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Title

Acceptability of Digital Health Interventions in Perioperative Care: A Systematic Review and Narrative Synthesis of Clinician Perspectives.

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ABSTRACT

Introduction: Digital health interventions (DHIs) are increasingly used in the peri-operative setting. Clinicians play a key role in their implementation, so an understanding of factors which influence clinician acceptability is key to facilitate long-term adoption and success.

Objectives: To identify themes relating to clinician acceptability of DHIs in the perioperative setting.

Methods: A systematic review and narrative synthesis was performed with a literature search across Medline, Embase and CINAHL. Studies published between inception and March 6, 2023 in English were included if they provided qualitative data on clinician perceptions of DHIs in the context of adult perioperative care. An inductive-deductive framework synthesis approach was employed. Included studies were coded inductively by a single reviewer. Codes were organised into themes based on conceptual similarities. Collaborative discussions with a second and third reviewer enabled higher-order interpretations and the emergence of subthemes. Themes and subthemes were systematically mapped onto the seven constructs of the Theoretical Framework of Acceptability (TFA).

Results: A total of 3234 publications were identified, of which 18 were selected for inclusion. DHIs studied included telemedicine platforms, mobile health applications, website-based programmes, and EHR-integrated software. The most commonly reported TFA construct was perceived effectiveness, followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy.

Conclusions: Clinicians' acceptance of DHIs is primarily driven by perceived effectiveness. Optimism about the potential for DHIs to enhance care is often overshadowed by concerns about patient safety, privacy, and opportunity costs. As clinicians are key gatekeepers in DHI adoption, these perspectives have a significant impact on the long-term integration of these technologies into perioperative care. Co-creation of DHIs with clinicians is required to ensure future interventions are better aligned with clinical workflows and patient needs, enhancing their utilisation and uptake in the long-term.

Strengths and limitations of this study:

Strengths:

1. First rigorously conducted, comprehensive qualitative synthesis of clinician perspectives of DHI acceptability in perioperative care.
2. Thematic analysis performed through the lens of the Theoretical Framework of Acceptability which has been widely validated.

Limitations:

3. Comparisons between studies are limited by differences in study design, participant characteristics, and intervention type.
4. Over-representation of studies conducted in high-income countries undermines applicability of results to low- and middle- income settings.

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Disclosures:

None.

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Introduction

Digital health interventions (DHIs) include information and communication technologies designed to enhance and support health care, e-health (online and offline computer-based applications), and m-health (mobile) applications¹⁻³. These electronic tools are increasingly utilised to modify health related behaviours and monitor chronic conditions including (but not limited to) cardiovascular disease and mental illness⁴⁻⁷. DHIs are recognised as a cost-effective and feasible means for health care providers to remotely assess, monitor, inform and treat health conditions⁸⁻¹⁰.

Over the past decade, there has been significant growth in the use of DHIs, with the World Health Organisation (WHO) adopting digital health as a key element in its global strategy for achieving health-related Sustainable Development Goals (SDGs)¹. In parallel with the progress of the current technological era, health systems are also being shaped by the worldwide expansion of DHIs¹¹. Data suggest that hundreds of health-related mobile applications are being added daily, with a total 5.4 billion global users reported by the end of 2022¹². Thus, DHIs have been identified as an emerging asset in healthcare, offering boundless potential to promote the health objectives of today's technologically adept population.

Currently, DHIs are utilised across various health care domains, including surgery¹³. The application of digital health tools in the context of perioperative management has been shown to be associated with positive pre- and post-operative health behaviours, particularly in the context of remote monitoring and shared decision making¹³. Despite these benefits, evidence suggests a lack of sustained implementation of digital health in the perioperative context¹⁴. While they are perceived to be instrumental in the attainment of SDGs, low clinician compliance with DHIs has been a challenge for developers¹⁵. Most DHIs are discontinued in less than a year and non-compliance manifests as failure to improve associated mortality and morbidity¹⁶.

Resistance to the use of DHIs in general has been attributed to limited motivation amongst users (patients) and providers (clinicians)¹⁴ with cited concerns including ethical and legal issues, lack of standardisation, accuracy of results and perceived effectiveness¹⁶⁻¹⁸. Furthermore, the scarcity of evidence based DHIs contributes to user reluctance. Many publicly available interventions are not evidence-based and are selected based on user rating or perceived relevance¹⁹. While the National Health Service (NHS) has undertaken initiatives to establish repositories of endorsed health apps, many apps lack the necessary evidence²⁰.

Low motivation and intention to use DHIs consistently are associated with reduced acceptability, which has been shown to result in decreased efficiency and effectiveness of interventions. Given this, researchers have focused their attention on factors affecting the acceptability of digital technologies. Several studies have been conducted to investigate the lack of acceptability of DHIs by patients²¹⁻²⁵. However, studies documenting acceptability by clinicians are scarce. Further investigation into this is imperative, as acceptability has been highlighted by the Medical Research Council (MRC) as a major element in DHI design and implementation success²⁶.

The Theoretical Framework of Acceptability (TFA) serves as a valuable guide for the evaluation of clinician acceptance. It emphasises that the perceptions of users influence their intention to utilise interventions²⁷. The TFA encompasses seven key constructs: affective attitudes, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness, and self-efficacy (Appendix 1, Supplemental Figure 1).

Clinicians' expertise makes their input vital to the development of DHIs. However, evidence suggests that researchers neglect the perceptions of clinicians, prioritising patient experiences instead²⁸⁻³⁰. This approach may result in the production of interventions which are not perceived to be useful by clinicians and imply excessive effort³¹. Indeed, limited involvement of clinicians in DHI development is frequently reported and could hinder their continued engagement with DHIs³¹.

The existing literature indicates that a number of studies have explored the perceptions of clinicians regarding DHIs. Yet, most of these studies considered a single intervention, and there remains a gap in the systematic synthesis of perspectives toward DHIs, particularly in perioperative care. Therefore, this review aimed to explore clinicians' perceptions of DHIs and to examine the factors influencing their acceptance in perioperative care, guided by the TFA.

Methods

Search strategy

This review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines with a protocol accessible on PROSPERO (registration number: CRD42023403205). A systematic search of three electronic databases (Medline, Embase and Cumulative Index to Nursing and Allied Health Literature (CINAHL)) was carried out between February 21 and March 6, 2023 to identify peer-reviewed articles published from inception until March 6, 2023. A grey-literature (Google, Google Scholar) and manual search of the reference lists of included articles was conducted to find additional studies that met the inclusion criteria. Search strategies for all databases are available in Appendix 1.

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Eligibility criteria and study selection

Studies were included if they met the following criteria: (1) implemented a qualitative or mixed-methods study design, using interviews, focus groups and open-ended questionnaires; (2) reported clinicians’ experiences with DHIs prior to, during or following surgery/in the perioperative context; (3) evaluated a digital health intervention intended for use by clinicians or adult patients, as described by the WHO.

Studies were excluded if they: (1) reported only patient or other non-clinician data (2) presented a digital health intervention utilised by paediatric clinicians or patients (3) were not available in English. Editorial comments, reviews, protocols, abstracts, and conference proceedings were also excluded.

Data analysis and synthesis

The search results were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia - www.covidence.org), for screening and data extraction. Following deduplication, the primary reviewer (AA) filtered articles by title and abstract and screened full-text articles against the eligibility criteria. Concordance checking was undertaken by a second reviewer (CWH) on a sample of 10% of full-text articles. All included articles were also reviewed by CWH. A third reviewer (EVC) was available to resolve disagreements regarding eligibility, where consensus could not be reached. Cohen’s Kappa was calculated to establish interrater reliability.

AA extracted data on author, year of publication, country, aims, methods, sample size, clinical specialty, and intervention characteristics, using Microsoft Excel (see Table 1).

The included articles were imported into NVivo 12 (2017), a qualitative data management program. To ensure a comprehensive interpretation and analysis of the data, a framework synthesis approach was taken²². The author utilised an inductive-deductive, line-by-line coding technique to analyse the data. Following review by CWH, codes were compared across studies and organized into themes, based on their conceptual similarities. Themes were explored in detail to evaluate their alignment with the TFA, before they were systematically mapped to the seven TFA constructs²⁷. Group discussion between AA, CW and EVC facilitated further examination of the relationships between codes, themes and TFA constructs.

Quality assessment

The Critical Appraisal Skills Programme (CASP) criteria for qualitative studies was used to determine the methodological rigor of the publications included. The following questions were considered: 1) Was there a clear statement of the aims of the research? 2) Is a qualitative methodology appropriate? 3) Was the research design appropriate to address the aims of the research? 4) Was the recruitment strategy appropriate to the aims of the research? 5) Was the data collected in a way that addressed the research issue? 6) Has the relationship between researcher and participants been adequately considered? 7) Have ethical issues been taken into consideration? 8) Was the data analysis sufficiently rigorous? 9) Is there a clear statement of findings?

Quality assessment was undertaken by one reviewer (AA) and verified by a second reviewer (CW) (Figure 1). To allow for a comprehensive exploration of the available qualitative data, publications were not excluded based on quality.

Ethical considerations

No ethical approval was sought for this study as it involves the use of qualitative data from published studies which are freely available in the public domain.

Patients and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

Results

The literature search retrieved 3838 records in total. After deduplication, 3234 abstracts were screened for eligibility. 549 articles were selected for full-text review. Of these, 18 articles met the inclusion criteria³²⁻⁴⁹ (Figure 2). Interrater reliability for full-text review was strong (Cohen's kappa: 0.81, overall agreement: 93.3%).

Study characteristics

Included studies were conducted between 2012 and 2022, with the majority (n=13) published between 2019 and 2022. Studies were undertaken across six countries: United Kingdom (n=6), United States (n=5), Canada (n=2), Netherlands (n=2), Taiwan (n=1) and Uganda (n=1). Four categories of DHIs were evaluated: telehealth interventions (n=7), mobile health applications (n=6), website-based programmes (n=4) and EHR-integrated software (n=1). A summary of study characteristics is

presented in Table 1. Clinician participants included surgeons, physicians, nurses, physiotherapists, dietitians, and psychologists. The studies represented DHIs utilised in a range of specialities (Appendix 1, Supplemental Table 1).

Summary of findings

Our analysis identified 7 TFA constructs and 20 themes reflecting clinicians' perspectives on DHIs across the included studies, each described in turn below (Figure 3, Table 2).

