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Citation (APA)
Bodell, F. K., Pannunzio, V., Houwen, J., Lame, G., Snelders, D., & Kleinsmann, M. (2025). Design knowledge for digital health implementation: a scoping review based on citation analysis. *Design Science*, *11*, 1-34. Article e31. https://doi.org/10.1017/dsj.2025.10022

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Design Science

Design knowledge for digital health implementation: a scoping review based on citation analysis

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Abstract

Implementing changes to digital health systems in real-life contexts poses many challenges. Design as a field has the potential to tackle some of these. This article illustrates how design knowledge, through published literature, is currently referenced in relation to the implementation of digital health. To map design literature's contribution to this field, we conducted a scoping review on digital health implementation publications and their use of references from nine prominent design journals. The search in Scopus and Web of Science yielded 382 digital health implementation publications, of which 70 were included for analysis. From those, we extracted data on publication characteristics and how they cited the design literature. The 70 publications cited 58 design articles, whose characteristics were also extracted. The results show that design is mainly cited to provide information about specific design methods and approaches, guidelines for using them and evidence of their benefits. Examples of referenced methods and approaches were co-design, prototyping, human-centered design, service design, understanding user needs and design thinking. The results thus show that design knowledge primarily contributed to digital health implementation with insights into methods and approaches. In addition, our method showcases a new way for understanding how design literature influences other fields.

Keywords: design research, digital health, healthcare design, implementation, scoping review

Received 19 September 2024
Revised 04 July 2025
Accepted 10 July 2025

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Des. Sci., vol. 11, e31
journals.cambridge.org/dsj
DOI: 10.1017/dsj.2025.10022

1. Introduction

Herbert Simon famously wrote "*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones*" (as cited in Simon 1996, p. 111). To change a situation into a preferred one and realize the proposed benefits of the new situation, the developed ideas for change have to be implemented in real-life contexts. In this article, we will explore how design knowledge can contribute to this process of implementation.

Design knowledge has been described by Horváth (2004) as both knowledge *about* design and knowledge *for* (i.e used in) design. Since design is both a field of investigation and a human practice, there is a general consensus that design

https://doi.org/10.1017/dsj.2025.10022 Published online by Cambridge University Press

knowledge exists in many forms, such as in artifacts, tacit knowledge within practitioners and scientific knowledge in published research (Cross 1982; Horváth 2004; Stolterman 2021). As we are interested in sharing knowledge between fields, we will focus on the formal design knowledge that the academic design research community publishes. Building formal design knowledge in the form of theories, ideas and concepts has been described as a way to challenge and inspire current practice to improve it (Stolterman 2021). By continuing to build a rich body of knowledge on implementation, we can improve implementation processes and maximize the impact of investments in using new innovations (Bauer *et al.* 2015; Cabassa 2016).

In this article, we will focus on the digital health domain and illustrate how researchers in digital health implementation use design knowledge in their published contributions. This is because implementation is a particularly prominent topic in healthcare. In this domain, Chambers, Glasgow, & Stange (2013, p. 3) define implementation as the "initial process of embedding interventions within settings." An example could be the implementation of video calling (an intervention) to a general practice office (a specific setting) to connect with patients remotely. The intervention, video calling, is employed to achieve an intended purpose, and the context of application is defined by the general practice staff, the patients, the technological infrastructure and other elements. Here, the starting point is different from that of a design project. When designing, the starting point is a setting that is to be improved; in contrast, implementation starts with an intervention that is meant to improve the setting but still needs to be adapted and embedded in the context.

Digital health covers various technologies, such as wearables, patient record systems, video conferencing, mobile applications and artificial intelligence. These technologies are currently used to increase the quality of care, reduce inefficiencies, improve access to care and improve patient personalization (U.S. FDA 2020). Although there are clear potential benefits to these technologies, realizing them has often been slower than anticipated due to difficulties in implementation (Wachter 2016). For example, digital health implementations are often planned around an oversimplified model of the condition, with unclear value propositions, and plausible reasons for users to reject the intervention; in addition, there is often an inability to adapt and evolve these technologies over time to continue to meet the intended needs (Greenhalgh *et al.* 2017). Digital health solutions are also often incompatible with existing systems, work practices (Ross *et al.* 2016) and system-level complexities such as financial, regulatory, legal and policy constraints (Greenhalgh *et al.* 2017; Bente *et al.* 2024). To address some of these implementation issues, methods and approaches from the design field can help, for example, by identifying and designing for the needs of different stakeholders (Clarkson 2018; Heiss & Kokshagina 2021) while keeping into consideration the broader system (da Costa Junior, Diehl, & Snelders 2019). Given the increasingly constrained healthcare landscape and the many challenges digital health faces, establishing and improving implementation processes is crucial for realizing the benefits that digital health solutions can bring. This makes digital health a good candidate for exemplifying the use of design knowledge in implementation.

The topic of designers and design research taking part in implementation has previously been brought to attention by Norman & Stappers (2015), who suggest

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that designers should contribute to implementation when dealing with complex sociotechnical problems. Karlsson *et al.* (2024) also argue that design practices such as co-creation, prototyping and user research can potentially be beneficial during implementation. More generally, implementation issues can be seen as examples of ill-defined or 'wicked' problems that often arise in social systems, with multiple stakeholders with conflicting interests and different perspectives (Buchanan 1992). One of the fundamental roles of design is to tackle such ill-defined problems (Cross 1982) by creating and reflecting on additions and changes to the artificial world (Cross 2001). Treating implementation processes as ill-defined problems and attempts to change the artificial world suggests that design can contribute to implementation processes. Design methods and approaches also have the potential to create more implementable solutions through understanding users and changing and evaluating the intervention iteratively (Simonsen & Hertzum 2012; Wiltschnig, Christensen, & Ball 2013), which can help to adapt the intervention to improve the integration with the target context.

Research question

To explore the potential contribution of design knowledge in digital health implementation, we have limited ourselves to formal design knowledge published in the academic literature, as this literature often seeks to reveal knowledge within design. Starting from design research literature, we aimed to illustrate how its insights have already made their way into the literature on digital health implementation[1]. The intention is to understand current areas where the design field contributes to the implementation of digital health and use this as a basis to discuss future steps. To explore this, we sought to answer the following research question: *How is design literature cited in digital health implementation literature?* We looked at this from three perspectives: (1) the purpose of citing the design literature, (2) the concept from the design literature that is referred to and (3) the characteristics of the design articles that are cited. The first two perspectives will be explored by examining digital health implementation articles, while the third one will be explored by examining the design articles being cited. This will provide insights into how design knowledge is thought to contribute to digital health implementation and which design approaches or methods are considered to be valuable for digital health implementation. This, in turn, can help the design research community understand how to shape its research to be beneficial for the digital health implementation research audience.

The structure of the article is as follows. First, we present the methodological approach of the study. We then present the results and discuss the potential of design to contribute to digital health implementation and what the design community could do to improve its impact on implementation.

2. Method

To investigate how design knowledge contributes to digital health implementation, we are limiting ourselves to formal knowledge published in academic design research. In this study, 'design knowledge' thus means formal knowledge

[1]In another ongoing complementary study, we are interviewing designers doing digital health implementation to understand how they are contributing with their practices.

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shared in the academic design research community, in the form of academic publications.

