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The state of inclusive and human-centred design in oral healthcare

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Abstract: Inclusive Design and Human-Centred Design are increasingly applied to health and healthcare systems. However, there is limited evidence of the utilisation and understanding of these approaches specifically in oral healthcare. This paper reviews the state of Inclusive and Human-Centred Design in oral healthcare. A systematic map of 104 design in oral healthcare is screened to identify 50 projects of explicit and implicit relevance to Inclusive Design and/or Human-Centred Design. The projects are analysed to examine the nature of Inclusive and Human-Centred Design in oral healthcare; reflect on who is being designed for and with; and assess the balance of outcomes and contributions being produced. The review reveals limited recognition and awareness of both Inclusive and Human-Centred Design in oral healthcare and highlights significant inconsistencies in design communication and application. Strategic observations include expanding interventions across the four orders of design; increasing theory development; and advancing approaches to public engagement.

Keywords: inclusive design; human-centred design; oral healthcare; systematic mapping review

1. Introduction

There is growing interest in the potential of design to address fundamental and practical challenges to our societies' health (D. Campbell et al., 2020; Chamberlain, 2015). Design's capacity in healthcare has expanded beyond its traditional role in the development of medical equipment, and it is increasingly being applied as a central agent of innovation, rethinking healthcare services and systems, tackling complex problems and shaping the future of healthcare practice (Komashie et al., 2021; Tseklevs & Cooper, 2017). While this wider design in health discourse is well-established and growing, there is limited evidence on the utilisation and understanding of design specifically in oral healthcare. This paper is part of a larger body of work that systematically reviews the nature, scope and extent of design activity in oral healthcare. Specifically, this paper focuses on the state of Inclusive Design and Human-Centred Design within the wider context of design in oral healthcare.



Oral healthcare is in a period of change, with shifts towards person-centred approaches and advancements in technology transforming current models of care, alongside challenges such as population ageing and health inequalities placing increasing and unsustainable pressures on oral healthcare systems (Glick et al., 2021). Inclusive Design and Human-Centred Design are highly relevant and potentially significant to supporting the complexities of future oral healthcare, offering holistic methodologies for problem framing, problem-solving and innovation. In order to effectively achieve the potential of Inclusive Design and Human-Centred Design in oral healthcare, it is useful to first review and reflect on the current state of understanding and application.

2. Aim and research questions

The aim of this paper is to review the state of Inclusive Design (ID) and Human-Centred Design (HCD) in oral healthcare. Such investigation intends to describe the current landscape, enabling critical reflection and informing future design contributions to oral healthcare. Four distinct research questions (Table 1) guide the enquiry.

Table 1. Research Questions (RQs)

Situating ID and HCD within the wider design in oral healthcare landscape.	RQ1 What level of recognition and awareness of ID and HCD is there within design in oral healthcare?
	RQ2 What are the outcomes of ID and HCD in oral healthcare?
Characterising current ID and HCD in oral healthcare in order to inform strategic transitions.	RQ3 Which type of contributions are ID and HCD making in oral healthcare?
	RQ4 Who is being designed for/with by ID and HCD in oral healthcare?

3. Methodology and methods

3.1 Systematic map of design in oral healthcare

A systematic mapping study (conducted by the research team) which collated evidence of design in oral healthcare, is used to identify evidence relevant to this review. A summary of the systematic mapping study is provided below. Further information including the study protocol and database of included projects are available online (Leason, 2021a).

Search strategy

Figure 1 illustrates the searching and screening process. The search terminology was informed by (Chamberlain, 2015), and refined and tested through pilot searches in order to find an appropriate balance between sensitivity and specificity. Databases were selected

based on health or design subject areas, or because of their multidisciplinary coverage. Grey literature searching and snowballing of references was carried out to support and understand gaps in the database review.

Screening process

It should be noted that design projects are the primary unit of analysis and interest. A single project may have multiple publications about it, and each of these may contribute useful information. Therefore, where multiple publications related to the same project they were grouped and screened for inclusion together (Lefebvre et al., 2021).

Projects were included if:

- they were to the field of oral healthcare, and
- had input from a designer, or clear implementation of a design methodology or approach.

Projects were excluded if either:

- the full text was unavailable;
- there was no English language version available.

A review team (two from design and two from oral health) independently screened a sample of the dataset to ensure consistency. A total of 104 design projects in oral healthcare were included.

3.2 Uncovering evidence relevant to ID and HCD

Systematic maps often provide the basis for detailed exploration of a specific theme (James et al., 2016). As such, the systematic map of design in oral healthcare was searched to uncover evidence relevant to the state of ID and HCD in oral healthcare.

Pilot searching of the systematic map looked to identify mentions of the core and neighbouring fields. However, during these searches projects were identified which didn't explicitly mention the core or neighbouring fields but applied relevant design principles, mindsets, practices or techniques (Carlgren et al., 2016) and were deemed of potential significance to understanding and progressing ID and HCD in oral healthcare. As such, the criteria was extended, and projects were included in the study if there was either:

- explicit mention of ID, HCD or a neighbouring field;
- application of ID or HCD principle, mindset, practice or method (these must be ID or HCD specific (Giacomin, 2014; John Clarkson & Coleman, 2015)).