Perceived effectiveness

Perceived effectiveness was explored in all studies (n=18)³²⁻⁴⁹. Clinicians' views of DHI effectiveness were shaped by their potential utility (n=18)³²⁻⁴⁹, observed success (n=15)^{32-36 38-40 42-45 47-49} and accessibility to patients (n=12)^{32-34 36-39 41 43 45 46 48}.

Potential utility

Clinicians believed that DHIs may not be suited to their intended purpose^{33 34 43}. They expressed scepticism about the value of telehealth in surgical care, indicating that it is unlikely to meet the needs of their patients^{33 34}. However, some clinicians recognized the potential for digital health to facilitate assessment, offer personalised patient support and aid decision-making, as intended^{40 46 48 49}. Clinicians were optimistic that DHIs had the capacity to streamline processes, addressing treatment delays and surgical backlogs^{32 35 36 38 40-44 47}. They also believed that DHIs could act as a feasible alternative to in-person consultations and expand access to previously out of reach services, improving patient care^{33 34 37 39 40 45 48}.

Observed success of intervention

Clinicians discussed instances where DHIs fulfilled their intended purpose. Interventions allowed participants to successfully communicate with patients and obtain the necessary information, virtually^{44 45 48 49}. Clinicians reported that a digital decision aid effectively triaged patients prior to surgery⁴⁰. Remote peri-operative consultations were also seen to meet their needs and were comparable to face-to-face appointments⁴⁵. They also described experiences where telemedicine and mobile applications were effective and practical, requiring fewer resources and smaller-scale equipment than in-person care^{32-36 38-40 42 43 45 47 48}.

Patient accessibility

There was variation in beliefs about the accessibility of DHIs, with some clinicians suggesting that their digital tool is inclusive of all patients,^{32 33 36 37 39} and others acknowledging that patients without adequate computer literacy, resources or technical proficiency may face challenges in using and benefiting from DHIs^{34 38 43 45 46 48}. There were also concerns that older patients may be wary of technology and less able to access interventions^{34 41}. However, clinicians in one study highlighted that age does not always hinder accessibility, reporting positive experiences with elderly patients. Some clinicians also suggested that younger patients could assist older patients in accessing DHIs⁴⁸.

Affective attitudes

Clinicians exhibited a range of affective attitudes toward DHI. Positive affective attitudes were observed in the majority of studies (n=15)^{32 33 35-42 44 46-49}. This included optimism (n=15)^{32 33 35-42 44 46-49} and open-mindedness (n=4)^{37-39 41}. Negative affective attitudes such as scepticism (n=8)^{32-34 37 40 41 43 44} and apprehension (n=10)^{32 33 37-43 46} appeared in numerous studies (n=12)^{32-34 36-44 46 49}. Indifference was expressed in one study (n=1)⁴⁴.

Positive affective attitudes

Clinicians were optimistic about the ability of digital health to improve perioperative management and efficiency and to expand to other aspects of care^{32 33 35-42 44 46-49}. Clinicians were open-minded about the use of digital tools as an alternative or supplement to face-to-face^{37-39 41}. These attitudes were often based on successful past experiences with digital technology^{32 33 39 47}. Clinicians also appreciated the opportunity to utilise new tools to keep pace with advancements in their field⁴⁸. In addition, they valued the flexibility that DHIs afforded themselves and their patients^{43 48}.

Negative affective attitudes

Clinicians were sceptical about the applicability and efficacy of DHIs in perioperative assessments, highlighting that some physical examination techniques cannot be replicated virtually^{32-34 37 40 41 43 44}. They were apprehensive about the limitations of DHIs and the possibility of miscommunication or misdiagnosis^{32 33 37-43 46}. Some clinicians refused to rely solely on DHIs, while others rejected them³³. Clinicians were also wary about the potential for DHIs to replace face-to-face care and the loss of physical office space⁴³.

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Indifference

In one study, clinicians were indifferent to the use of DHIs. They did not believe that digital health had a meaningful impact on perioperative care and that they could complete their clinical tasks with or without it⁴⁴.

Opportunity costs

Most studies raised concerns about the opportunity costs of utilizing DHIs (n=15)^{32-35 37-44 46 48 49}. Clinicians believed that the adoption of various interventions had the potential to impact patient safety (n=9)^{32 33 37-39 42-44 49}, data privacy and security (n=5)^{34 37 41 43 49} and efficiency (n=15)^{32-35 37-44 46 48 49}.

Data privacy and security

Clinicians highlighted the potential for patient privacy breaches arising from the use of communication and information storage mechanisms associated with DHIs^{34 37 41 49}. They also conveyed unease about the need to disclose their personal phone number to patients or employ personal devices in lieu of secure platforms^{34 43}.

Patient safety

Clinicians cited concerns about impaired quality of examination, accuracy of risk management, delayed communication, and unsafe care^{33 37-39 42 43 49}. They were also worried about the negative impact of DHIs on patients' well-being⁴⁴. Clinicians also believed that, if successful, DHIs could enhance patient safety through early symptom identification and improved patient-provider communication³².

Efficiency

Clinicians believed that DHIs could lead to decreased efficiency through increased workload^{32 46} or time demands in adapting clinical processes and workflows^{32 37 39}. Decreased efficiency was seen to be an opportunity cost of ineffective DHI implementation⁴⁴. Nonetheless, clinicians viewed DHIs as a powerful tool for increasing efficiency in healthcare, in several studies^{32-35 37-44 46 48 49}. They believed interventions could save time for themselves, streamline clinical processes, and expedite care for patients^{32 33 35 38-41 43 44 48}.

Ethicality

Multiple studies (n=13)^{32-39 41 43 46 48 49} emphasized the implications of DHI implementation on a clinician's professional obligation to promote patient autonomy (n=6)^{35 36 39 41 46 48}, beneficence (n=9)^{32 35-39 41 43 48}, non-maleficence (n=7)^{33 37-39 43 46 49} and justice (n=6)^{34 36 38 41 43 46}.

Autonomy

Clinicians convey that DHIs could provide patients with the necessary information to facilitate independent decision making and self-management, giving them greater control over their health^{35 36 39 41 46 48}.

Beneficence

Clinicians believed that DHI implementation may be in the best interests of patients with limited access to healthcare facilities^{35 37 38 41 43}. DHI use may also align with beneficence if it enhances perioperative management and reduces the risk of postoperative complications^{32 35-37 39 48}.

Non-maleficence

Clinicians worried that the use of DHIs may imply additional risks, inappropriate management, or substandard care, resulting in harm to patients^{33 38 39 43 49}. They also related apprehensions about the potential for DHIs to negatively impact patients' physical or psychological health^{33 46}.

Justice

Clinicians were wary about the lack of inclusivity of DHIs and its impact on the equitable delivery of care^{34 36 38 41 43 46}.

Burden

Perceived burdens of DHIs were identified in several studies (n=12)^{32 34 37-41 43-46 48}. These included cost (n=7)^{37-41 44 45}, increased workload (n=6)^{32 37 39 43 44 46}, and the need for user training (n=6)^{34 37-39 41 48}.

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Cost

Clinicians acknowledged that the implementation of DHIs may come at a cost to the patient or provider. They discussed the financial implications of utilizing DHIs, underscoring the costs associated with an intervention, expressing uncertainty about costs, or identifying costs as a barrier to adoption^{40 41 44}. However, some clinicians indicated that DHIs may be financially advantageous to patients by reducing the costs associated with travel and consultation or assessment^{37-39 45}.

Increased workload

Perceptions of increased workload stemmed from the need to undertake more time-consuming tasks^{32 37 39 46} and additional administrative responsibilities^{43 44}. Inefficiencies arising from DHI malfunction were also a contributing factor⁴⁴. Clinicians felt this was counterproductive, highlighting that interventions should reduce workload⁴⁶. In some studies, clinicians recognized the potential for DHIs to decrease workload by streamlining clinical processes^{37 44}.

Need for user training

Clinicians suggested that they needed to overcome their limited experience with digital health to participate in their DHIs^{34 37 38}. In some cases, they needed to learn about a new platform/device to effectively engage with an intervention^{34 37 39 41 48}. They also believed that additional practical opportunities to consolidate technical skills and knowledge were required to maintain technical proficiency for patient treatment⁴⁸.

Intervention coherence

Across studies, intervention coherence was linked to the clinicians' perspective of the simplicity of the interventions (n=12)^{33 34 37 39-44 47-49}.

Simplicity of intervention

Clinicians communicated that some DHIs were easy to understand and use^{39 40 42 43 47-49}. They characterized the set-up and application of these DHIs as simple and intuitive^{40 48 49}. In some cases, DHI use was perceived to be simpler than pre-existing practices⁴⁷. However, for more complex interventions, some clinicians believed that their understanding was limited and possibly inadequate^{33 34 37 41 44}.

Self-efficacy

Clinician perceptions of self-efficacy were related to their views on the prerequisites for use of interventions (n=10)^{36-38 40-42 44 45 48 49}.

Prerequisites for use

Clinicians were confident in their ability to engage with DHIs that required minimal technical knowledge or training^{40 42 45 48}. This was a result of well-designed, user-friendly platforms^{36 48}. Confidence in DHI operability was diminished by the limited availability of newer equipment, additional space, or extra resources, as required by DHIs^{37 38 44 49}. Some clinicians also saw their lack of experience with DHI as a barrier, emphasizing the need for regular utilisation to establish mastery^{37 41 48}.

Discussion

Main findings

This systematic review aimed to assess clinicians' perceptions of DHIs in perioperative care. Our results show that, across eighteen studies, perceived effectiveness was the most commonly identified TFA construct, followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy. This information is crucial, given clinicians' role as key stakeholders in the implementation of DHIs. Indeed, clinicians' perspectives carry substantial implications for the long-term adoption and efficacy of these technologies as they are the ones to allocate resources efficiently and identify patients most suitable for treatment^{27 50}. These findings support previous studies which indicate that clinician beliefs regarding the utility and success of DHIs positively influence their acceptance⁵¹.