In this investigation, we explored how design articles are cited through a scoping review. This type of review appears to be suitable for our scope, as this study aims to provide an overview of existing literature (Munn *et al.* 2018). To structure our review process, we used the five steps from Arksey and O'Malley's (2005) framework. The first step in conducting the scoping review was to create a research question. This was a collaborative effort among all co-authors, where the starting point was to understand how design knowledge makes its way into digital health implementation and how we can gather insights about this through literature. However, this scoping review differs from traditional scoping reviews, as we use a set of journals as a starting point for our search. By using journals, we did not have to limit the search to specific keywords and could be open to any topics that might occur. Using this approach, we first examined the digital health implementation publications that cite design articles, and second, we examined the design articles that were cited by these publications, creating two sets of publications. The process was structured as follows:

Steps relating to digital health implementation journals.

1. Define key design journals to represent the design literature (explained in 2.1).
2. Search for digital health implementation records that cite publications from the selected design journals (explained in 2.2).
3. Screen the records abstracts and full text (explained in 2.3)
4. Collect and analyze data from the digital health implementation publications (explained in 2.4).

Step relating to design journals.

5. Collect and analyze data from the cited design publications (explained in 2.5).

These steps will be elaborated upon in the next section. When reporting the process and results of the scoping review, we followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco *et al.* 2018).

2.1. Journal selection

To identify publications on digital health implementation that cite design literature, the design field had to be defined. To represent the design research field, we chose to select a number of key design journals. The starting point for this selection was an article by Gemser *et al.* (2012) that divides design journals into general design journals and journals that are specialized in a subdiscipline of design. We chose to use the general design journals as they publish articles across subdisciplines. Cash (2018) and Huynh-Dagher *et al.* (2022) have taken a similar approach and also added journals to the initial list by Gemser *et al.* Together, they added *Design Science* and *Research in Engineering Design* as general design journals. We added those two journals as well. Additionally, we chose to include *She Ji*, as it can be regarded as a new general design journal, which did not yet exist at the time of the publication of the article by Gemser *et al.* The complete list of selected journals thus includes *Design Studies, International Journal of Design, the Design Journal, Design Issues, Journal of*

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Engineering Design, Research in Engineering Design, She Ji, Journal of Design Research and *Design Science*.

2.2. Search strategy for digital health implementation records

To find digital health implementation records, we conducted searches in Scopus and Web of Science (WoS). These databases contain both design and digital health articles, and they also make it possible to conduct searches that start from pre-specified journals, which was required for our two-step method. We searched for digital health implementation records that cite each of the selected design journals by:

a. Searching for the name of each design journal as source title (Scopus) or publication title (WoS).
b. For Scopus, selecting all articles from the journal and choosing "View cited by" to present all records that cited the design journal.

For WoS, selecting "Citation Report" and then the total number of articles citing the papers from the journal under "Citing Articles."

c. Using the search query below to find all records about digital health implementation that cited the selected design journals. *TITLE-ABS-KEY ("eHealth" OR "e-Health" OR "Telehealth*" OR "Tele-health*" OR "telemedicine" OR "telemedicine" OR "mHealth" OR "m-health" OR "mobile health" OR "health information technolog*" OR "health informat*" OR "digital health*" OR "digital medicine") AND TITLE-ABS-KEY ("implement*" OR "embed*" OR "integrat*" OR "realiz*" OR "realis*" OR "adopt*")*

This search query was used in Scopus, and the same, but removing '*TITLE-ABS-KEY*' from both parts of the query, was used in WoS.

These three steps were conducted for all nine of the selected design journals in both databases. For each step, we also noted the number of publications from each publication, the number of publications that cited the journal in total and the number of publications that cited the journal and were about digital health implementation. The initial search and data collection were conducted on the 5th of January 2024, and the search query and data collection were revised on the 9th of July 2024. The search was then updated on the 17th of March 2025 after peer review.

2.3. Abstract screening and eligibility assessment

We used the Rayyan.ai online platform to support the screening process, which was based on three inclusion criteria (Table 1). After uploading all records to Rayyan, we removed duplicates and checked for inclusion criterion 1. Three researchers (FB, VP and JH) then screened the publications' titles, abstracts and keywords for inclusion criterion 2. At least two researchers independently screened the titles and abstracts for each publication, and disagreements were resolved through discussion among the three researchers. After the abstract screening, full texts were checked for eligibility using criteria 2 and 3 (see Table 1). After full-text screening,

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Table 1. Criteria used for eligibility assessment

Inclusion criterion 1	The publication is a research article, conference paper or book chapter written in English.
Inclusion criterion 2	Implementation of digital health intervention(s) is a central theme of the publication.
Inclusion criterion 3	At least one article from a general design journal is cited in relation to a topic that is presented as relevant for implementation.
Definition of *implementation* used for eligibility criteria	"Initial process of embedding interventions within settings" (Chambers *et al.* 2013, p. 3).
Definition of *digital health* used for eligibility criteria	Categories such as mobile health, health information technology, wearable devices, telehealth and telemedicine, and personalized medicine (U.S. FDA 2020).

Note: After full-text screening, we also excluded a publication written by many of the authors of this publication (self-authored), as the two were written in parallel, and the results of this publication might have influenced that publication.

70 publications on digital health implementation were included for data collection and analysis.

2.4. Data collection and data analysis of digital health implementation publications

We extracted the first author's country, year of publication, journal name, publication category (i.e., position paper, review, or original research) and publication type (i.e., conference paper, book chapter or journal article) from the included articles on digital health implementation. Additionally, we searched Scopus for the journal's subject area using the journal name.

To extract data from the records, we identified the fragments of text that referenced one of the selected design journals. The fragments consisted of pieces of text (one to four sentences long) in which one of the selected design journals was cited. All fragments were coded in ATLAS.ti (v23.2.1). We then followed the Reflexive Thematic Analysis method, with a constructivist epistemology view (Braun & Clarke 2012), to analyze the data inductively. We identified patterns and grouped them into themes related to the use of design knowledge in implementing digital health. This process was conducted through the following steps. To begin with, the first author collated the coded fragments into potential themes and topics (sub-themes) based on shared characteristics. Four other co-authors then reviewed the themes and topics, and each discussed their feedback with the first author. These discussions primarily addressed the alignment between codes and categories and the relations between the categories. The analysis developed through each revision, where the discussions primarily focused on enhancing the analysis rather than discussing different opinions on categorizing codes and categories. Initially, the discussions resulted in significant changes to the themes. Later revisions focused on smaller adjustments to the labelling of the topics and quotes. Lastly, the first author prepared a written presentation using selected data extracts to illustrate the themes. All co-authors reviewed and annotated this document, after which they discussed their comments with the first author. After two iterations, consensus was achieved.