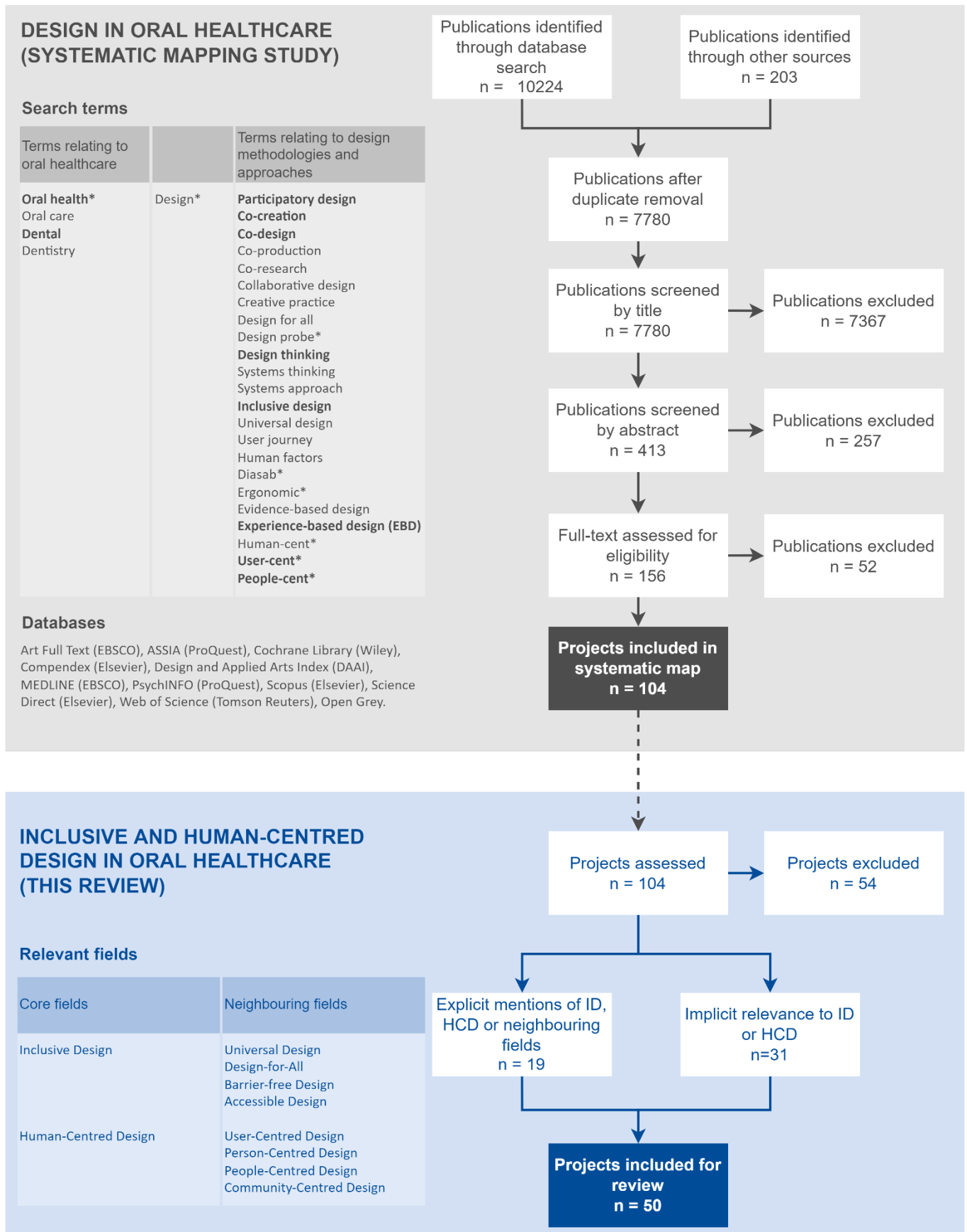


Figure 1. Searching and screening process, including previous systematic mapping study.

3.3 Data extraction and analysis

Data extraction was structured around the four research questions. The coding process followed a deductive-inductive approach. Categories were defined a priori (deductive approach) and adjusted during the coding process (inductive approach). This allows for the combination of “the strength of firm theoretical grounding with general openness towards unexpected findings” (Seuring & Gold, 2012).

The deductive approach was based on the following two sources:

1. Four Orders of Design model (Buchanan, 2001), which is applied to RQ2 to classify outcomes of design (Table 2).
2. Four Types of Design Contribution classification system (O’Sullivan and Nickpour, 2020), which is applied to RQ3 (Table 3).

The full coding procedure is outlined in Table 4.

Table 2. Four orders of design outcomes (Buchanan, 2001).

1st order	2nd order	3rd order	4th order
The design of graphics and communication.	The design of physical and tangible objects.	The design of human experiences; including interfaces, activities and services.	The design of complex systems and environments.

Table 3. Design contribution types (O’Sullivan & Nickpour, 2020, from Wobbrock & Kientz, 2016).

Interventional	Empirical	Methodological	Theoretical
New or improved products, services, systems or artefacts.	Data sets, surveys, arguments or findings which reveal formerly unknown insight and analysis of behaviours, capabilities, or interactions with interventions, etc.	Methodologies, methods, processes or techniques.	Conceptual models, frameworks, policies or principles.

4. Results

From the systematic map of 104 design projects in oral healthcare, 50 were identified as relevant to the state of ID and HCD in oral healthcare and included in this study. The full list of coded projects is published online (Leason, 2021b). This section describes the findings according to the previously defined research questions and coding procedure.

Table 4. Coding procedure.

	Codes	Description
RQ1	Recognition and awareness <i>(Explicit, Implicit)</i>	Coded as explicit where ID, HCD or a neighbouring field is directly mentioned, and implicit if not.
RQ2	Outcome <i>(1st order, 2nd order, 3rd order, 4th order)</i>	Design outcome (interventions) are assigned an order (Table 2). A project can only be assigned one order as higher orders encompass those below them.
RQ3	Contribution <i>(Interventional, Empirical, Methodological, Theoretical)</i>	Projects assigned the relevant contribution type(s) (Table 3). A project may have multiple contributions.
RQ4	Collaborators	The disciplines or stakeholder groups involved in producing the contribution.
	Audiences	The patient group that the contribution concerns.