Despite the importance of clinician involvement in intervention development, a recent review noted that their collaboration with the developers of DHIs was insufficient⁵². Therefore, DHIs remain in the early stages of implementation and lack evaluation during practice⁵³. This may undermine clinician confidence in DHIs, contributing to the recurring focus on their effectiveness. This is evident in the diverse affective attitudes exhibited in this study. Clinicians' optimism and open-mindedness regarding the value of DHIs to patients and providers align with prior studies on digital interventions⁵⁴. However, their scepticism and ambivalence regarding the security and utility of DHIs in surgical and clinical settings has also been reported previously⁵⁵⁻⁵⁷. These attitudes significantly impact acceptability, consistent with a systematic review by Sekhon et al²⁷.

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Clinicians have expressed legitimate apprehensions about patient safety, data security, privacy and efficiency⁵⁸⁻⁶⁰. With the integration of digital health into perioperative pathways, the malfunction, or failure of DHIs could have far-reaching ethical consequences and opportunity costs^{57 61 62}. Prior research also relays the negative impact of these factors on care provision⁶³, exemplified by a systematic review revealing that 67% of smart phone calculator apps placed diabetes patients at serious risk of insulin overdose⁶⁰. Furthermore, as DHIs to diagnose melanoma were reported to be inaccurate in 30% of cases, physicians continue to discourage their use⁶⁴. This lack of confidence in DHI efficacy may arise from clinicians' continued safety concerns^{52 65}. Moreover, without a clear sense of the benefits of new interventions, they may be more wary of risks.

Clinicians' reluctance to embrace DHIs may also be attributed to their fear that these interventions could exacerbate existing inequalities, compromising the quality of treatment available to patients facing mental illness and socio-economic challenges^{66 67}. These concerns are in line with the 'inverse care law,' which suggests that interventions may be least accessible to those who stand to benefit the most from them⁶⁸. For example, older populations are less able to use digital technology despite requiring health monitoring the most⁶⁹. The lack of benefit conferred by DHIs to older patients has been acknowledged by both clinicians and patients alike⁷⁰. This digital divide could limit care to patients marginalized by age, disability, low literacy, or lack of digital access⁶⁶. Our study also reflects previously expressed concerns that the availability of DHIs on electronic platforms may undermine patient privacy and data security^{69 71 72}. These sentiments are justified as cyber thieves have recently targeted health insurance information, while millions of stolen phones put personal health records at risk^{42 57 73}. Such third-party access to data may also lead to discrimination and profiling by marketing agencies, causing psychological distress⁶⁵.

Our results convey clinicians' belief that DHIs may undermine efficiency, despite their potential to expedite care. This may be due to perceived difficulties in using technology, as previously highlighted by a systematic review⁷⁴. Clinicians also considered cost, increased workload, and training requirements as burdens associated with DHIs. Concerns about limited grant funding for DHIs have been documented previously⁷⁵⁻⁷⁸ and clinicians' perspectives on the financial implications of DHIs are frequently overlooked^{52 79}. This is relevant as most universal healthcare systems such as the NHS lack sufficient budgets for long-term DHI adoption⁷⁵. Perceived workload has been cited as another barrier to DHI adoption^{51 71 72 76 77 80-83}. The need for training in the use of DHIs contributes to perceptions of increased workload^{71 84}, as does low intervention coherence. This is an important consideration, as subjective clinician perceptions of workload are a greater predictor of burnout than actual workload^{85 86}. Addressing these challenges, the use of user-centred design principles has proven effective in promoting simplicity and ease of use of DHIs. This, in turn, facilitates their integration into existing workflows^{25 87}. Notably, perceived usability also plays a role determining

whether an intervention meets the needs of patients or providers, influencing its acceptance⁸⁸. These factors collectively shape perceptions about the pre-requisites for DHI use, their attainability and in turn clinicians' self-efficacy in engaging with DHIs⁸⁹. Despite these concerns, clinicians value the role of DHIs in promoting patient autonomy through increased access to information and communication channels⁷³. These views are echoed by patients, who view DHIs as predominantly beneficial^{58 59}.

Strengths and limitations

This is the first study to assess the acceptability of a wide range of DHIs in perioperative care, offering a comprehensive synthesis of a diversity of perspectives. Our focus on clinicians is an important strength, given their essential role in implementing DHIs. The qualitative inductive-deductive approach draws out important themes, which may not have been captured in traditional quantitative analyses. This contributes to a more nuanced understanding of the factors influencing the acceptability of multiple DHIs across specialties and perioperative phases. The utilization of a validated framework (TFA) enabled a structured and systematic evaluation of the factors influencing DHI acceptability²⁷. This, alongside the rigorous methodology employed in screening, coding and synthesis maximized the objectivity and reliability of our findings. The inter-rater reliability of 0.81 suggests a high level of agreement among reviewers, indicating a consistent evaluation process.

However, due to the heterogeneity of the data, variations in perspective based on intervention type and specialty may have been overlooked. Furthermore, disparities in methodology and methodological rigor among constituent studies may have limited the reliability of inter-study comparisons. The lack of standardized approach to weighting the evidence across studies is another potential limitation. Additionally, the predominantly single-reviewer approach to screening, coding, and synthesis could also be a source of bias. Moreover, the absence of newer technology such as watch-based applications and wearable devices within our synthesis may have resulted in a narrower range of insights. The inclusion of only English-language studies also limits the relevance of the review to non-English cultural contexts. The overrepresentation of studies from high-income countries could also constrain the broader applicability of our findings.

Clinical implications and future research

The findings of this study have significant implications for the planning and development of DHIs as well as their incorporation into perioperative care pathways. Our narrative synthesis informs policymakers, service providers and DHI developers about the key factors influencing the acceptance of DHIs. These insights can serve as a foundation for enhancing the short- and long-term impact of DHIs. They may also guide the strategic involvement of clinicians in the design and deployment of

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DHIs. As such, this study highlights the importance of a collaborative approach to DHI development. It emphasizes the need for clinicians' active participation in co-creating solutions to barriers underlying intervention implementation. This will ensure that DHIs are aligned with clinical workflows and patient needs, thereby optimizing their efficacy and utility in healthcare settings. Future research should aim to include studies from a broader range of countries to enhance the applicability of the results to diverse socioeconomic contexts. Conducting subgroup analyses could allow for a deeper insight into perspectives by intervention type and specialty.

Conclusion

In conclusion, this systematic review and narrative synthesis provides valuable insights into the perspectives of clinicians regarding the use of DHIs during the perioperative period. Our results reveal that clinicians' acceptance of DHIs was primarily driven by their perceived effectiveness. While clinicians expressed optimism about the potential for DHIs to expedite and extend patient care beyond hospital settings, ethical concerns surrounding patient safety and privacy, coupled with opportunity costs, elicited apprehension and scepticism. This negatively influenced clinicians' intention to adopt DHIs. Notably, clinicians' perceptions about the accessibility of DHIs coincided with those of patients. These findings underscore the influence of clinicians' perceptions and their crucial role as gatekeepers in the long-term acceptance and adoption of DHIs.

Contributors:

EVC led the project, with CWH and AA contributing to review concept and design. AA and CWH screened search results. AA independently coded records and extracted data from included studies. AA, CWH and EVC contributed to data interpretation, analysis, and synthesis. AA prepared the first version of the manuscript. EVC, YG and SA reviewed and revised the manuscript critically for content. All authors (AA, CWH, EVC, YG and SA) edited and approved the final manuscript.

Data availability statement

Additional data are available from Mendeley Data repository, DOI: 10.17632/spy3gb757t.1

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Tables

Table 1: Characteristics of included publications

Author (Year), Country	Clinician participants	Data collection method	Type of digital health intervention	Intervention description
Afable et al. (2017), United States [32]	Anaesthesiologists (n=10)	Semi-structured interviews	Electronic consultations	Platform for provider-to-provider consultation using a shared electronic health record (EHR) or web-based portal.
Brown-Johnson et al. (2021), United States [33]	Plastic surgeons (n=10)	Semi-structured interview	Telemedicine	EHR integrated software to provide remote video consultations to patients prior to plastic surgery
Byrnes et al. (2020), United States [34]	Colorectal surgeons (n=58)	Semi-structured interview	Telemedicine	Virtual consultations with patients before colorectal surgery
Chen et al. (2020), Taiwan [35]	Heart transplant physician (n=1), cardiac intensive care unit assistant head nurse (n=1), cardiac surgery nurse practitioner (n=1)	Semi-structured interviews	Mobile health application	Mobile application to facilitate monitoring and management of patients after heart transplant surgery
Cnossen et al. (2016), Netherlands [36]	Head and neck surgeons (n=2), oncology nurse (n=1), physiotherapist (n=1), dietician (n=1), psychologist (n=1)	Focus group interviews	Web-based programme	Web-based self-care program for patients following total aryngectomy
Cottrell et al. (2017), Australia [37]	Directors of physiotherapy (n=4), clinical leaders (n=8), treating clinicians (n=14)	Semi-structured interview	Telemedicine	The use of a telemedicine platform to deliver remote prehabilitation services to patients before orthopaedic surgery or neurosurgery
Damery et al., (2021), United Kingdom [38]	Physicians (n=2)	Semi-structured interviews	Web-based software	Web-based software which allows for the provision of remote clinical consultations to patients before liver transplant surgery.
Dunphy et al. (2017), United Kingdom [39]	Physiotherapists (n=4)	Semi-structured interview	Web-based platform	Interactive web-based application to support patient rehabilitation after orthopaedic surgery
Elahi et al. (2020), Uganda [40]	Emergency medicine physicians (n=5), intern physicians (n=11), general surgeons (n=6), neurosurgeons (n=6)	Semi-structured interview	Mobile, web-based application	Application to facilitate emergency assessment of traumatic brain injury in patients
Eno et al. (2019), United States [41]	Transplant surgeons(n=2), clinical care supervisors (n=1), donor medical directors (n=1), clinical transplant director (n=1), consultant (n=1)	Semi-structured interviews	Mobile health application	Mobile application to support the follow-up of patients following liver transplant surgery
Feinberg et al. (2019), United States [42]	Obstetrics and gynaecology resident physicians (n=33)	Survey with open-ended questions	Mobile application	HIPAA compliant secure messaging system for use by clinicians and patients
Gilbert et al. (2021), United Kingdom [43]	Physiotherapists (n=14)	Semi-structured interview	Telemedicine	Phone and video consultations for the delivery of rehabilitation services after orthopaedic surgery
Heller et al.(2020), Canada [44]	Physicians (n=10)	Semi-structured interview	Real-time location system mobile application, software	Mobile application and software which provides tracking information to physicians, family members, and friends throughout a patient's operative journey
Joughin et al. (2021), United Kingdom [45]	Geriatricians (n=3)	Survey with open-ended questions	Telemedicine	Remote video or telephone consultations for the pre-operative screening of geriatric patients
Miller et al. (2020), United Kingdom [46]	Medical (n=5), nursing (n=3) and pharmacy (n=1) professionals	Semi-structured interview, focus group	Digital monitoring application	Digital remote monitoring application to support and enhance management of patients after colorectal cancer surgery
Park et al. (2019), United Kingdom [47]	Perioperative nurses (n=4)	Semi-structured interview, focus group	Smartphone application	Commercially available smartphone application to facilitate communication between perioperative nurses before and after orthopaedic surgery
Rothgangel et al. (2019), Netherlands [48]	Therapists (n=10)	Semi-structured interviews	Telemedicine	The delivery of post-amputation mirror therapy through a telemedicine platform
Sauro et al. (2016), Canada [49]	Adult neurologists (n=2), adult neurology residents (n=2), paediatric neurologists (n=3), paediatric neurology residents (n=2)	Semi-structured interview, focus groups	Web-based clinical decision tool	Web-based tool which aids physicians in assessing patients for epilepsy surgery