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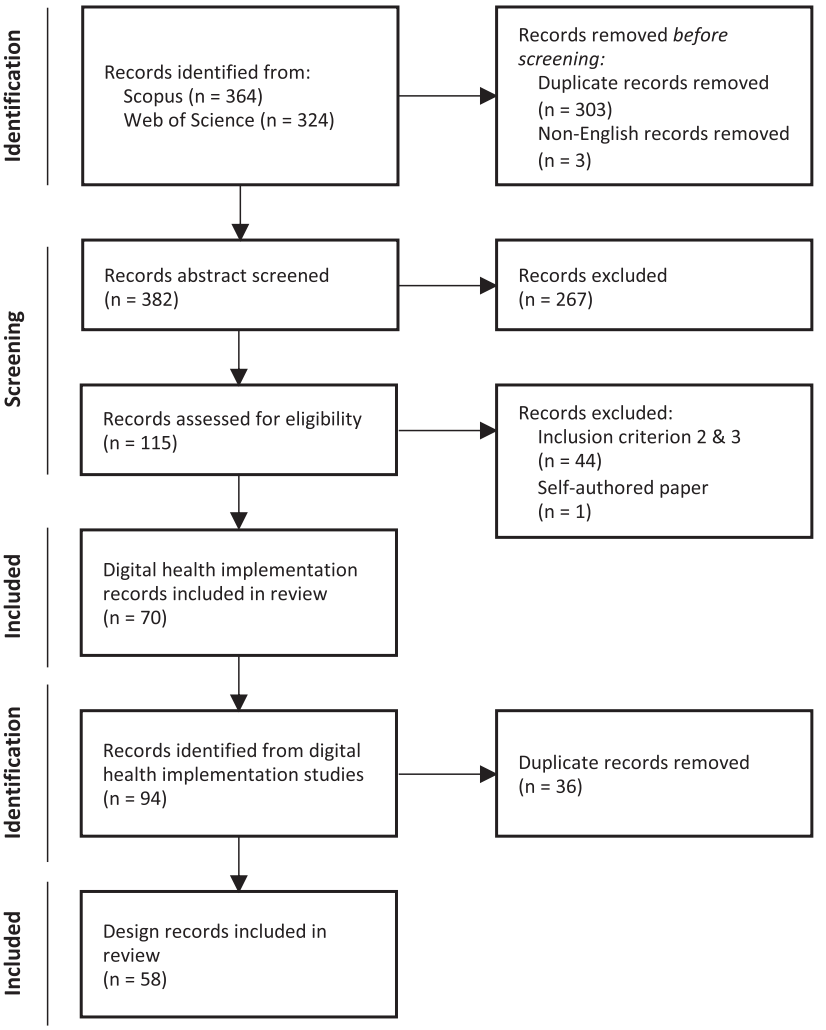

Figure 1. Flow diagram for the publication selection process.

2.5. Data collection and data analysis of the cited design articles

Aside from analyzing *how* design concepts are used in articles on digital health implementation, we also wanted to understand the type of design articles that get cited by digital health implementation researchers. We identified the cited design articles by looking at the reference list of the included digital health implementation records. By doing this, 58 design articles were included. To chart them, we read the design articles and classified them into three types:

- Original research, based on the collection and analysis of primary or secondary data.
- Position papers, which present and discuss new concepts or the author's opinion.

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- Literature reviews, which report the state of the art of academic knowledge in a given topic.

The design articles were also classified by open access status and focus on healthcare, to see if these two variables affect the extent to which they are cited in the digital health implementation literature. The article's healthcare focus was classified by examining the title, abstract and keywords and by reading any included case studies. Here, we categorized them as healthcare-focused if they were related to a type of illnesses, such as mental health, diabetes or cardiovascular disease. We also categorized them as healthcare-focused if the articles focused on health service delivery in general or on medical devices. We did not classify the articles as healthcare-related if they, for example, focused on well-being, mood or delivering services to elderly people who were not mentioned to have any illnesses.

3. Results

The results from this scoping review are presented in four subchapters: Section 3.1 describes the number of records for each step of the selection process. Section 3.2 presents the general characteristics of included digital health implementation records. Section 3.3 presents the characteristics of citations from design literature, and Section 3.4 presents characteristics of the cited design articles. A complete overview of the characteristics of the included articles is available in supplementary file 1.

Table 2. Number of records in each journal, citing the journal in total and after the search query

Journal name	Records in journal (Scopus | Web of Science)	Records that have cited the journal (Scopus | Web of Science)	Journal records cited in digital health implementation publications (Scopus | Web of Science)
Design Journal	1,379 | 1,398	7,938 | 5,356	90 | 81
Design Studies	1,561 | 714	34,160 | 15,894	80 | 69
International Journal of Design	371 | 373	10,155 | 7,147	80 | 73
Design Issues	670 | 1,310	8,374 | 8,563	39 | 45
Journal of Engineering Design	1,181 | 1,181	18,057 | 1,312	36 | 35
She Ji	290 | 255	2,590 | 1,384	15 | 10
Journal of Design Research	313 | –	2,292 | –	13 | –
Research in Engineering Design	607 | 495	16,241 | 9,675	8 | 8
Design Science	243 | 269	2,728 | 1,932	3 | 3
			Total Nr of query results: 364 | 324

Note: Obtained from Scopus and Web of Science on the 17th of March 2025.

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3.1. The number of records for each step of the selection process

The database search yielded 382 digital health implementation records that cited work from the selected design journals. The number of articles from each journal can be found in Table 2. After screening the records, 70 publications were included in the first part of the analysis (Figure 1).

3.2. General characteristics of included digital health implementation records

The list of study characteristics is presented in Table 3. In it, we can see that the publications came from 18 countries based on the first author's affiliation. It also shows how many included publications are original empirical research, viewpoints or position papers, protocols, literature reviews, book chapters and editorials. The records included journal articles, conference papers and book chapters. It also shows the topics of the included journals. The included publications were primarily published after 2017 (87%), see Figure 2.

3.3. Characteristics of citations by digital health implementation records

In the 70 included records on digital health implementation, we identified 101 fragments that cited the selected design journals. Through thematic analysis, we identified 27 topics, 21 of which fit within two larger themes. These themes describe the purpose of citing a design article. In the first theme, the design literature is cited to *show the potential benefit of an approach or method.* In the second theme, the design literature is cited to *explain the process of using an approach or method.* Six topics did not fit the two larger themes. Table 4 shows how the topics are divided across the themes.

3.3.1. Theme 1: Show the potential benefit of an approach or method

Fifty of the included 70 publications cited the selected design journals to show the potential benefit of an approach or method. These cited approaches and methods are primarily related to co-design, human-centered design or understanding user needs. The cited benefits of these methods and approaches in digital health implementation, with supporting quotes, can be found in Table 5.

3.3.2. Theme 2: Explain the process of using an approach or method

28 of the included 70 publications cited at least one of the selected design journals to describe a method or approach. What they describe is primarily co-design, human-centered design and prototyping. Quotes that illustrate how the design literature is referenced can be found in Table 6.

3.3.3. Other topics

Ten coded fragments, out of the 101 total coded fragments, did not fit into the two main themes above. Two topics that had at least two citations were technology acceptance and evaluation of the implementation, and four had only one. Quotes to show how each is cited can be found in Table 7.