4.1 Recognition and awareness

ID and HCD contributions are noted under two distinct categories of ‘Explicit mentions’ and ‘Implicit applications’.

Explicit mentions

Figure 2 illustrates the design projects from the systematic map of design in oral healthcare which were identified as relevant and included in this study. Of the projects included, 38% explicitly mention one or more of ID, HCD or a neighbouring field. This is 18% of the total design projects in oral healthcare. The first explicit recognition of ID or HCD occurs in 2003, where two projects state a user-centred approach in relation to the design of clinical information systems (B. Campbell et al., 2003; Koch, 2003). Following this, there appears to be no significant increase in the explicit recognition of ID and HD each year, despite growth in design activity in oral healthcare (Figure 2).

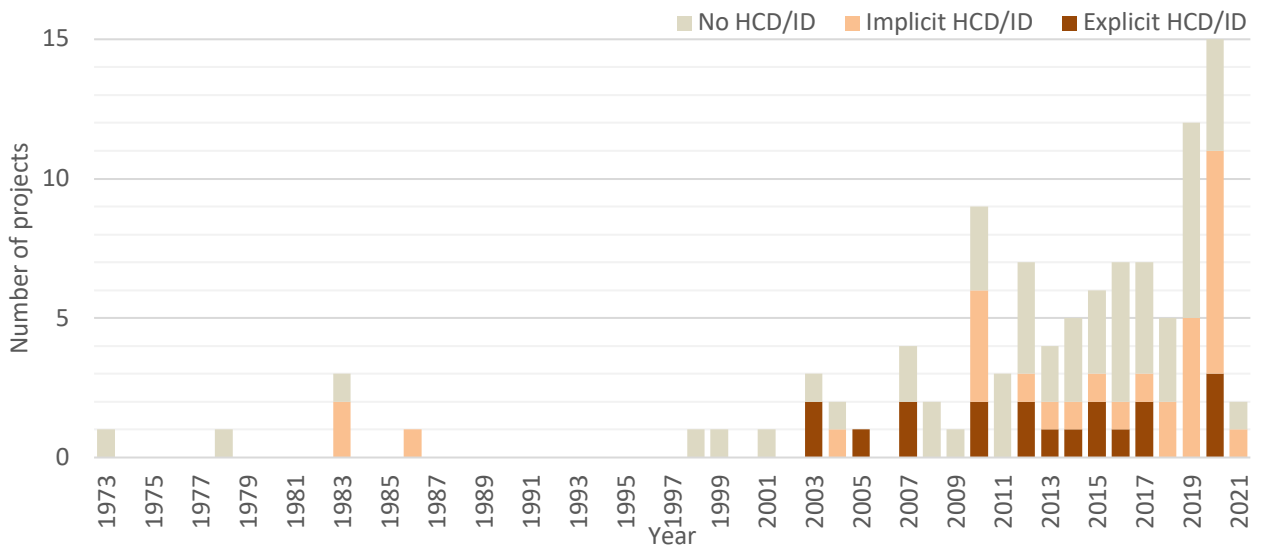


Figure 2. Design activity in oral healthcare identified by the systematic mapping study. Projects are classified as either explicit mentions of ID/HCD, implicit applications ID/HCD or no ID/HCD as described in the screening criteria. Searching for contributions ended in February 2021, hence the drop in activity in 2021.

Figure 3 shows all of the fields explicitly identified. ID makes up just 9% of these explicit mentions and none of its neighbouring fields are identified, while HCD and its neighbouring fields make up the remaining 91%. Notably, none of the projects mention both HCD (or a neighbouring field) and ID (or a neighbouring field).

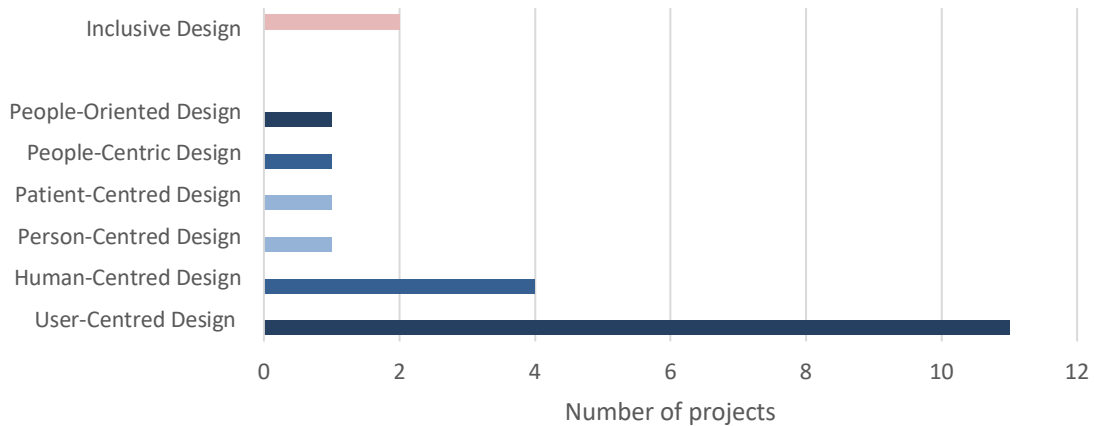


Figure 3. Explicit mentions of ID, HCD and neighbouring fields in the included projects.