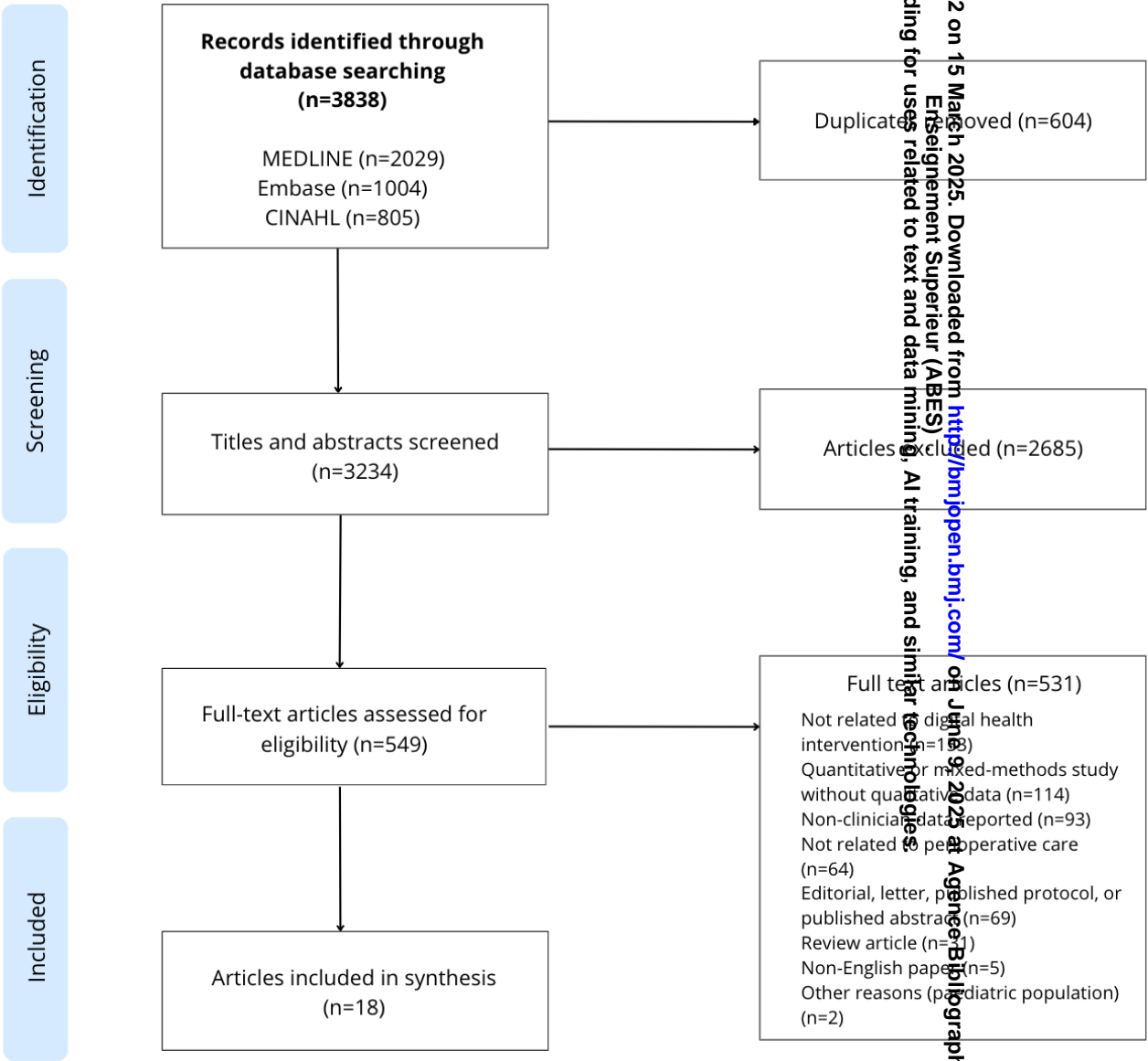
Table 2: Themes extracted from included publications with exemplar quotes.

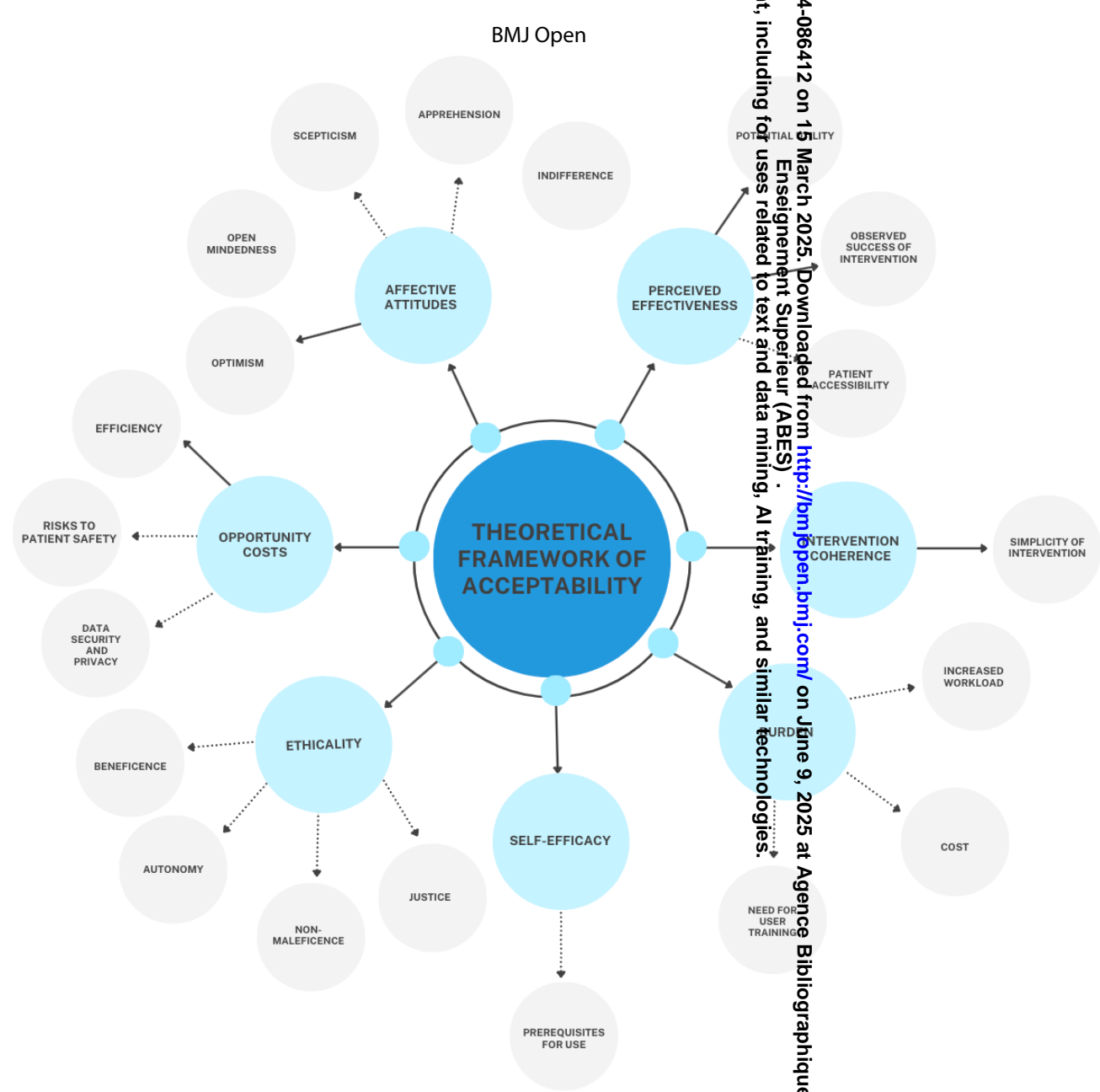
Construct	Theme	Frequency (n)	Exemplar quote
<i>Perceived effectiveness</i>	Potential utility	18	"This tool would be useful to frontline health workers because they activate neurosurgery teams. If there is uncertainty, the frontline workers may take their time before calling the neurosurgery team, causing a delay. This could help reduce that time to activate [the neurosurgery] team" [40]
	Observed success	15	"Where is my patient?" because it's so often wrong that there's no point in me going to the board [to find] where my patient is" [44]
	Patient accessibility	12	"I mean, you got like a 75-year-old guy with colon cancer, and he can't like get on MyChart and figure, he doesn't have a smart phone to use and all this different stuff" [34]
<i>Affective attitude</i>	Optimism	15	"I think it could really benefit and help us be compliant..." [41]
	Open-mindedness	4	"[W]ould certainly be willing to give it a go" [37]
	Scepticism	8	"I think less than 10% of my patients would I be able to do anything. I'd think, worthwhile with telemedicine" [34]
	Apprehension	10	"I thought they were in this place and I thought they were doing this and exercise z and I saw them and they were worse than I thought they were. That has also frightened people—therapists I guess, thinking that, oh I thought they were better" [43]
	Indifference	1	"I'm not hurt by not getting the text message. It doesn't change anything. It's like extra peas for dinner; if it's there, it's there; if not, it's fine" [44]
<i>Opportunity costs</i>	Efficiency	15	"It's faster, it's efficient, we use less resources than clinic..." [33]
	Patient safety	9	"Most worrisome is how long it some- times takes for messages to be delivered—it has caused many mis- communications, arguments, and delays in care" [42]
	Data privacy and security	5	"I think there would be a part of just assuring that it was all HIPAA-compliant and that there weren't any concerns about...information being able to be hacked" [41]
<i>Ethicality</i>	Beneficence	9	"You can better supervise patients' self-management on the long-term, remind them what they can do themselves and control their training" [48]
	Non-maleficence	7	"In addition, the inability to carry out a heart and lung examination and take specific patient measurements were also considered limiting factors that could create problems during surgery" [33]
	Autonomy	6	"We are giving back that locus of control to the patient" [39]
	Justice	6	"There was a recognition that different individuals would have different access to resources" [43] "Potential for elderly/low socioeconomic groups to have difficulty with technology..." [46]
<i>Burden</i>	Cost	7	"Well for both the hospital and the client it would be financial, so cost input would be a key consideration" [37]
	Increased workload	6	"I think e-consultations are helpful, but when they add to the workload and we get ten per week, then we have to assign someone to do them because [it is] too much work for those at the clinic" [32]
	Need for user training	6	"It's not just as easy as sitting in front of camera and both ends and away you go, there's probably a significant amount of learning on how to do that effectively" [37]
<i>Intervention coherence</i>	Simplicity of intervention	12	"The clarity and brevity of the tool was a facilitator to its use in clinical practice" [49]
<i>Self-efficacy</i>	Prerequisites for use	10	"I need to work with it more regularly to get more confident" [48]