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Table 3. Characteristics of the included digital health implementation records

Countries	Nr of records	Percent of total
United States	13	19%
Australia	10	14%
United Kingdom	8	11%
The Netherlands	8	11%
Sweden	6	9%
South Africa	5	7%
France	4	6%
Canada	3	4%
Italy	2	3%
Thailand	2	3%
Denmark, China, Japan, Malaysia, Ireland, Rwanda, Singapore and Taiwan	1[a]	1%[a]
No affiliation stated	1	1%
Publication type	**Nr of records**	**Percent of total**
Original research	41	59%
Viewpoint/Editorial/Position paper	11	16%
Review	10	14%
Protocol	8	11%
Source type	**Nr of records**	**Percentage of total**
Journal article	62	89%
Conference paper	6	9%
Book chapter	2	3%
Journal subject	**Nr of journal a rticles[b]**	**Percentage of Journal Articles**
Medicine	50	81%
Computer Science	14	23%
Social Science	9	15%
Nursing	6	10%
Engineering	6	10%
Psychology	5	8%
Health Professions	4	6%
Biochemistry, Genetics and Molecular Biology	4	6%
Chemical Engineering	3	5%
Immunology and Microbiology	2	3%
Multidisciplinary	2	3%
Business Management and Accounting	1	2%

[a]For each country to the left of the number.
[b]The 'Journal subject' total is greater than 62 because Scopus can list multiple subjects per journal.

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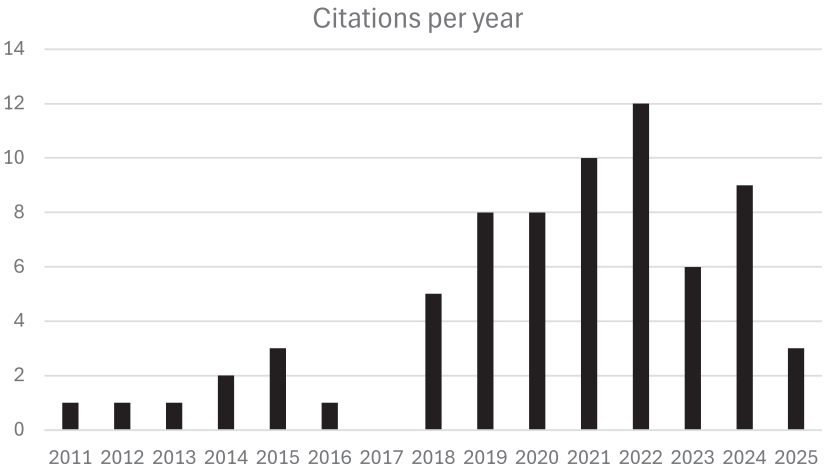

Figure 2. The number of digital health implementation records citing at least one of the selected design journals per year of publication.

Table 4. Publications and coded fragments per theme and topic

Theme and topics	Records citing design journals for the theme	Fragments coded
Show the potential benefit of an approach or method	50	58
Co-design	18	22
Human-centered design	7	7
Understanding user needs	6	6
Service design	3	6
Prototyping	3	3
Design thinking	3	3
Personas	2	2
Wicked problems	2	2
Design for healthcare	2	2
System integration	1	2
Systems thinking	1	1
Design for behavior change	1	1
Considering the context	1	1
Explain the process of using an approach or method	28	33
Co-design	13	16
Human-centered design	6	7
Prototyping	4	4
Technology-driven design	1	2

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Table 4. Continued

Theme and topics	Records citing design journals for the theme	Fragments coded
Inclusive vs customized design	1	1
Digital health can be co-designed	1	1
Design science research	1	1
Iterative design	1	1
Other topics		
Technology acceptance	4	4
Evaluate the implementation	2	2
Criteria for product or service success	1	1
Degree of co-design	1	1
Design for behavior change	1	1
Digital health can be co-designed	1	1

Table 5. Theme 1: Benefits of approaches and methods (with supporting quotes)

Topic	Cited benefit	Supporting quotes
Co-design	Improve collaboration and efficiency	Pickering *et al.* (2022, p. 2): "Co-design has been shown to lead to more efficient decision-making, reduced development time and costs, and greater stakeholder investment and cooperation (Steen, Manschot, & De Koning 2011; other reference)"
	Improve adoption	Engdahl *et al.* (2020, p. 8): "Users will not enjoy or adopt products that focus on their limitations, but they are capable of suggesting ways to reduce focus on the negative aspects of CMD (Wilkinson & De Angeli 2014)"
	Reducing risks in adoption	Lewis *et al.* (2021, p. 10): "…address these risks by using EBCD (experience-based co-design) to support clinicians and researchers working together in a process of shared decision-making and co-design leading to an app that… (Van der Bijl-Brouwer & Dorst 2017)"
	Creating ownership	Gillam *et al.* (2023, p. 2): "Co-design necessitates a shift in the traditional power balance between researchers

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Table 5. Continued

Topic	Cited benefit	Supporting quotes
		and end-users to ensure collective ownership, equal participation and legitimate shared decision-making (Donetto *et al.* 2015)."
Human-centered design	Enhancing the experiences of the users	Hardy *et al.* (2022, p. 2): "Human-centered design is increasingly employed in health care innovation to enhance user experience, thereby promoting engagement (Dorst 2019; four other references)."
	Improve the development and implementation success	Khatib *et al.* (2023, p. 2): HCD" …can improve the development process, iteration speed, and implementation success, with the potential to improve patient outcomes (Steen *et al.* 2011; two other references)."
	Taking the people and system into consideration when making changes	Choosri *et al.* (2022, p. 4): "The hospital wanted to ensure that the new system would avoid any radical changes to the current operational flow that might frustrate elderly patients who were already familiar with the system. The implementation process adopted the User Centered Design (UCD) philosophy in a similar vein to the study done by Wilkinson & De Angeli (2014)."
	Improving functionality, usability and safety	Wang *et al.* (2024): "Regarding the functionality, safety, and usability of DH (Digital Health) systems, more rigorous EBD (Evidence Based Design) and HCD considerations are needed (Tsekleves & Cooper 2017)."
Understanding user needs	Enhancing acceptability of the intervention	Pickering *et al.* (2022, p. 7): "Incorporating features relevant to different stakeholders into the website design and functioning may be expected to enhance acceptability or 'buy-in' across all groups thus increasing the likelihood of service adoption, penetration and sustainability upon implementation (Steen *et al.* 2011; other reference)."
	Adapting to user needs	Duong *et al.* (2015, p. 2): "Thus, the success of product or service in healthcare relies on the ability for a

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Table 5. Continued

Topic	Cited benefit	Supporting quotes
		solution to meet expert users expectations i.e.e facility, convenience, easy to understand and daily live improvement (Medina, Kremer, & Wysk 2013)."
	Promoting equity by removing disparities	Lyon *et al.* (2020, p. 743): ""The incorporation of user perspectives to promote equity is critical across all phases (…) As Giacomin (2014) puts it, design methods support "… obtaining an understanding of their needs, desires and experiences which often transcends that which the people themselves actually knew and realized.""""
Service design	Creating value for the stakeholders	Nyatuka & De La Harpe (2022, p. 16): "For instance, the research recommends the use of a design approach in the redesigning of health care services such as service design (SD) strategy which embraces value-creation (Pamedytyte & Akoglu 2019; other reference)."
	Activating stakeholders	Nyatuk & De La Harpe (2021, p. 66): "The service concept has potential value in terms of contribution to the future of health care organizations and services since it empowers consumers to become active participants when designing health care services and or activities (Tsekleves & Cooper 2017)."
	Sustaining the implementation	Sibuyi, De la Harpe, & Nyasulu (2022, p. 11): "The fact that MomConnect is still in existence in all 9 provinces despite initial imbalances bears testimony to extrinsic factors such as the role played by reputable service designers and providers outside of the NDOH policy-making value chain (Lin *et al.* 2011; other reference)."
Prototyping	Engaging stakeholders in discussing intangible things	Scanzera *et al.* (2023, p. 6): "A concept or prototype offers a tangible representation with which to engage stakeholders in imagining future states that do not yet exist, making it a