Implicit applications

The remainder of projects did not explicitly mention the core or neighbouring fields. Projects in this 'implicit' category make up 62% of results, and represent 30% of all design projects in oral healthcare. An overview of common principles, mindsets, practices and techniques identified within these projects is shown in Figure 4.



Figure 4. Principles, mindsets, practices and techniques of ID and HCD identified in the 'implicit' code.

The first incidences of implicit application occur in 1983, 20 years before the first explicit mention of the fields (Figure 2). These projects include the design of portable dental chairs (Baycar, Aker, & Serowski, 1983; Baycar, Aker, Serowski, et al., 1983) and an automatic tooth brushing unit for people unable to use their hands (Rommerdale et al., 1983). Following this, there is a paucity of design projects in oral healthcare, until the 2000's where there is a growth of design activity, and implicit applications of ID and HCD appear to increase correspondingly.

RQ1 demonstrates limited recognition and awareness of ID and HCD and suggests that they not being utilised in oral healthcare. In order to promote and progress the use of ID and HCD it is useful to investigate their current state in order to establish both what might be transitioned away from as well as towards. This is done through RQ2-4.

4.2 Outcome

A design outcome was identified in 86% of the projects. Such outcomes fall under interventional classification, and their distribution across the four orders of design is shown in Figure 5.

1st order design - Graphics outcomes are found in 6% of the projects. These include toothbrush packaging (DOGA, n.d.), a children's oral health animation (Scott et al., 2020), and patient educational leaflets (Juntos, 2020).

2nd order design - Object outcomes are found in 24% of projects. These include dental chair redesigns (Baycar, Aker, & Serowski, 1983; Baycar, Aker, Serowski, et al., 1983; *Design Specific*, n.d.; Kundal et al., 2017; Lakshmi & Madankumar, 2020; Tamazawa et al., 2004), mouth brushing devices (Coventry University, n.d.; Herath et al., 2020), and a redesigned dental drill (Reynolds & Liu, 2019).

3rd order design - Interaction and Service outcomes are the most common, occurring in 56% of projects. Examples of 3rd order projects include a teledentistry smartphone application (Tobias & Spanier, 2020), a communication aid for patients with intellectual

disabilities (Menziés et al., 2013), and a oral health support service for socioeconomically disadvantaged families (Nanjappa et al., 2015).

4th order design - System outcomes occur in 2% of projects. This one design project which proposes a revised user-centred oral healthcare system for China (Chen & Li, 2020). Notably, this is also the only 4th order outcome in the wider systematic map of design projects in oral healthcare.

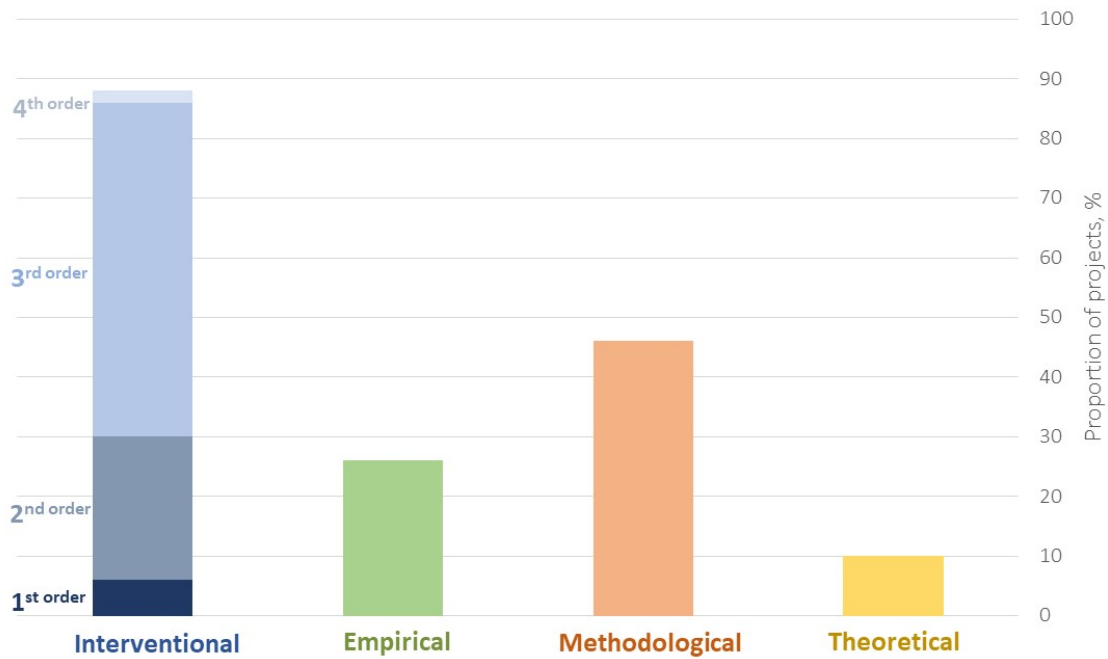


Figure 5. Outcomes (four orders of design) and contributions (interventional, empirical, methodological and theoretical) of ID and HCD projects in oral healthcare.

4.3 Contributions of ID and HCD

Figure 5 shows the balance of contributions from ID and HCD in oral healthcare across interventional, empirical, methodological and theoretical classifications. In some cases, a project included multiple contributions, resulting in 79 contributions from the 50 projects.

Interventional contributions are the most common, occurring in 86% of the projects. This includes both projects where an intervention has remained conceptual, such as redesign of a paediatric dental drill (Reynolds & Liu, 2019), as well as those which have been commercialised or implemented, such as toothbrush packaging redesign (DOGA, n.d.).

