMA-ScR flowchart.[12] No other search limiters will be applied. As the final step, reviewers will also conduct a 'cited reference search', and a 'related documents search' for the most relevant articles in Scopus to source additional studies. The reviewers have no intention of contacting the authors of any primary or the secondary sources for the further information.

Study selection

All identified sources will be exported and uploaded into EndNote X9, and duplicates will be removed. The references will then be exported to RAYYAN, a web-based systematic review tool.[13] At this stage, pilot testing will be conducted.

Two reviewers will screen independently identified sources in two stages. In stage one, one reviewer will screen the titles and abstracts of the retrieved sources to identify potentially relevant documents. The second reviewer will then independently check the decisions of the first reviewer by assessing both included and excluded sources. In stage two, full texts of potentially relevant sources will be retrieved and assessed against the eligibility criteria by one reviewer. The second reviewer will then independently check the decisions of the first reviewer by assessing both included and excluded sources. These processes will be conducted 'blindly' in RAYYAN. Any disagreements arising between the reviewers at any stage of the selection process will be resolved through discussion, and a third reviewer will make the final decision where required.

A Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review (PRISMA-ScR) flow diagram shown in the Figure 1 with the numbers of identified, screened, and excluded sources will be utilised. A narrative description of the selection process will accompany this. The reasons for sources being excluded at each stage of the selection process will also be reported.

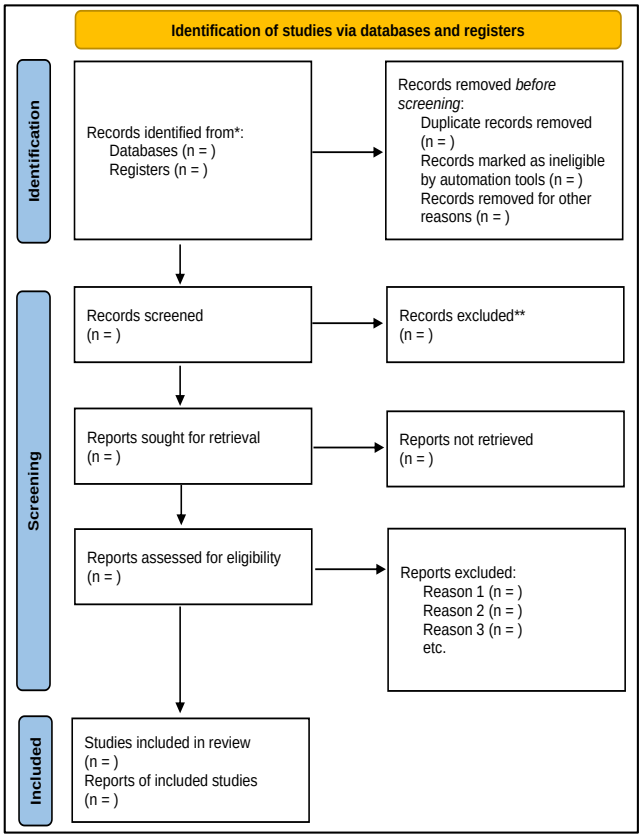

Figure 1: PRISMA extension for scoping reviews, 2020 flow diagram indicating number of studies identified, screened, and included for this mapping review.

*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Data extraction

Data will be extracted from all sources included in the mapping review using a data extraction table developed by the reviewers. The two reviewers will pilot test the data extraction table for three sources. The results will be discussed, and, if required, modifications will be introduced to the table.

The data extraction table show in the Table 2 below may be further refined during the extraction process if the reviewers decide additional data may be useful and should be extracted. Additionally, some categories may not be included in the final review if the reviewers decide those categories to be the irrelevant or not very useful.

Table 2: Data extraction table.

First author, year	Type of source	Category	Product, if applicable	Design features	Key findings	Suggestion for future research, if applicable
-	-	-	-	-	-	-
-	-	-	-	-	-	-

The author's aim is to provide a broad overview of the existing literature and to do so, the risk of bias assessment will not be performed regardless of the sources methodological quality. Any changes to the data extraction table will be recorded and reported in the mapping review. One reviewer will extract data, and the second will verify the data for accuracy. Any disagreements that arise between the reviewers at any stage of the data extraction process will be resolved through discussion, and a third reviewer will make the final decision.

Data analysis and presentation

The results of the included sources will be descriptively mapped. In addition, an overview of concepts, patterns/themes, key findings, and suggestions included in the studies will be provided.

Primary studies will be categorised by study objectives (for example, assessment of various toothbrush filaments, evaluation of safety, assessment of participants' satisfaction) and study population (for example, individuals with disabilities and individuals with orthodontic appliances). A table or chart may be used to represent studies by year visually and the questions they aim to answer.

A form of a table, chart, bubble plot or mind map may be used to present the analysed results. A narrative description will also accompany all tables and diagrams. They would show the number of studies on different topics and subtopics. The authors believe that the study results will map existing literature with toothbrush design and consider future research in the field.

DISCUSSION

To the best of their knowledge, the authors claim that no mapping review has been conducted investigating toothbrush design, comfort, and safety. This mapping review will offer a broad overview mapping key concepts within the existing literature focusing on toothbrush design or design features adaptable to manual toothbrushes. This protocol is created per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) and Joanna Briggs Institute (JBI) guidelines.[9,10] The results will be presented in both visual and narrative formats. Any research gaps will be identified and presented descriptively. This will further help to guide future research better and provide insight for advancements in product design.[14]

Studies published in other languages focusing on this review question will be excluded from this review due to a lack of translation services, which is a limitation of the protocol.

CONCLUSION

Mapping the design features of dental toothbrushes will be highly advantageous in understanding the type of designs that have been manufactured and researched to date. Additionally, determining the superiority in instrument design, ergonomics, ease of use, and safety of a particular design feature or product can be facilitated by this review. Besides providing insights for advancements in product design, it will recognise and comprehend the progress made to date and provide suggestions for future research.

ACKNOWLEDGEMENTS

Authors would like to thank Mr. Andrew South, Liaison librarian for health at the Auckland University of Technology, for his assistance in developing the search strategy for this study. We would also like to thank Dr. Yilei Li (DDS, MDS), an employee of Grin Natural Products, for her assistance with reviewing the evidence selection process.

Funding: Funding sources by a research grant from Grin Natural Products Limited
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Divate S, Morse Z. A mapping review protocol for toothbrush design. Int J Clin Trials 2022;9(4):274-8.