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Table 5. Continued

Topic	Cited benefit	Supporting quotes
		valuable tool in healthcare research (Camburn *et al.* 2017; two other references)."
	Testing how the solution is expected to function	Blackman-Lees (2018, p. 4377): "The prototype simulation demonstrated how the artifact was expected to function in a production environment. Artifacts developed in IS (Information Systems) research could be evaluated using the process of simulation (Eekels & Roozenburg 1991; other reference)."
	Enhancing creative thinking and dialogue	McCarthy *et al.* (2020, p. 10): "IPJM (integrated patient journey mapping) also promotes creative thinking around service reform goals and fosters dialogue among stakeholders, potentially leading to better solutions overall (Donetto *et al.* 2015."
Design thinking	Understanding the problem and generating solutions for it	Hardy *et al.* (2018, p. 3): "Design thinking is a process whereby challenges to therapy access, uptake, and adherence can be addressed. It involves developing a rich understanding of the problem area and its context to identify valued outcomes. From this, themes are derived to develop possible new ways of framing the problem by highlighting its paradoxes, and solutions are then generated to resolve them (Dorst 2011; Dorst 2015)."
Personas	Improving focus on the target audience, priority setting, innovativeness, and evaluation	Triberti & Barello (2016, p. 154): "Miaskiewicz & Kozar (2011) used a Delphi methodology to identify benefits of personas for design, and identified 22 of them, ranging from improved focus on the target audience, to correct priority setting, and enhanced innovativeness and evaluation."
	Enhancing discussion of patient needs	Bartels *et al.* (2022, p. 4): "By giving a narrative and name, personas facilitate a more concrete discussion

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Table 5. Continued

Topic	Cited benefit	Supporting quotes
		of patient needs, and to what extent the treatment might match those needs (Miaskiewicz & Kozar 2011)."
Wicked problems	Addressing wicked problems	Reeder *et al.* (2011, p. 3): "This approach is supported by the writings of Cross who summarizes forty years of design and notes that the "wicked problems" characterized by Rittel are more appropriately satisfied by "an 'argumentative', participatory process in which designers are partners with the problem 'owners'" rather than by a rigid, step-wise process (Cross 2007)."
Design for healthcare	Supporting healtcare in general	Nyatuk and De La Harpe (2021, p. 4): "In the quest to provide design researchers with an interest in health and the advent of digital technology with new insights, Tsekleves & Cooper (2017) proposed a framework comprising of three main themes to guide the design for health care."
System integration	An integrated system can benefit clinicians, patients, and payers	Semple *et al.* (2019, p. 566): "…and the value of an integrated system that can generate substantial benefit to clinicians, patients, and payers (Pirinen 2016; other reference)."
Systems thinking	Addressing complexity	Ruyobeza, Grobbelaar, & Botha (2023, p. 805)"…the integration adopted a systems thinking approach in an attempt to confront the complexity of the healthcare apparatus (van der Bijl-Brouwer & Malcolm 2020; other reference)"
Design for behavior change	Helping peers to support each other	Berg *et al.* (2018, p. 8): "…using models of how to accomplish a feeling of social connectedness (Visser, Vastenburg, & Keyson 2011)…"
Considering the context	Improving sensitivity towards patients	Nyatuk and De La Harpe (2021, p. 68): "…the overall health care context plays a central role in the designing and implementation of patient-sensitive interventions (Tsekleves & Cooper 2017; other reference)."

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Table 6. Theme 2: Descriptions of approaches and methods cited from design records (with supporting quotes)

Topic	What is being described	Supporting quotes
Co-design	The process of co-design	Schofield, Shaw, & Pascoe (2019, p. 7): "Co-design refers to collective creativity as it is applied across the whole span of a design process (Steen *et al.* 2011). Specifically, this entails experts […] working together with end users (consumers) from concept creation, prototype review, to final product."
	Participatory design	Senteio (2019, p. 810): "At present, participatory design is a methodology that defines the research process as one that seeks to understand how individuals perform ´everyday´ activities of interest, and how to enhance said activities (Bazzano & Martin 2017)."
	How participating in co-design can be tiring	Bevan Jones *et al.* (2020, p. 936): "Negative comments included how activities were 'exhausting' (Hodson *et al.* 2019)."
	That conflicting requirements can be a challenge for co-design	Austin *et al.* (2022, p. 11): "Dealing with conflicting requirements (and goals, expectations, and power dynamics) is a known challenge in co-design even without introducing top-down requirements (Pirinen 2016; other reference)."
Human-centered design	What human-centered design is	Scanzera *et al.* (2023, p. 3): "Human-centered design uses participatory mixed methods, rapid prototyping and iterative field testing to guide the delivery of novel health products or delivery strategies (Giacomin 2014; three other references)."
	What human-centered design is and how it is viewed	Holeman & Kane (2020, p. 488): "Those who see human-centered design as reflecting the influence of participatory approaches (Björgvinsson, Ehn, & Hillgren 2012; other reference) and a scientific approach to user research (other reference) will tend to see human-centered design as a more encompassing umbrella term."
	What user-centered design is	Duong *et al.* (2015, p. 2). "UCD (User-centered design) emphasizes the knowledge of users psychological, ethnological, sociological, organizational, economical aspects (Kouprie & Visser 2009; three other references)."

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Table 6. Continued

Topic	What is being described	Supporting quotes
Prototyping	How to use prototypes	Ippoliti *et al.* (2021, p. 249): "When refined and polished prototypes are presented, participants are more likely to hold back critical feedback if they believe much of the design is already fixed (Deininger *et al.* 2019)."
	The process of using prototypes	Blackman-Lees (2018, p. 22): "To deploy the prototype, the demonstration incorporated the process of simulation which expanded on two sub-phases of model development: (1) construction of the model and (2) deducing predictions from the developed model (Eekels & Roozenburg 1991)."
Inclusive vs customized design	The different ways in how to approach the target audience	Christie *et al.* (2024, p. 6): "Previous research has explored the tension between opposite pushes for so-called 'easy-to-use', inclusive versus specifically targeted, customised design (Bianchin & Heylighen 2017)."
Design science research	How design science research can be used	Kao *et al.* (2018, p. 818)": The DSR concept can redefine human experiences, leading to the development of problem solving and innovation practices that embody design thinking (Buchanan 2015; other reference)."
Iterative design	Steps in iterative design	Sezgin *et al.* (2024, p. 5): "Study 2 focuses on iterative design, which includes the stages of ideation, prototyping, and refinement (Drain & Sanders 2019; other reference)."
Technology-driven design	What it means to use a technology-driven design approach	Phua, Borriraklert, & Mayakul (2024, p. 2): "It (technology-driven design approach) is aimed at promoting new technology by assessing and interpreting its application to a user scenario (Zurlo & Cautela 2014)."
Design thinking	What it means to use design thinking	Hardy *et al.* (2018, p. 2–3): "It (design thinking) involves developing a rich understanding of the problem area and its context to identify valued outcomes. From this, themes are derived to develop possible new ways of framing the problem by highlighting its paradoxes, and solutions are then generated to resolve them (Dorst 2011; Dorst 2015)."