Empirical contributions are present in 26% of the projects. These include investigations aiding understanding of a problem space, such as a study of the dental photography work cycle (Altiparmakogullari et al., 2017), as well as evaluation of design solutions, such as validation of an interactive learning environment for children with dental anxiety (Salam et al., 2010).

Methodological contributions occur in 46% of the projects. This includes both where an existing design method or methodology has been applied, such as use of co-design to develop an oral health animation (Scott et al., 2020), as well as where a novel or refined method or methodology is reported, such as methods for accessible dental office design (Bill & Weddell, 1986). The former is most common, with 83% of the methodological contributions being the application of established design methods and methodologies.

Theoretical contributions are found in 10% of the projects. These include both the application of existing models, frameworks and principles, such as application of persuasive design principles to the design of an intervention for child dental anxiety (Salam et al., 2010), and the development of new or refined ones such as principles of workspace layout and lean manufacturing specifically for dental office spaces (Ahearn et al., 2010).

4.4 Collaborators and audiences of ID and HCD

Separate codes are used to indicate who the design is for (audiences) as well as who has been involved in the design project (collaborators) since the relevant population hadn't always participated in the design process.

Collaborators include both lead contributors and all others involved, such as patients who participated in a project but didn't author the documentation. Collaborators are classified by their profession or stakeholder group. Due to the variety of professional titles used across disciplines, five broad codes were chosen to synthesise the contributor types, these are shown in Figure 6.

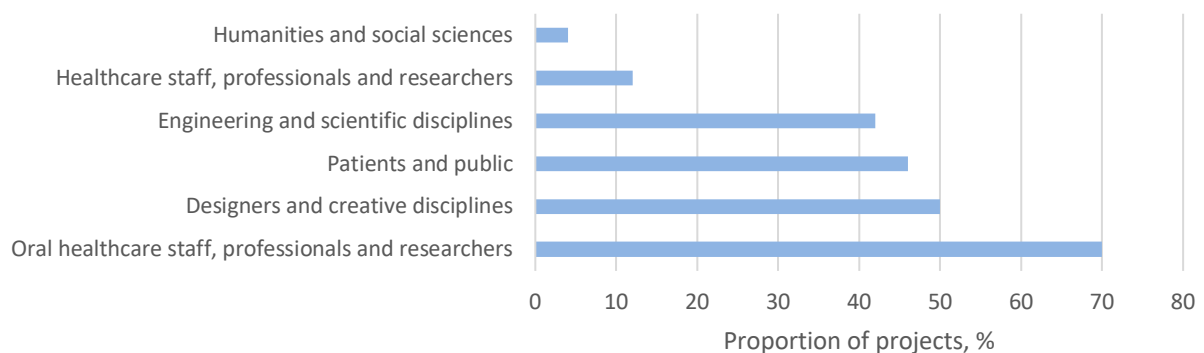


Figure 6. Collaborators to ID and HCD projects in oral healthcare, shown by the percentage of projects they were involved in.

Audiences are the specific patient groups affected by the ID and HCD projects in oral healthcare. This might not necessarily be the end-user of an intervention or the audience of a contribution, but the patient group to which it is relevant. For example, the intended user of Reynolds and Liu's dental drill is dentists, however, the relevant patient group is children with dental anxiety (Reynolds & Liu, 2019). This coding approach was selected to uncover potentially extreme or excluded user groups that are relevant to ID and HCD in oral healthcare. The patient groups identified are shown in Figure 8.

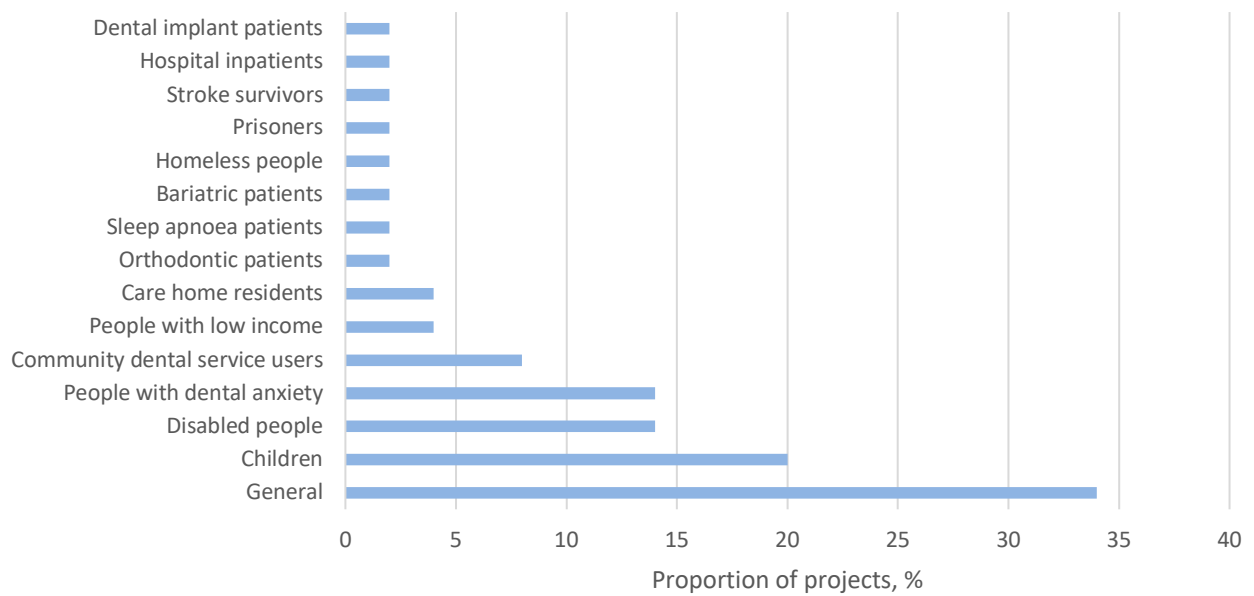


Figure 7. Audiences of design projects in oral healthcare, shown by the percentage of projects they were involved in.