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Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	Total
Was there a clear statement of the aims of the research?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Is a qualitative methodology appropriate?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Was the research design appropriate to address the aims of the research?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Was the recruitment strategy appropriate to the aims of the research?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Was the data collected in a way that addressed the research issue?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Has the relationship between researcher and participants been adequately considered?	+	+	+	+	-	-	-	ct	+	-	ct	+	ct	ct	-	+	-	ct	7
Have ethical issues been taken into consideration?	+	+	+	+	+	+	+	+	+	+	+	+	+	ct	+	+	+	+	18
Was the data analysis sufficiently rigorous?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18
Is there a clear statement of findings?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18

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Appendix 1

Search strategy

Ovid (MEDLINE, EMBASE)

- 1 Computer Communication Networks/
- 2 Local Area Networks/
- 3 Internet/
- 4 Internet-Based Intervention/
- 5 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) adj3 (care or deliver* or healthcare or health care or consult* or counsel* or interven* or monitor* or psychiatr* or rehab* or service? or treat* or therap*)).tw,kf.
- 6 Smartphone/
- 7 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) adj3 (app or apps or application?)).tw,kf.
- 8 (mobile adj3 (app or apps or application?)).tw,kf.
- 9 (digital* adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 10 ((technology-based or technology-facilitated) adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 11 (video* adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 12 Patient Portals/
- 13 (patient? adj2 (portal or portals)).tw,kf.
- 14 ((health information or medical information or clinical information) adj3 (portal or portals)).tw,kf.
- 15 ((health data or medical data or clinical data) adj3 (portal or portals)).tw,kf.
- 16 health portal?.tw,kf.
- 17 Electronic Mail/
- 18 (electronic mail* or email* or e-mail*).tw,kf.
- 19 exp Telephone/
- 20 (telephon* or tele-phon* or phone or phoned or phones or phoning or answering service? or telefacsimile* or tele-facsimile* or FAX).tw,kf.
- 21 exp Television/
- 22 (televis* or tele-vis* or TV or TVs or videorecord* or video-record* or videotap* or video tap*).tw,kf.
- 23 Videoconferencing/
- 24 (videoconferenc* or video-conference* or videophon* or video-phon*).tw,kf.
- 25 Electronic Health Records/
- 26 electronic health record?.tw,kf.
- 27 (EHR or EHRs or EMR or EMRs or PHR or PHRs).tw,kf.
- 28 Telecommunications/
- 29 (telecommunicat* or tele-communicat*).tw,kf.
- 30 exp Telemedicine/

- 31 Telenursing/
- 32 (ehealth or e-health or mhealth or m-health or mobile health).tw,kf.
- 33 (telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*).tw,kf.
- 34 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
- 35 exp Medical Informatics Applications/
- 36 medical informatics applications/ or exp decision making, computer-assisted/ or exp decision support techniques/ or exp "information storage and retrieval"/ or exp information systems/ or exp medical informatics computing/
- 37 34 or 35 or 36
- 38 (doctor* or clinician* or practitioner* or health professional* or health personnel or provider* or physician* or GP or GPs or nurs* or allied health* or psychologist* or counsellor* or counselor* or social work* or therapist* or psychiatrist* or emergency medical technician* or paramedic* or ambulance or ((healthcare or health care) adj2 (worker* or personnel))).mp,kw.
- 39 37 and 38
- 40 exp Specialties, Surgical/
- 41 specialties, surgical/ or exp colorectal surgery/ or exp general surgery/ or exp gynecology/ or exp neurosurgery/ or exp obstetrics/ or exp ophthalmology/ or exp orthognathic surgery/ or exp orthopedics/ or exp otolaryngology/ or exp surgery, plastic/ or exp surgical oncology/ or exp thoracic surgery/ or exp traumatology/ or exp urology/
- 42 exp Surgical Procedures, Operative/
- 43 Perioperative Medicine/ or Perioperative Care/ or Perioperative Period/
- 44 Preoperative Care/
- 45 Preoperative Period/
- 46 Postoperative Care/
- 47 Postoperative Period/
- 48 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47
- 49 39 and 48
- 50 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide) adj2 (interview* or discussion* or questionnaire)).tw,kw.
- 51 (focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant").tw,kw.
- 52 interviews as topic/ or focus groups/ or narration/ or qualitative research/
- 53 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide or guides or follow up or self report) adj3 (interview* or discussion* or questionnaire)).tw.
- 54 (focus group* or advisory group* or qualitative or ethnograph* or fieldwork or field work or key informant or thematic analy* or grounded theor* or phenomenolog* or discourse analy* or content analy* or narrative* or observational method* or open ended evaluation* or action research or inductive analy* or emic or etic or hermeneutic* or constant compar* or grounded theor* or lived experience* or life experience* or theoretical sampl* or purposive sampl* or quasi-experiment* or (case adj2 stud*)).tw.
- 55 50 or 51 or 52 or 53 or 54