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Table 7. Topics that are cited for other reasons

Topic	Supporting quotes
Technology acceptance	Zaman *et al.* (2022, p. 12): "Acceptance of these electronic or digital technologies may be more difficult for the current generation of older adults who did not grow up with these technologies (Lim 2010; other reference)."
	Fareed *et al.* (2021, p. 1): "Prior technology experience may be particularly valuable in supporting the adoption of technologies that are similar, as this experience may give individuals confidence in their abilities to use other technologies with similar functionalities (Blackler, Popovic, & Mahar 2003)."
Evaluating the implementation	Poot *et al.* (2023, p. 9): "We aimed to also assess user-experience with the Pick-A-Mood (PAM) tool, a cartoon-based pictorial instrument to measure self- reported mood states (Desmet, Vastenburg, & Romero 2016)."
	Brodersen & Lindegaard (2015, p. 193): ""To analyse the implementation of the Smart Floor, we used the concepts of domestication and scripts. In this investigation, the script concept is important, because: "It conceptualizes the connection of design and use. […] This means that the designer has not only in-scripted the user but also the whole network including workspace safety, longevity, and so forth as representations" (Fallan 2008)"".
Criteria for product or service success	Duong *et al.* (2015, p. 2): "Thus, the success of product or service in healthcare relies on the ability for a solution to meet expert users expectation that is facility, convenience, easy to understand and daily live improvement (Medina *et al.* 2013)."
Degree of co-design	MacDougall *et al.* (2021, p. 7): "Generating new knowledge about predictors of satisfaction and use (eg, treatment readiness, non–health-related texting use, degree of co-design (Donetto *et al.* 2015)…"
Design for behavior change	Berg *et al.* (2018, p. 8): "However, it must be recognized that the recent increasing importance and subtleties of research processes focusing on design to accomplish behavior change are still treated in specific research fields such as design studies (Cash, Hartlev, & Durazo 2017)."
Digital health can be co-designed	May (2015, p. 1): "Since the 1990s, there has been a longstanding movement to reconceptualise health technologies as elements of care that can be co-designed and co-produced (Lehoux *et al.* 2011)."

3.4. Characteristics of cited design articles

In total, 58 articles from the selected design journals were cited by the 70 publications on digital health implementation. Of these 58 design articles, 45 were cited once, and 13 were cited more than once (see Table 8).

Out of the eight most cited design articles, four described co-design, and three were published in the Design Journal. All articles cited more than twice can be seen in Table 9 with the number of citations, title and the journal in which it was published.

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Table 8. Number of citations from the digital health implementation literature for the selected design journals

Cited design journal	Digital health implementation records citing the journal	Publications cited from the journal	Publications that are cited more than once
The Design Journal	22	8	4
Design Studies	20	15	3
International Journal of Design	17	6	3
Journal of Engineering Design	12	9	2
Design Issues	11	9	1
She Ji	5	5	0
Research in Engineering Design	4	4	0
Design Science	1	1	0
Journal of Design Research	1	1	0
Total		58	13

Table 9. Design articles that were cited more than twice by digital health implementation literature

Citations	References	Title	Journal
9	Steen *et al.* (2011)	Benefits of co-design in service design projects	International Journal of Design
7	Donetto *et al.* (2015)	Experience-based co-design and healthcare improvement: realizing participatory design in the public sector	the Design Journal
4	Miaskiewicz & Kozar (2011)	Personas and user-centered design: how can personas benefit product design processes?	Design Studies
6	Giacomin (2014)	What is human-centred design?	the Design Journal
3	Lim (2010)	Designing inclusive ICT products for older users: taking into account the technology generation effect.	Journal of Engineering Design
3	Steen (2013)	Co-design as a process of joint inquiry and imagination	Design Issues
3	Pirinen (2016)	The barriers and enablers of co-design for services.	International Journal of Design
3	Tsekleves & Cooper (2017)	Emerging trends and the way forward in design in healthcare: An expert's perspective	the Design Journal

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Table 10. Study characteristics of design articles

Type of research that is cited	Nr of articles (total = 58)	Citations (total = 94)
Original research	26 (45%)	53 (56%)
Position paper/Viewpoint/Editorial	24 (41%)	32 (34%)
Literature review	8 (14%)	9 (10%)
Healthcare-related	18 (31%)	40 (43%)
Not healthcare-related	40 (69%)	52 (57%)
Open access	24 (41%)	42 (46%)
Not open access	34 (59%)	49 (54%)
Year	**Nr of articles (total = 58)**	**Citations (total = 94)**
1989–2000	4 (7%)	4 (4%)
2001–2005	6 (10%)	6 (6%)
2006–2010	9 (16%)	12 (13%)
2011–2015	22 (38%)	49 (52%)
2016–2020	17 (29%)	23 (24%)

The types of articles cited were primarily original research and position papers. Literature reviews were the least cited type of research. Average citations per paper were 2 for original research, 1.3 for position papers and 1.1 for literature reviews. Of the cited design articles, a third were healthcare-related. The healthcare-related articles were cited 2.2 times per article, against 1.3 for the not healthcare-related articles. For an overview of research type, year, open access status, and healthcare focus, see Table 10.

4. Discussion

This study investigated what type of design knowledge is used in digital health implementation publications. By analyzing how digital health implementation publications have cited a corpus of preselected design journals, we distinguished two main themes. Through charting the data from the cited design articles, we also identified metrics that show what type of design articles digital health implementation publications cite most often. Next, we will offer a set of reflections regarding selected topics in these themes, followed by a discussion on the defining characteristics of the cited design articles. Thereafter, we will discuss the strengths and limitations of the study and finally present some future directions for how design knowledge can contribute to digital health implementation.

4.1. How digital health implementation publications cite the design literature

Based on our analysis, we found two main themes for how digital health implementation literature cites design literature.

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- To *show the potential benefit of an approach or method*, justifying *why* it is chosen in their study on digital health implementation
- To *explain the process of using an approach or method*, describing *how* to use it and describe conditions for using it in their study on digital health implementation.

These two themes point to how design knowledge can contribute to digital health implementation in addressing some of the barriers to implementing digital health solutions, mentioned by Greenhalgh *et al.* (2017), Ross *et al.* (2016), and Bente *et al.* (2024). By virtue of creating, describing and evaluating methods and approaches that can address barriers to digital health implementation, design knowledge can contribute to improving the fit between intervention and context. This role is in line with the purpose of creating knowledge, being to challenge current practice and inspire ways of improving it (Stolterman 2021), which can also be used to challenge and inspire implementation practice.

Across the two overarching themes in which design knowledge contributes, we found several recurring topics. Combining the topics from both themes, the three most cited topics were:

- *Co-design*, which was cited to show that it can improve adoption and communication with users. Citations were also made to explain co-design and the challenges of involving users.
- *Human-centered design*, which was cited to show that it can improve user experience and usability, as well as take people and systems into consideration when making changes to interventions and contexts. Citations were also made to explain what it is and how it is viewed.
- *Prototyping*, which was cited to show that it contributes to engaging stakeholders in discussions on user needs, prioritizing changes and enhancing creativity. Citations were also made to explain how to use prototypes and the risks of using them.