5. Discussion

Discussion of the results is structured around the four RQs.

5.1 What level of recognition and awareness of ID and HCD is there in design in oral healthcare?

The review reveals a limited number of explicit mentions of ID, HCD and their neighbouring fields within the wider design and oral healthcare landscape. Furthermore, there has been no increase in the explicit recognition of ID and HCD in recent years, despite the significant growth of design presence and activity in oral healthcare. This indicates that current recognition and awareness of ID and HCD in oral healthcare is limited and stagnant. In order for ID and HCD to progress and establish themselves in oral healthcare, there is a need to understand why they have seen no growth, and to interrogate barriers and drivers to their adoption.

The missing voice of ID

One prominent gap is the paucity of ID, which features in less than 2% of all design projects in oral healthcare. In contrast, oral healthcare is more aware of HCD and its neighbouring fields, with user-centred design being particularly prominent. Such recognition could be in part due to pushes towards patient-centred care in dentistry (Alrawiai et al., 2020), as there is perhaps implicit relevance of HCD to patient-centred care reflected in the terminology as well as the approach itself.

Despite a lack of recognition, an ID approach could be potentially significant and instrumental to key issues facing modern oral healthcare systems such as oral health inequalities, poor preventative oral health, and population ageing (Benda et al., 2020). Interestingly, the review uncovered numerous projects which do not mention ID but tackle problems and work with populations highly relevant to ID. For example, areas such as designing for disability, mental health and wellbeing, ageing and marginalised communities could potentially benefit from holistic ID involvement. This raises the question of why ID isn't already recognised and involved in such projects, and presents an opportunity for the value of ID to be explored and demonstrated in these areas.

Inconsistent design communication and application

The screening and coding of evidence uncovered variations and inconsistencies in the communication and application of ID and HCD in oral healthcare. We suggest that this is significant as both design communication and application play an important role in the recognition and awareness of ID and HCD.

Projects included in this study range from those which directly mention ID or HCD but don't apply it ('superficial' ID/HCD), to those which don't mention ID or HCD but apply it ('hidden' ID/HCD). Figure 8 illustrates these scales of design communication and application, and the nature of ID and HCD projects found at their intersections.

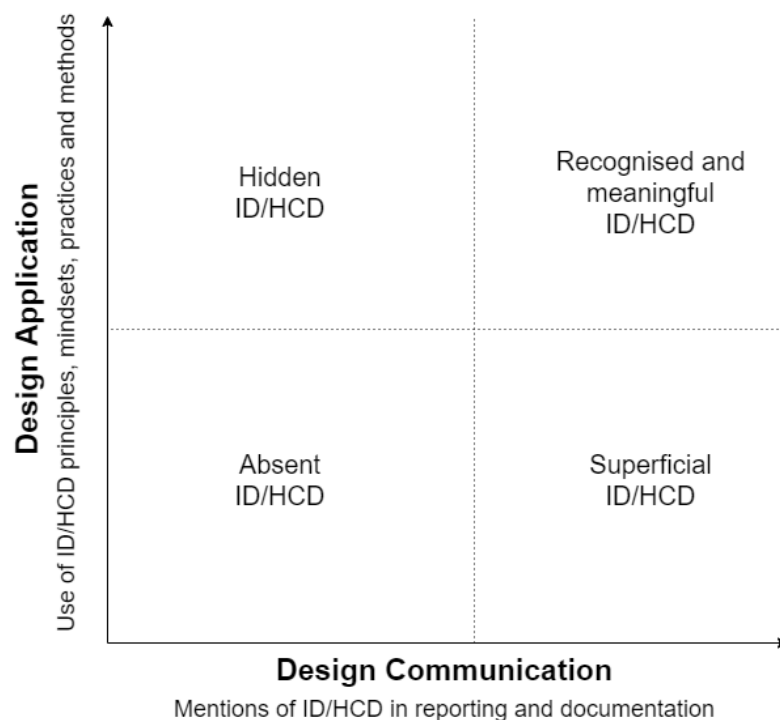


Figure 8 A Matrix of Design Communication and Application.

Issues around design communication are highlighted by the large body of design activity which includes only implicit notions of ID and HCD. Such projects are significantly more

common than explicit uses of ID and HCD. This demonstrates an important barrier to future recognition and awareness of ID and HCD in oral healthcare. Implicit application and poor communication results in 'hidden ID/HCD', ultimately limiting recognition and further uptake of the fields. For example, 62% of the projects included in this study would not have been identified through searching for ID, HCD and adjacent terminology, and were only identified due to the methodology which reviewed an existing systematic map of design in oral healthcare.

Poor communication is likely linked to the varied reporting standards within design, and an assumed shared knowledge of approaches between designers. In contrast, at the other end of the design communication axis, a project explicitly mentions the field in the title, abstract, key words, and text, making it easy to identify. Clear communication of ID and HCD is essential when operating in a different field such as oral healthcare, as it enables recognition and appreciation of the fields for non-designers.