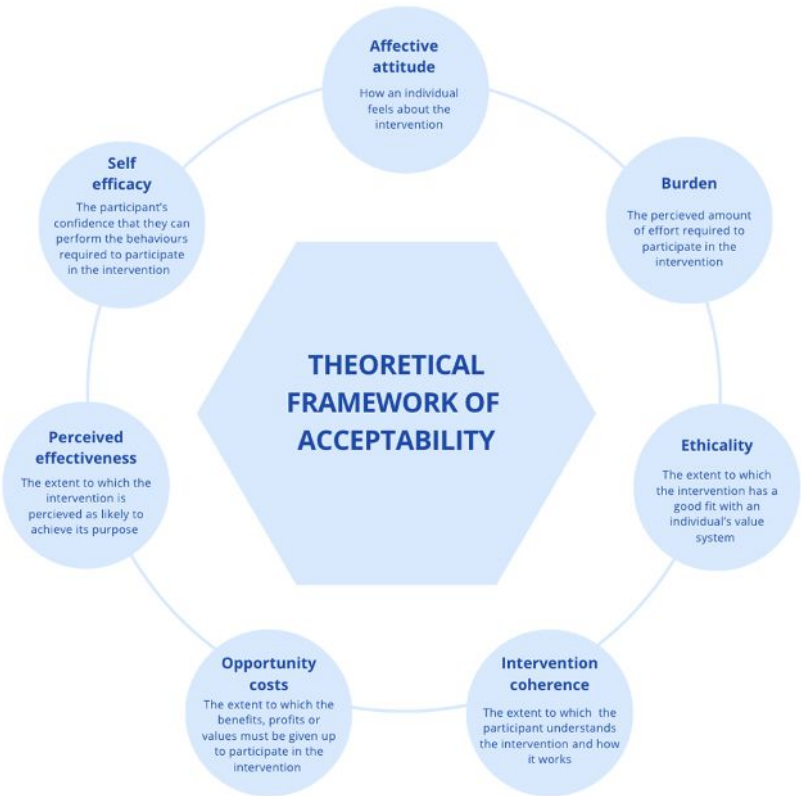
56 49 and 55

CINAHL

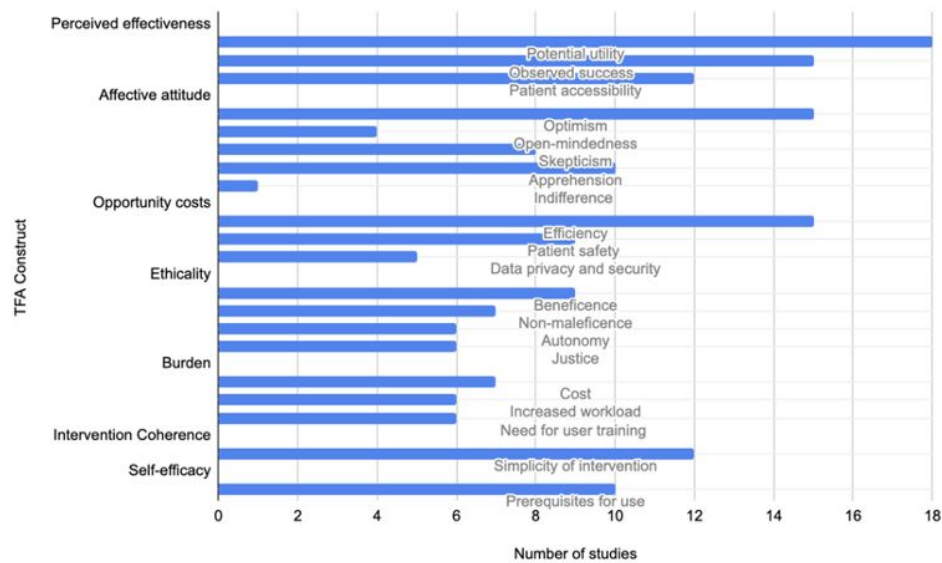
- 1 (MM "Computer Communication Networks")
- 2 (MM "Local Area Networks")
- 3 (MM "Internet")
- 4 (MM "Internet-Based Intervention") OR (MM "World Wide Web Applications") OR (MM "World Wide Web")
- 5 "((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) N (care or deliver* or healthcare or health care or consult* or counsel* or interven* or monitor* or psychiatr* or rehab* or service? or treat* or therap*))"
- 6 (MM "Smartphone") OR (MM "Mobile Applications") OR (MM "Computers, Hand-Held+") OR (MM "Cellular Phone+") OR (MM "Text Messaging")
- 7 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) N (app or apps or application?))
- 8 (mobile N (app or apps or application?)).
- 9 (digital* N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 10 ((technology-based or technology-facilitated) N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 11 (video* N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 12 (MM "Patient Portals")
- 13 (patient? N (portal or portals))
- 14 ((health information or medical information or clinical information) N (portal or portals))
- 15 (MH "Health Information Systems+") OR (MM "Integrated Advanced Information Management Systems") OR (MM "Management Information Systems") OR (MM "Appointment and Scheduling Information Systems")
- 16 ((health data or medical data or clinical data) N (portal or portals)).
- 17 (MM "Routinely Collected Health Data") OR (MM "Clinical Data Repository") OR (MM "Electronic Data Interchange") OR (MM "Public Reporting of Healthcare Data")
- 18 health portal?
- 19 (MM "Email")
- 20 (MM "Telephone+") OR (MM "Cellular Phone+")
- 21 (telephon* or tele-phon* or phone or phoned or phones or phoning or answering service? or telefacsimile* or tele-facsimile* or FAX)
- 22 (MM "Telephone Consultation (Iowa NIC)")
- 23 Television
- 24 (MM "Television")
- 25 (televis* or tele-vis* or TV or TVs or videorecord* or video-record* or videotap* or video tap*)

- 26 (MM "Videoconferencing")
- 27 (videoconferenc* or video-conference* or videophon* or video-phon*)
- 28 (MH "Electronic Health Records+")
- 29 (MM "Patient Record Systems") OR (MH "Medical Records, Personal") OR (MM "Electronic Data Interchange") OR (MH "Health Information Management Personnel") OR (MM "Medical Records")
- 30 (EHR or EHRs or EMR or EMRs or PHR or PHRs)
- 31 (MM "Telecommunications")
- 32 (telecommunicat* or tele-communicat*)
- 33 (MH "Telemedicine+") OR (MH "Telehealth+") OR (MM "Telerehabilitation")
- 34 (ehealth or e-health or mhealth or m-health or mobile health)
- 35 (MH "Telehealth+") OR (MM "Telemedicine") OR (MM "Telenursing") OR (MM "Telepsychiatry") OR (MH "Teledentistry")
- 36 "(telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*)"
- 37 "(telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*)"
- 38 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37
- 39 (MM "Medical Informatics")
- 40 (MH "Decision Making, Computer Assisted+") OR (MM "Diagnosis, Computer Assisted") OR (MM "Therapy, Computer Assisted") OR (MM "Data Analytics") OR (MM "Virtual Reality") OR (MM "Remote Access to Information") OR (MM "Artificial Intelligence")
- 41 S38 OR S39 OR S40
- 42 (MH "Health Personnel+") OR (MM "Allied Health Personnel") OR (MM "Alternative Health Personnel") OR (MM "Case Managers") OR (MM "Community Health Workers") OR (MM "Coroners and Medical Examiners") OR (MM "Expert Clinicians") OR (MM "Faculty, Nursing") OR (MM "Health Facility Administrators") OR (MM "Health Personnel, Infected") OR (MM "Health Personnel, Minority") OR (MM "Home Health Aides") OR (MM "Medical Staff") OR (MM "Midwives") OR (MM "Multiskilled Health Practitioners") OR (MM "Nurses") OR (MM "Nursing Home Personnel") OR (MM "Operating Room Personnel") OR (MM "Personal Trainers") OR (MM "Personnel, Health Facility") OR (MH "Pharmacists") OR (MM "Physicians") OR (MM "Podiatrists") OR (MM "Rapid Response Team") OR (MM "Registry Personnel") OR (MM "Rural Health Personnel") OR (MM "Transplant Coordinators") OR (MM "Information Technology Personnel")
- 43 (doctor* or clinician* or practitioner* or health professional* or health personnel or provider* or physician* or GP or GPs or nurs* or allied health* or psycholog* or counsellor* or counselor* or social work* or therapist* or psychiatr* or emergency medical technician* or paramedic* or ambulance or ((healthcare or health care) N (worker* or personnel)))

- 44 S42 OR S43
- 45 (MH "Specialties, Surgical+")
- 46 (MM "Specialties, Surgical") OR (MM "Gynecology") OR (MM "Neurosurgery") OR (MM "Obstetrics") OR (MM "Ophthalmology") OR (MM "Orthopedics") OR (MM "Surgery, Plastic") OR (MM "Thoracic Surgery") OR (MM "Traumatology")
- 47 (MH "Surgery, Operative+") OR (MH "Surgical Count Procedure")
- 48 (MM "Perioperative Care") OR (MM "Perioperative Care (Iowa NIC)") OR (MM "Perioperative Medicine")
- 49 (MM "Preoperative Care") OR (MM "Preoperative Period") OR (MM "Teaching: Preoperative (Iowa NIC)") OR (MM "Preoperative Education")
- 50 (MM "Postoperative Care") OR (MM "Postoperative Complications") OR (MM "Postoperative Pain")
- 51 (MM "Postoperative Period") OR (MM "Intraoperative Period")
- 52 S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
- 53 (MM "Semi-Structured Interview") OR (MM "Unstructured Interview") OR (MM "Structured Interview")
- 54 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide) N (interview* or discussion* or questionnaire*))
- 55 (focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant")
- 56 (MM "Fieldwork") OR (MM "Focus Groups")
- 57 (MH "Qualitative Studies+") OR (MM "Action Research") OR (MM "Phenomenological Research") OR (MM "Naturalistic Inquiry") OR (MM "Ethnonursing Research") OR (MM "Ethnographic Research")
- 58 interviews as topic/ or focus groups/ or narration/ or qualitative research/
- 59 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide or guides or follow up or self report) N (interview* or discussion* or questionnaire*))
- 60 (focus group* or advisory group* or qualitative or ethnograph* or fieldwork or field work or key informant or thematic analy* or grounded theor* or phenomenolog* or discourse analy* or content analy* or narrative* or observational method* or open ended evaluation* or action research or inductive analy* or emic or etic or hermeneutic* or constant compar* or grounded theor* or lived experience* or life experience* or theoretical sampl* or purposive sampl* or quasi-experiment* or (case N stud*))
- 61 S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60
- 62 S41 AND S44 AND S52 AND S61



Supplemental Figure 1: An illustration of the seven components of the TFA based on the model by Sekhon et al. [27]



Supplemental Figure 2: The frequency distribution of themes categorised by TFA construct across studies (n=18). Themes are displayed in grey below each bar.

Specialty	Frequency of studies, n%
Orthopaedic surgery	4 (22.2)
General surgery	4 (22.2)
Colorectal surgery	3 (16.7)
Neurosurgery	2 (11.1)
Vascular surgery	1 (5.6)
Urology	1 (5.6)
Plastic surgery	1 (5.6)
Cardiothoracic surgery	1 (5.6)
Anaesthesia	1 (5.6)
Otolaryngology	1 (5.6)
Obstetrics and gynaecology	1 (5.6)
Neurology	1 (5.6)
Geriatrics	1(5.6)

Supplemental Table 1: Medical specialties represented across all publications (n=18)

BMJ Open

Acceptability of Digital Health Interventions in Perioperative Care: A Systematic Review and Narrative Synthesis of Clinician Perspectives.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2024-086412.R1
Article Type:	Original research
Date Submitted by the Author:	22-Nov-2024
Complete List of Authors:	Ahmed, Amal; Imperial College London, Institute of Global Health Innovation Ho, Chik Wai; Imperial College London, Institute of Global Health Innovation Grant, Yasmin; Imperial College London, Institute of Global Health Innovation Archer, Stephanie; University of Cambridge, Department of Public Health and Primary Care; University of Cambridge, Department of Psychology Carrington, Emma ; Imperial College London, Institute of Global Health Innovation
Primary Subject Heading:	Qualitative research
Secondary Subject Heading:	Surgery, Health informatics
Keywords:	Telemedicine < BIOTECHNOLOGY & BIOINFORMATICS, SURGERY, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, QUALITATIVE RESEARCH

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Manuscripts



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Title

Acceptability of Digital Health Interventions in Perioperative Care: A Systematic Review and Narrative Synthesis of Clinician Perspectives.

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3 1 ABSTRACT

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6 3 Objectives: To identify themes relating to clinician acceptability of DHIs in the perioperative setting.

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8 4 Design: Systematic review and narrative synthesis applying an inductive-deductive framework

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10 5 synthesis approach.

11 6 Data sources: Medline, Embase and CINAHL for studies published between inception and March 6,

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13 7 2023.

14 8 Eligibility criteria: Studies with qualitative data on clinician perceptions of DHIs in the context of adult

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16 9 perioperative care.

17 10 Data extraction and synthesis: Included studies were coded inductively by a single reviewer. Codes

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19 11 were organised into themes based on conceptual similarities. Collaborative discussions with a second

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21 12 and third reviewer enabled higher-order interpretations and the emergence of subthemes. Themes

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23 13 and subthemes were systematically mapped onto the seven constructs of the Theoretical Framework

24 14 of Acceptability (TFA).

25 15 Results: A total of 3234 publications were identified, of which 18 were selected for inclusion. DHIs

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27 16 studied included telemedicine platforms, mobile health applications, website-based programmes, and

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29 17 EHR-integrated software. The most commonly reported TFA construct was perceived effectiveness,

30 18 followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-

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32 19 efficacy.