In the first theme, where citations were used to show the benefit of an approach or method, additional topics were found: *understanding user needs, service design, design thinking, personas, wicked problems, design for healthcare, systems integration, systems thinking, design for behavior change* and *considering the context.* Looking at the design topics cited in the digital health implementation literature, design knowledge seems to be primarily used to understand the needs and perspectives of the people involved in the implementation. This is seen in multiple of the cited topics, such as *co-design, human-centered design, prototyping, understanding user needs, personas* and *service design.* Additionally, some of these topics contribute to how to move towards implementation in collaboration with the involved stakeholders. The following discussion will focus on the role of design knowledge in relation to the three most cited topics: *co-design, human-centered design* and *prototyping.*

4.1.1. Co-design

Co-design was the most cited topic from the design literature. Co-designing with relevant stakeholders in the implementation process is, for instance, seen as a means to understand the patients (Lewis *et al.* 2021) and create collective ownership (Gillam *et al.* 2023). Both are described as essential aspects for a successful

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implementation. Co-design was also cited as a way to create a more efficient implementation process by improving communication and adoption from the users.

From reading the digital health implementation publications, we notice that different sources view co-design differently. Some see co-design as an approach where users take part in creating the service, including the implementation process. For example, the paper by Bevan Jones *et al.* (2020) describe co-design as an active involvement of stakeholders throughout the process. Others see co-design as gathering feedback from stakeholders, primarily end-users, through methods such as focus groups or interviews. For example, Manski-Nankervis *et al.* (2021) describe how they gathered feedback from end-users and other stakeholders on prototypes in an iterative way. Another example is Pickering *et al.* (2022) who present a focus group study where participants were asked to provide their thoughts on the problem and ideas for features to include in a possible solution. Liang *et al.* (2024), on the other hand, describe that in co-design, the stakeholders are treated as equal collaborators; however, their method describes three of the same type of workshops as the only form of outside stakeholder participation. This lack of consensus on what constitutes co-design in implementation practice can create issues. If articles on co-design suggest that certain benefits will come from using co-design, the way co-design is used certainly affects the degree to which those benefits will be achieved. With an existing strong link to co-design, future research directions within design research could be dedicated to establishing more specific links between types of co-design and their implementation benefits. To do this, it could help to differentiate studies using co-design longitudinally or to gather insights at distinct points.

4.1.2. Human-centered design

Human-centered design (HCD) was the second most cited topic in the digital health implementation literature. However, how it was applied differed. For example, Stein *et al.* (2019) interacted with different stakeholders to get their perspectives at multiple points in time throughout the process, while Choosri *et al.* (2022) focused on understanding the effectiveness of the intervention for different stakeholders by conducting interviews at one point in time. Both state that they adopted a human-centered design approach. The purpose of adopting this approach also varied. It was, for instance, presented as a way to enhance the user experience (Hardy *et al.* 2022), help understand the context, not to disrupt it when implementing a change (Choosri *et al.* 2022), and foster more equitable implementations (Holeman & Kane 2020).

HCD has previously been presented as a valuable approach for redesigning care delivery systems to fit the needs of everyone within them (Erwin & Krishnan 2016). Here, we see potential in HCD to consider both human and system-level factors to help align digital health innovations with the lived realities of care delivery. From our findings, we see that adopting HCD can potentially improve the experience and usability for people in a care delivery system, and incorporate both people and system factors into making changes. In this sense, design knowledge contributes to digital health implementation by describing how to use HCD and its benefits to further its adoption. With digital health implementors experiencing many issues relating to aligning with human needs (Ross *et al.* 2016; Greenhalgh *et al.* 2017), we

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suggest that furthering research efforts into the role of HCD in implementation could improve implementation practices while also improving the impact of design knowledge.

4.1.3. Prototyping

Prototyping was the third most cited topic from design knowledge in digital health implementation literature. Using prototypes was seen as a way to improve implementation by creating tangible representations with which to engage stakeholders (Scanzera *et al.* 2023) and promote creative thinking among stakeholders (McCarthy *et al.* 2020). The diversity of prototyping tools in the included publications spans across scenarios, journey maps, paper mock-ups and high-fidelity physical prototypes. Most researchers in digital health implementation describe using these prototypes to test for potential issues with the implementation. This is done either by having users try out a prototype or by presenting the prototype to different stakeholders. Using prototypes in this way can help with collaboration and communication of ideas of future states (Blomkvist & Segelström 2014). This can foster a better understanding of various perspectives on a digital health intervention during implementation.

As digital health implementation can experience barriers such as incompatibility with existing work practices (Ross *et al.* 2016) and can benefit from methods that help understand the digital health solutions fit with its context before adoption (Greenhalgh *et al.* 2017), knowledge about how to create and use prototypes can be a potentially impactful contribution from design. Karlsson *et al.* (2024) have identified from interviews with design practitioners that they are using prototypes to create a common language with stakeholders and to understand end users through reflection or testing. As such, we can observe how a designerly, constructivist approach to understanding and involving different kinds of stakeholders with prototypes can be applied not only to the development and testing of new solutions but also to their implementation in context. Building additional knowledge about applying prototypes in relation to implementation could therefore contribute further to digital health implementation.

4.2. Design articles cited by digital health implementation

The analysis of the cited design articles reveals insights about the type of records being cited in digital health implementation publications. When it comes to the type of article, original research articles are the most cited, making up 56% of all citations, while position papers account for 33% of citations. This is possibly due to a preference for original studies from healthcare researchers. The healthcare-related design articles saw a greater amount of citations per article (about 1.7 times more) than the design articles that were not related to healthcare. This might suggest that they are easier to find for digital health researchers or might be seen as more relevant and applicable to improving health systems. Regarding the year of publishing, most cited design articles were published after 2010, and no design articles published after 2020 were cited. This could suggest either a lag in citation accumulation, a more established reliance on earlier foundational works, or that topics from this time are more interesting for digital health implementation researchers.

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Our results also show that the selected design journals were cited by digital health implementation papers more and more every year from 2018 to 2022, but that there was a drop in 2023. This might have to do with Covid-19 and the shift in focus for what to publish during this time. A search on Scopus with the same digital health search query shows that there was generally a small decline in papers published on digital health in the same period.

Reviewing the cited design articles, we can also see that the most cited articles have clearly described topics in the title and abstract. Titles of these papers are for example *"The core of 'design thinking" and its application"* (Dorst 2011), *"Benefits of co-design in service design projects"* (Steen *et al.* 2011) and *"What is human-centred design?"* (Giacomin 2014). This might suggest that researchers in the digital health domain who seek knowledge from design have an easier time understanding if what they are looking for exists within an article, if it contains specific concept keywords and describes how it will present knowledge around that concept.

When discussing what health research might find applicable from design knowledge, it should also be noted that these different research communities value and legitimize knowledge differently. Particularly, design might not live up to the standard of evidence expected from health research (Lamé 2018). Health research tends to prioritize methodological rigor and consistency (often from a positivist point of view), while design often emphasizes contextual tailoring and flexibility (often from a constructivist point of view). The focus on rigor and consistency over flexibility may result in overlooking more diverse or practice-based forms of knowledge. This might harm the building of knowledge that challenges and inspires new practice, especially in complex systems where you cannot predict outcomes of change. We therefore argue that to improve implementation, we should develop knowledge using multiple epistemologies. A cross-disciplinary dialogue on what counts as valid knowledge to contribute to improving the implementation of digital health solutions is thus necessary.