Issues around design application concern the extent to which ID or HCD has been meaningfully applied. Where ID and HCD are stated, significant disparity was found in the level of design application. For example, in Tobias and Spaniers publication "Developing a Mobile App (iGAM) to Promote Gingival Health by Professional Monitoring of Dental Selfies: User-Centered Design Approach", the term 'user-centred design' does not appear at any point in the full text, despite being stated in the title (Tobias & Spanier, 2020). Here, design has been communicated but not applied, resulting in 'superficial ID/HCD' and demonstrating the potential for ID and HCD to be used as "buzz-words" without any meaningful impact. In the oral healthcare landscape, such projects present a threat for ID and HCD as they risk unsuccessful solutions which undersell the value of ID and HCD to oral healthcare. In contrast, Erichson and Torgersson define and explain the rationale for the user-centred design approach and methods used in their development of mVisualiser (a patient data exploration interface) (Erichson & Torgersson, 2005). In this case, the design approach has been both clearly communicated and applied, hence the ID/HCD is 'recognised and meaningful'.

Uncovering incomplete and missed opportunities for ID and HCD

The Matrix of Design Communication and Application can be used to uncover incomplete and missed opportunities for ID and HCD.

The majority of projects in the 'implicit applications' code have issues with both design communication and application. While such projects are relevant to ID and HCD, and have some level of design application, they don't represent a holistic ID or HCD approach, often just incorporating one element rather than a whole package of principles, mindsets, practices and techniques. Reflecting on and recognising these incomplete and missed opportunities might help to progress ID and HCD and invites future projects to achieve potential in these areas.

5.2 What outcomes are ID and HCD producing in oral healthcare?

Mapping ID and HCD activity in oral healthcare to Buchanan's orders of design reveals a skew towards 3rd order design. This reflects recent advancements and increased adoption of technology within oral healthcare. For example electronic health records, connected products and virtual reality are increasingly used (Walls, 2017) which all require an element of 3rd order design. Simultaneously, fields such as service design and experience design have grown in recent years, and the wider design landscape has seen a boom in 3rd order design (Canvas Editorial, 2017).

The forgotten orders of design

One noticeable finding is the lack of 1st order contributions. The 1st and 2nd orders of design represent the traditional realm of design in communication and physical objects, and as such, it is surprising to see the newer 3rd order of design eclipsing these long-established orders.

It should be noted that these findings represent what has been documented and do not reflect the full extent of design practice in oral healthcare. Is design in the lower orders not happening in oral healthcare? Or is it just not deemed worthy of being documented? In either case, the lack of 1st order design in oral healthcare invites ID and HCD to consider whether there are missed opportunities in the lower orders. Furthermore, as ID and HCD mature in oral healthcare and expand into new applications in the higher orders, their value in the lower orders shouldn't be forgotten, ignored or undocumented.

Emergence into the 4th order

Within the wider landscape of design, the 4th order of design is a new and growing area (Buchanan, 2019). As such, we can expect an emergence of 4th order design in oral healthcare concerned with organisational transformations and systems shifting. It is promising that the only 4th order project from the wider systematic map was included in this review. ID and HCD are highly relevant as 4th order design emerges in oral healthcare, particularly in ensuring the development of equitable and person-centred systems of care.

5.3 Which types of contributions are ID and HCD making in oral healthcare?

In order to robustly establish the state of ID and HCD in oral healthcare, it is important to acknowledge and capture the wider and strategic landscape of design. While the four orders of design model has been used to understand the nature of interventional contributions, considering contribution types beyond this allows an assessment of the strategic value of design beyond outcomes. Figure 9 illustrates an extension of the four orders of design model which encourages consideration of contributions beyond the interventional level.

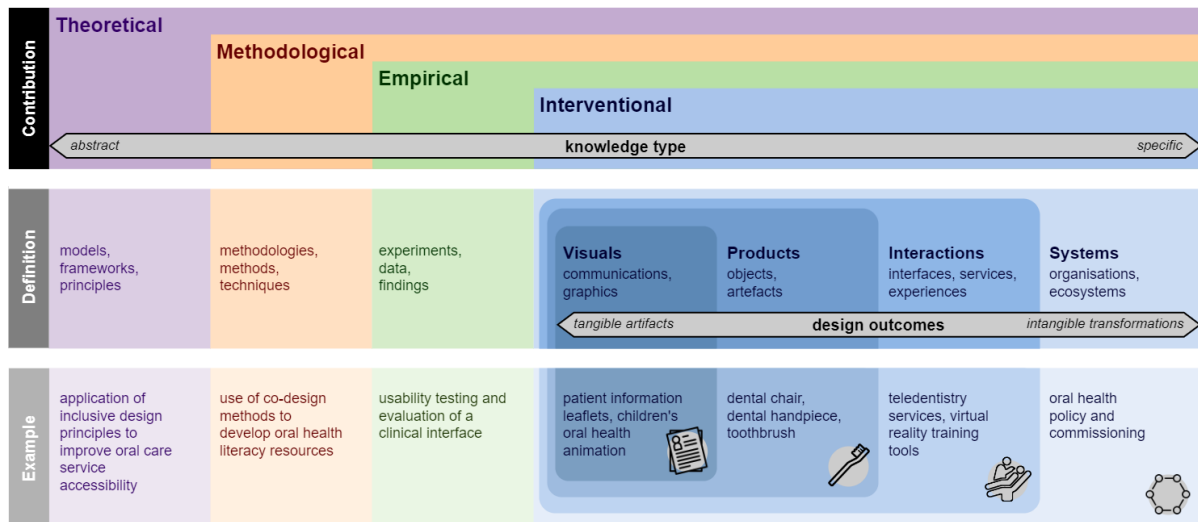


Figure 9 Design Outcomes and Contributions Canvas.