33 20 Conclusions: Clinicians' acceptance of DHIs is primarily driven by perceived effectiveness. Optimism

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35 21 about the potential for DHIs to enhance care is often overshadowed by concerns about patient safety,

36 22 privacy, and opportunity costs. As clinicians are key gatekeepers in DHI adoption, these perspectives

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38 23 have a significant impact on the long-term integration of these technologies into perioperative

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40 24 care. Co-creation of DHIs with clinicians is required to ensure future interventions are better aligned

41 25 with clinical workflows and patient needs, enhancing their utilisation and uptake in the long-term.

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Strengths and limitations of this study:

Strengths:

1. First rigorously conducted, comprehensive qualitative synthesis of clinician perspectives of DHI acceptability in perioperative care.
2. Thematic analysis performed through the lens of the Theoretical Framework of Acceptability which has been widely validated.

Limitations:

3. Comparisons between studies are limited by differences in study design, participant characteristics, and intervention type.
4. Over-representation of studies conducted in high-income countries undermines applicability of results to low- and middle- income settings.

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Introduction

Digital health interventions (DHIs) include information and communication technologies designed to enhance and support health care, e-health (online and offline computer-based applications), and m-health (mobile) applications¹⁻³. These electronic tools are increasingly utilised to modify health related behaviours and monitor chronic conditions including (but not limited to) cardiovascular disease and mental illness⁴⁻⁷. DHIs are recognised as a cost-effective and feasible means for health care providers to remotely assess, monitor, inform and treat health conditions⁸⁻¹⁰.

Over the past decade, there has been significant growth in the use of DHIs, with the World Health Organisation (WHO) adopting digital health as a key element in its global strategy for achieving health-related Sustainable Development Goals (SDGs)¹. In parallel with the progress of the current technological era, health systems are also being shaped by the worldwide expansion of DHIs¹¹. Data suggest that hundreds of health-related mobile applications are being added daily, with a total 5.4 billion global users reported by the end of 2022¹². Thus, DHIs have been identified as an emerging asset in healthcare, offering boundless potential to promote the health objectives of today's technologically adept population.

Currently, DHIs are utilised across various health care domains, including surgery¹³. The application of digital health tools in the context of perioperative management has been shown to be associated with positive pre- and post-operative health behaviours, particularly in the context of remote monitoring and shared decision making¹³. Despite these benefits, evidence suggests a lack of sustained implementation of digital health in the perioperative context¹⁴. While they are perceived to be instrumental in the attainment of SDGs, low clinician compliance with DHIs has been a challenge for developers¹⁵. Most DHIs are discontinued in less than a year and non-compliance manifests as failure to improve associated mortality and morbidity¹⁶.

Resistance to the use of DHIs in general has been attributed to limited motivation amongst users (patients) and providers (clinicians)¹⁴ with cited concerns including ethical and legal issues, lack of standardisation, accuracy of results and perceived effectiveness¹⁶⁻¹⁸. Furthermore, the scarcity of evidence based DHIs contributes to user reluctance. Many publicly available interventions are not evidence-based and are selected based on user rating or perceived relevance¹⁹. While the National Health Service (NHS) has undertaken initiatives to establish repositories of endorsed health apps, many apps lack the necessary evidence²⁰.

Low motivation and intention to use DHIs consistently are associated with reduced acceptability, which has been shown to result in decreased efficiency and effectiveness of interventions. Given this, researchers have focused their attention on factors affecting the acceptability of digital technologies. Several studies have been conducted to investigate the lack of acceptability of DHIs by patients²¹⁻²⁵. However, studies documenting acceptability by clinicians are scarce. Further investigation into this is imperative, as acceptability has been highlighted by the Medical Research Council (MRC) as a major element in DHI design and implementation success²⁶.

The Theoretical Framework of Acceptability (TFA) serves as a valuable guide for the evaluation of clinician acceptance. It emphasises that the perceptions of users influence their intention to utilise interventions²⁷. The TFA encompasses seven key constructs: affective attitudes, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness, and self-efficacy (Appendix 1, Supplemental Figure 1).

Clinicians' expertise makes their input vital to the development of DHIs. However, evidence suggests that researchers neglect the perceptions of clinicians, prioritising patient experiences instead²⁸⁻³⁰. This approach may result in the production of interventions which are not perceived to be useful by clinicians and imply excessive effort³¹. Indeed, limited involvement of clinicians in DHI development is frequently reported and could hinder their continued engagement with DHIs³¹.

The existing literature indicates that a number of studies have explored the perceptions of clinicians regarding DHIs. Yet, most of these studies considered a single intervention, and there remains a gap in the systematic synthesis of perspectives toward DHIs, particularly in perioperative care. Therefore, this review aimed to explore clinicians' perceptions of DHIs and to examine the factors influencing their acceptance in perioperative care, guided by the TFA.

Methods

Search strategy

This review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines with a protocol accessible on PROSPERO (registration number: CRD42023403205). A systematic search of three electronic databases (Medline, Embase and Cumulative Index to Nursing and Allied Health Literature (CINAHL)) was carried out between February 21 and March 6, 2023, to identify peer-reviewed articles published from inception until March 6, 2023. A grey-literature (Google, Google Scholar) and manual search of the reference lists of included articles was conducted to find additional studies that met the inclusion criteria. Search strategies for all databases are available in Appendix 1.

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1 **Eligibility criteria and study selection**

2 Studies were included if they met the following criteria: (1) implemented a qualitative or mixed-
3 methods study design, using interviews, focus groups and open-ended questionnaires; (2) reported
4 clinicians' experiences with DHIs prior to, during or following surgery/in the perioperative context; (3)
5 evaluated a digital health intervention intended for use by clinicians or adult patients, as described by
6 the WHO.

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8 Studies were excluded if they: (1) reported only patient or other non-clinician data (2) presented a
9 digital health intervention utilised by paediatric clinicians or patients (3) were not available in English.
10 Editorial comments, reviews, protocols, abstracts, and conference proceedings were also excluded.

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12 **Data analysis and synthesis**

13 The search results were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia -
14 www.covidence.org), for screening and data extraction. Following deduplication, the primary reviewer
15 (AA) filtered articles by title and abstract and screened full-text articles against the eligibility criteria.
16 Concordance checking was undertaken by a second reviewer (CWH) on a sample of 10% of full-text
17 articles. All included articles were also reviewed by CWH. A third reviewer (EVC) was available to
18 resolve disagreements regarding eligibility, where consensus could not be reached. Cohen's Kappa
19 was calculated to establish interrater reliability.

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21 AA extracted data on author, year of publication, country, aims, methods, sample size, clinician
22 participants, clinical specialty, and intervention characteristics, using Microsoft Excel (see Table 1).

23
24 The included articles were imported into NVivo 12 (2017), a qualitative data management program.
25 To ensure a comprehensive interpretation and analysis of the data, a framework synthesis approach
26 was taken²². The author utilised an inductive-deductive, line-by-line coding technique to analyse the
27 data. Following review by CWH, codes were compared across studies and organized into themes,
28 based on their conceptual similarities. Themes were explored in detail to evaluate their alignment with
29 the TFA, before they were systematically mapped to the seven TFA constructs²⁷. Group discussion
30 between AA, CW and EVC facilitated further examination of the relationships between codes, themes
31 and TFA constructs.

Quality assessment

Evaluation of the quality of included studies was performed using The Critical Appraisal Skills Programme (CASP) tool. This was selected as it is the most commonly used checklist for quality appraisal in healthcare related quality evidence synthesis^{32 33}. It is endorsed by Cochrane and the World Health Organisation for this purpose^{33 34}. It utilises the following criteria: 1) Was there a clear statement of the aims of the research? 2) Is a qualitative methodology appropriate? 3) Was the research design appropriate to address the aims of the research? 4) Was the recruitment strategy appropriate to the aims of the research? 5) Was the data collected in a way that addressed the research issue? 6) Has the relationship between researcher and participants been adequately considered? 7) Have ethical issues been taken into consideration? 8) Was the data analysis sufficiently rigorous? 9) Is there a clear statement of findings?

Quality assessment was undertaken by one reviewer (AA) and independently verified by a second reviewer (CW) (Figure 1). To allow for a comprehensive exploration of the available qualitative data, publications were not excluded based on quality.

Ethical considerations

No ethical approval was sought for this study as it involves the use of qualitative data from published studies which are freely available in the public domain.

Patients and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

The literature search retrieved 3838 records in total. After deduplication, 3234 abstracts were screened for eligibility. 549 articles were selected for full-text review. Of these, 18 articles met the inclusion criteria³⁵⁻⁵² (Figure 2). Interrater reliability for full-text review was strong (Cohen's kappa: 0.81, overall agreement: 93.3%).

Study characteristics

Included studies were conducted between 2012 and 2022, with the majority (n=13) published between 2019 and 2022. Studies were undertaken across six countries: United Kingdom (n=6), United States (n=5), Canada (n=2), Netherlands (n=2), Taiwan (n=1) and Uganda (n=1). Four categories of DHIs

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3 1 were evaluated: telehealth interventions (n=7), mobile health applications (n=6), website-based
4 2 programmes (n=4) and EHR-integrated software (n=1). A summary of study characteristics is
5 3 presented in Table 1. Clinician participants included surgeons, physicians, nurses, physiotherapists,
6 4 dietitians, and psychologists. The studies represented DHIs utilised in a range of specialities
7 5 (Appendix 1, Supplemental Table 1).

11 6
12 7 **Summary of findings**

14 8 Our analysis identified that the 7 TFA constructs (perceived effectiveness, affective attitudes,
15 9 opportunity costs, ethicality, burden, intervention coherence, and self-efficacy) effectively described
16 10 clinicians' perceptions of DHIs. Upon further analysis 20 more detailed themes emerged. These are
17 11 summarised in Figure 3, with representative quotes provided in Table 2.

20 12
21 13 **Perceived effectiveness**

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23 15 Perceived effectiveness was explored in all studies (n=18)³⁵⁻⁵². Clinicians' views of DHI effectiveness
24 16 were shaped by their potential utility (n=18)³⁵⁻⁵², observed success (n=15)^{35-39 41-43 45-48 50-52} and
25 17 accessibility to patients (n=12)^{35-37 39-42 44 46 48 49 51}.