In reading the cited design articles, we also noticed that few details are provided on the boundary conditions for when the explained methods and approaches will be appropriate. However, describing methods and approaches in context is crucial, as it permits the consideration of factors (such as the skills of the method users and the attributes of the environment) that might affect results (Gericke, Eckert, & Stacey 2022). This is discussed in Steen *et al.* (2011), one of the included design articles, which reports on tailoring co-design processes to each case, and characterizes this as a challenge for co-design. As implementations are very context-dependent, knowing how to use design methods and approaches depending on the context is essential for grasping how to adopt them. Clearly describing the context in which implementation methods and approaches are applicable could therefore support wider adoption of design knowledge.

4.3. Strengths and limitations

Searching for how design is cited in other domains by using sets of journals is, as far as we are aware, a novel approach to understanding the impact of design knowledge on another field. In this case, we used it for digital health implementation;

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however, it could also be used to understand, for example, how design knowledge has made its way into the literature on education, sustainability, policy, manufacturing, entrepreneurship, artificial intelligence or management. As it is sometimes difficult to show how design knowledge makes its way into other fields, we encourage other researchers to use similar methods to explore the impact of design knowledge.

However, we acknowledge that our method presents several limitations. First, a limitation in our study is that we have chosen to focus exclusively on design knowledge presented in academic journals rather than, for instance, tacit knowledge and knowledge within artifacts. To fill this knowledge gap, we will also submit a paper on how design professionals use their knowledge to contribute to digital health implementation in real-life projects. Secondly, we have included two major databases, limiting our results for both sets of articles (design and digital health implementation) to those indexed in Scopus and Web of Science.

Finally, to map the contribution of design knowledge to digital health implementation, we had to create a searchable scope. In doing so, we narrowed down the design literature to a set of nine general design journals, selecting journals similar to previous examples by Gemser *et al.* (2012), Cash (2018), and Huynh-Dagher *et al.* (2022). Using design journals made it possible not to limit the search to specific keywords that had to represent the broad design field, and instead kept it open for any topics that might occur. However, we used a relatively limited definition of design literature as we did not include journals focusing on specific design subdisciplines, such as *CoDesign*, *AI-EDAM*, *International Journal of Design Creativity and Innovation, Design for Health, Human-Computer Interaction, Human Factors, Strategic Design Journal, Design and Culture, Design Management Journal, Applied Ergonomics* and *Journal of Mechanical Design*, as well as conference publications. While we did this to avoid skewing our results towards any specific design subfields, we see that this choice constitutes a major limitation of our study, as it resulted in the exclusion of much potentially relevant design literature. To illustrate the potential scope of relevant literature in excluded journals, we conducted an additional search on April 29th using the same strategy, which showed 67 records for *CoDesign*, compared to 4 for *Design and Culture* and 491 for *Human Factors* before abstract screening. If other researchers would like to apply our method for a specific sub-topic within design, such as collaboration, we suggest adding specialized journals such as *CoDesign* for collaborative design or *Human Factors* for human factors-related design, in addition to the general design journals that we have used.

4.4. Future directions

Some of the cited topics, such as co-design or HCD, are already quite prevalent in the healthcare innovation field. However, the use of prototypes to address barriers to implementation seems to be a less prevalent topic. This presents an opportunity for the increased contribution of design knowledge. In particular, there seems to be room for expanding the view of prototypes and how to use them. For example, using prototypes as a means for co-developing digital product service systems (Kleinsmann & Ten Bhömer 2020) could help the co-implementation of digital health solutions. Similarly, 'service prototypes' have been suggested to make the intangible parts of service delivery more accessible to discuss and share (Blomkvist & Segelström 2014), which could prove useful in

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implementation processes. Camburn *et al.* (2017) show that there is not much research on using prototyping in advanced stages of development, when the product, service or system is being implemented. This presents an opportunity for prototyping to expand into implementation by using existing prototyping techniques and developing new ones.

Two topics that were less recognized, only being cited one and two times, respectively, but that we find interesting in relation to digital health implementation are *systems approaches* and *design for behavior change.* For the first topic, van der Bijl-Brouwer & Malcolm (2020) were cited to highlight that taking a systems approach can help with addressing complexities. As implementors have to deal with many influencing factors, such as policy, technology, finance, workflow and organization (Greenhalgh *et al.* 2017; Bente *et al.* 2024), different ways in which these complexities can be identified and addressed can help increase the chance of successful implementation. For example, systems approaches can help practitioners make intentional decisions on how to shape social structures and manage complexity (da Costa Junior *et al.* 2019; Vink, Wetter-Edman, & Koskela-Huotari 2021).

Regarding design for behavior change, Cash *et al.* (2017) were cited to exemplify that the design field is concerned with design for behavior change, and Visser *et al.* (2011) are cited to show how design can help create social connectedness which shapes behavior. Implementing a digital health solution often means transitioning from one way of working to another. By incorporating knowledge about how to design for shifting behavior, this transition might become easier. Behaviors have been suggested to, for example, be shaped by triggering specific experiences, improving knowledge or shifting attitudes (Fokkinga, Desmet, & Hekkert 2020), which the design field can support. Bay Brix Nielsen, Cash, & Daalhuizen (2024) have also suggested that further iterations during implementation can help to fit behaviors with the intervention.

Overall, in light of the collected results, we urge design researchers, especially those working in healthcare, to consider whether or not their research might be beneficial for implementation processes. If that is the case, we suggest that those findings should be presented as such in their articles, so that they can be picked up more easily by implementation researchers and practitioners. Design researchers who address implementation should explicitly use the word 'implementation' in their abstracts to make their paper easier to find for researchers and practitioners. Additionally, we urge design professionals and design researchers to collaborate with researchers doing implementation work in order to guide, improve and spread the use of design knowledge as a way of supporting implementation. Hopefully, this research can also inspire designers and design researchers to focus more on implementation processes. Additionally, positioning design as a contributing field can be beneficial for increasing the impact of design research. Here, it is possible to strengthen and broaden the current contribution of design knowledge, not only for creating new products and services but also for implementing them.

5. Conclusions

This scoping review has shown how design knowledge contributes to the implementation of digital health solutions. If we see the aim of design as changing a

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situation to a preferred one, this study has provided some insights into how design can contribute to the later stages of realizing the change. Our results show that design research is primarily cited to provide insights about using approaches or methods and the benefits of using them. The cited topics primarily focus on the involvement of people in implementation processes and on how to create and evaluate potential changes together with the relevant stakeholders. With this contribution, we hope to inspire researchers in both fields to strengthen their relationship. In particular, there is great potential in the broader research field of design to contribute to implementation processes in ways that are yet unforeseen by implementation researchers working in the context of digital health. By continuing to strengthen the contribution of design knowledge to implementation, we can facilitate transitions toward positive change and, ultimately, contribute to improving systems of care.

Supplementary material

The supplementary material for this article can be found at http://doi.org/10.1017/dsj.2025.10022.

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https://doi.org/10.1017/dsj.2025.10022 Published online by Cambridge University Press