A knowledge building gap

The results highlight an unbalanced landscape of HCD and ID contributions to oral healthcare, with the majority of contributions being interventional. Theoretical, methodological and empirical contributions lie in the wider model of design shown in figure 9 and are contributions to knowledge. There is a lack of HCD and ID knowledge contributions in oral healthcare. This is significant as it leaves little foundation for new interventional contributions to learn from and build upon. It also means that there are no rigorous principles or measures to assess quality, steer and define success in HCD and ID activity in oral healthcare. As ID and HCD activity and applications grow in oral healthcare, particularly into the 4th order of design, there is a need for an increased and enhanced knowledge basis.

5.4 Who is being designed for/with by ID and HCD in oral healthcare?

Patient and public involvement

A variety of stakeholders are involved in ID and HCD in oral healthcare. This is perhaps expected from ID and HCD approaches which are inherently interdisciplinary, collaborative and participatory (Giacomin, 2014; John Clarkson & Coleman, 2015).

Public and patient participation is of particular interest to not only ID and HCD but also oral healthcare because it is increasingly lauded in healthcare policy and practice, and is often a requisite for securing funding (Madden & Speed, 2017). Despite this, patients contributed to less than half of the projects. Moreover, levels of participation varied greatly; for example from surveying users to evaluate the design of a dental unit for wheelchair users (Tamazawa et al., 2004), to rich involvement and collaboration throughout the design process in co-producing oral health literacy resources (*FDI Whole Mouth Health*, n.d.).

The 'Ladder of Participation' (figure 10) sets out levels of participation ranging from 'coercing' to 'co-producing'. Projects included in this study mostly lie in the 'doing to and for' levels of the ladder, however, recent uptake of co-design methods has resulted in a general trend up the ladder. Future ID and HCD projects could help facilitate patient and public involvement in oral healthcare, continuing this move up the ladder towards the most meaningful and valuable engagement.



Figure 10 Ladder of participation (Slay & Stephens, 2013).

Design without designers

Designers and creative disciplines are only involved in half of the projects. Moreover, where a designer is involved, the level of contribution varies. An interesting example is from Scott et al, who used co-design to create a children's oral health animation (Scott et al., 2020). No design professional was involved in the co-design process, however, designers were employed to create the resulting animation. This demonstrates a wider problem in the design in the healthcare landscape. Despite interdisciplinary collaboration being common in healthcare innovation, design is often excluded, even when there is something clearly being designed or a design method is being used. No designer would attempt to perform dentistry, so why is it assumed that oral healthcare professionals can perform design without input from a designer? As designers we need to demonstrate the benefit of engaging with designers rather than just design methods.

Priority groups in oral healthcare

Designing with extreme and excluded groups is a key principle of ID, as such groups present the most diverse design challenges and opportunities (Clarkson & Coleman, 2015). The

populations identified give an indication of those currently excluded from mainstream oral healthcare solutions, with the most common groups being disabled people and children. Much of the current focus when designing for these groups is on physical access. There is an opportunity to explore HCD and ID beyond this, extending also to notions such as cognitive capabilities and emotional inclusion. Future work might interrogate how these groups have been identified, whether any groups are being missed, and how they might intersect.

6. Strategic observations on ID and HCD in oral healthcare

Examination of the RQs in Section 5 provide key strategic observations on the current state and future potential of ID and HCD in oral healthcare. These are outlined in Table 5.

Table 5. Strategic implications for ID and HCD in oral healthcare

Research Question	Implications for ID and HCD in oral healthcare
RQ1 Level of recognition and awareness	<ul style="list-style-type: none"> Ensuring ID and HCD are clearly communicated and meaningfully applied. Engage with ID and HCD holistically, both in problem-framing and problem-solving, and across principles, mindsets, practices and techniques.
RQ2 Design outcomes	<ul style="list-style-type: none"> Consider the value that ID and HCD could bring to 1st order design outcomes i.e. graphics and communication. Ensure the involvement of ID and HCD at 4th order design in oral healthcare, i.e. systems transformations.
RQ3 Type of design contributions	<ul style="list-style-type: none"> Establish and share foundational knowledge in the form of theoretical, methodological and empirical contributions to support design interventions.
RQ4 Collaborators and audiences	<ul style="list-style-type: none"> Facilitate meaningful patient and public involvement. Investigate excluded populations in oral healthcare, extending notions of inclusion beyond physical access.

7. Limitations

The ubiquitous nature of the word ‘design’ makes it difficult to conduct literature reviews. Limited documentation and dissemination of design practice, as well as a propensity for ‘journalistic’ titles and abstracts makes identifying design difficult, meaning that some design activity has likely been missed (Chamberlain, 2015).

Data was primarily retrieved from academic literature. Whilst methods were employed to identify grey literature, conducting an exhaustive grey literature search has inherent limitations. It is inevitable that there are design contributions to oral healthcare which are not well documented or published. As a result, the findings may be skewed towards design

research over industry. An element of novelty is generally required for a contribution to be considered worth publishing. As such the search methods are suited to capturing the state of the art in design, but perhaps lack representation of design status quo, or perceived without innovation. Also, academic literature is likely to be “cleaned-up” versions of real-world practice, and there is little representation of failure.

Finally, searches were carried out in the English language, meaning that the findings are likely Eurocentric and may not be representative of the nature of ID and HCD across all geographies and cultures.

8. Conclusion

This study examined the state of ID and HCD in oral healthcare. A systematic mapping review of design projects in oral healthcare was used to identify 50 projects of relevance to ID and HCD. The review uncovered limited recognition and awareness of ID and HCD in the wider landscape of design in oral healthcare; highlighting problems in design communication and application; uncovering incomplete and missed opportunities for ID and HCD; a focus on 3rd order design outcomes (i.e. interactions and services); and a knowledge building gap. Table 5 summarises key observations and strategic implications to enhance future ID and HCD research and practice in oral healthcare.

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