28 18
29 19 *Potential utility*

30 20
31 21 Clinicians believed that DHIs may not be suited to their intended purpose^{36 37 46}. They expressed
32 22 scepticism about the value of telehealth in surgical care, indicating that it is unlikely to meet the needs
33 23 of their patients^{36 37}. However, some clinicians recognized the potential for digital health to facilitate
34 24 assessment, offer personalised patient support and aid decision-making, as intended^{43 49 51 52}.
35 25 Clinicians were optimistic that DHIs had the capacity to streamline processes, addressing treatment
36 26 delays and surgical backlogs^{35 38 39 41 43-47 50}. They also believed that DHIs could act as a feasible
37 27 alternative to in-person consultations and expand access to previously out of reach services,
38 28 improving patient care^{36 37 40 42 43 48 51}.

40 29
41 30 *Observed success of intervention*

42 31
43 32 Clinicians discussed instances where DHIs fulfilled their intended purpose. Interventions allowed
44 33 participants to successfully communicate with patients and obtain the necessary information,
45 34 virtually^{47 48 51 52}. Clinicians reported that a digital decision aid effectively triaged patients prior to
46 35 surgery⁴³. Remote peri-operative consultations were also seen to meet their needs and were
47 36 comparable to face-to-face appointments⁴⁸. They also described experiences where telemedicine and
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mobile applications were effective and practical, requiring fewer resources and smaller-scale equipment than in-person care^{35-39 41-43 45 46 48 50 51}.

Patient accessibility

There was variation in beliefs about the accessibility of DHIs, with some clinicians suggesting that their digital tool is inclusive of all patients,^{35 36 39 40 42} and others acknowledging that patients without adequate computer literacy, resources or technical proficiency may face challenges in using and benefiting from DHIs^{37 41 46 48 49 51}. There were also concerns that older patients may be wary of technology and less able to access interventions^{37 44}. However, clinicians in one study highlighted that age does not always hinder accessibility, reporting positive experiences with elderly patients. Some clinicians also suggested that younger patients could assist older patients in accessing DHIs⁵¹.

Affective attitudes

Clinicians exhibited a range of affective attitudes toward DHI. Positive affective attitudes were observed in the majority of studies (n=15)^{35 36 38-45 47 49-52}. This included optimism (n=15)^{35 36 38-45 47 49-52} and open-mindedness (n=4)^{40-42 44}. Negative affective attitudes such as scepticism (n=8)^{35-37 40 43 44 46 47} and apprehension (n=10)^{35 36 40-46 49} appeared in numerous studies (n=12)^{35-37 39-47 49 52}. Indifference was expressed in one study (n=1)⁴⁷.

Positive affective attitudes

Clinicians were optimistic about the ability of digital health to improve perioperative management and efficiency and to expand to other aspects of care^{35 36 38-45 47 49-52}. Clinicians were open-minded about the use of digital tools as an alternative or supplement to face-to-face^{40-42 44}. These attitudes were often based on successful past experiences with digital technology^{35 36 42 50}. Clinicians also appreciated the opportunity to utilise new tools to keep pace with advancements in their field⁵¹. In addition, they valued the flexibility that DHIs afforded themselves and their patients^{46 51}.

Negative affective attitudes

Clinicians were sceptical about the applicability and efficacy of DHIs in perioperative assessments, highlighting that some physical examination techniques cannot be replicated virtually^{35-37 40 43 44 46 47}. They were apprehensive about the limitations of DHIs and the possibility of miscommunication or misdiagnosis^{35 36 40-46 49}. Some clinicians refused to rely solely on DHIs, while others rejected them³⁶.

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Clinicians were also wary about the potential for DHIs to replace face-to-face care and the loss of physical office space⁴⁶.

Indifference

In one study, clinicians were indifferent to the use of DHIs. They did not believe that digital health had a meaningful impact on perioperative care and that they could complete their clinical tasks with or without it⁴⁷.

Opportunity costs

Most studies raised concerns about the opportunity costs of utilizing DHIs (n=15)^{35-38 40-47 49 51 52}. Clinicians believed that the adoption of various interventions had the potential to impact patient safety (n=9)^{35 36 40-42 45-47 52}, data privacy and security (n=5)^{37 40 44 46 52} and efficiency (n=15)^{35-38 40-47 49 51 52}.

Data privacy and security

Clinicians highlighted the potential for patient privacy breaches arising from the use of communication and information storage mechanisms associated with DHIs^{37 40 44 52}. They also conveyed unease about the need to disclose their personal phone number to patients or employ personal devices in lieu of secure platforms^{37 46}.

Patient safety

Clinicians cited concerns about impaired quality of examination, accuracy of risk management, delayed communication, and unsafe care^{36 40-42 45 46 52}. They were also worried about the negative impact of DHIs on patients' well-being⁴⁷. Clinicians also believed that, if successful, DHIs could enhance patient safety through early symptom identification and improved patient-provider communication³⁵.

Efficiency

Clinicians believed that DHIs could lead to decreased efficiency through increased workload^{35 49} or time demands in adapting clinical processes and workflows^{35 40 42}. Decreased efficiency was seen to be an opportunity cost of ineffective DHI implementation⁴⁷. Nonetheless, clinicians viewed DHIs as a powerful tool for increasing efficiency in healthcare, in several studies^{35-38 40-47 49 51 52}. They believed

interventions could save time for themselves, streamline clinical processes, and expedite care for patients^{35 36 38 41-44 46 47 51}.

Ethicality

Multiple studies (n=13)^{35-42 44 46 49 51 52} emphasized the implications of DHI implementation on a clinician's professional obligation to promote patient autonomy (n=6)^{38 39 42 44 49 51}, beneficence (n=9)^{35 38-42 44 46 51}, non-maleficence (n=7)^{36 40-42 46 49 52} and justice (n=6)^{37 39 41 44 46 49}.

Autonomy

Clinicians convey that DHIs could provide patients with the necessary information to facilitate independent decision making and self-management, giving them greater control over their health^{38 39 42 44 49 51}.

Beneficence

Clinicians believed that DHI implementation may be in the best interests of patients with limited access to healthcare facilities^{38 40 41 44 46}. DHI use may also align with beneficence if it enhances perioperative management and reduces the risk of postoperative complications^{35 38-40 42 51}.

Non-maleficence

Clinicians worried that the use of DHIs may imply additional risks, inappropriate management, or substandard care, resulting in harm to patients^{36 41 42 46 52}. They also related apprehensions about the potential for DHIs to negatively impact patients' physical or psychological health^{36 49}.

Justice

Clinicians were wary about the lack of inclusivity of DHIs and its impact on the equitable delivery of care^{37 39 41 44 46 49}.

Burden

Perceived burdens of DHIs were identified in several studies (n=12)^{35 37 40-44 46-49 51}. These included cost (n=7)^{40-44 47 48}, increased workload (n=6)^{35 40 42 46 47 49}, and the need for user training (n=6)^{37 40-42 44 51}.

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Cost

Clinicians acknowledged that the implementation of DHIs may come at a cost to the patient or provider. They discussed the financial implications of utilizing DHIs, underscoring the costs associated with an intervention, expressing uncertainty about costs, or identifying costs as a barrier to adoption^{43 44 47}. However, some clinicians indicated that DHIs may be financially advantageous to patients by reducing the costs associated with travel and consultation or assessment^{40-42 48}.

Increased workload

Perceptions of increased workload stemmed from the need to undertake more time-consuming tasks^{35 40 42 49} and additional administrative responsibilities^{46 47}. Inefficiencies arising from DHI malfunction were also a contributing factor⁴⁷. Clinicians felt this was counterproductive, highlighting that interventions should reduce workload⁴⁹. In some studies, clinicians recognized the potential for DHIs to decrease workload by streamlining clinical processes^{40 47}.

Need for user training

Clinicians suggested that they needed to overcome their limited experience with digital health to participate in their DHIs^{37 40 41}. In some cases, they needed to learn about a new platform/device to effectively engage with an intervention^{37 40 42 44 51}. They also believed that additional practical opportunities to consolidate technical skills and knowledge were required to maintain technical proficiency for patient treatment⁵¹.

Intervention coherence

Across studies, intervention coherence was linked to the clinicians' perspective of the simplicity of the interventions (n=12)^{36 37 40 42-47 50-52}.

Simplicity of intervention

Clinicians communicated that some DHIs were easy to understand and use^{42 43 45 46 50-52}. They characterized the set-up and application of these DHIs as simple and intuitive^{43 51 52}. In some cases, DHI use was perceived to be simpler than pre-existing practices⁵⁰. However, for more complex interventions, some clinicians believed that their understanding was limited and possibly inadequate^{36 37 40 44 47}.

Self-efficacy

Clinician perceptions of self-efficacy were related to their views on the prerequisites for use of interventions (n=10)^{39-41 43-45 47 48 51 52}.

Prerequisites for use

Clinicians were confident in their ability to engage with DHIs that required minimal technical knowledge or training^{43 45 48 51}. This was a result of well-designed, user-friendly platforms^{39 51}. Confidence in DHI operability was diminished by the limited availability of newer equipment, additional space, or extra resources, as required by DHIs^{40 41 47 52}. Some clinicians also saw their lack of experience with DHI as a barrier, emphasizing the need for regular utilisation to establish mastery^{40 44 51}.

Discussion

Main findings

This systematic review aimed to assess clinicians' perceptions of DHIs in perioperative care. Our results show that, across eighteen studies, perceived effectiveness was the most commonly identified TFA construct, followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy. This information is crucial, given clinicians' role as key stakeholders in the implementation of DHIs. Indeed, clinicians' perspectives carry substantial implications for the long-term adoption and efficacy of these technologies as they are the ones to allocate resources efficiently and identify patients most suitable for treatment^{27 53}. These findings support previous studies which indicate that clinician beliefs regarding the utility and success of DHIs positively influence their acceptance⁵⁴.

Despite the importance of clinician involvement in intervention development, a recent review noted that their collaboration with the developers of DHIs was insufficient⁵⁵. Therefore, DHIs remain in the early stages of implementation and lack evaluation during practice⁵⁶. This may undermine clinician confidence in DHIs, contributing to the recurring focus on their effectiveness. This is evident in the diverse affective attitudes exhibited in this study. Clinicians' optimism and open-mindedness regarding the value of DHIs to patients and providers align with prior studies on digital interventions⁵⁷. However, their scepticism and ambivalence regarding the security and utility of DHIs in surgical and clinical settings has also been reported previously⁵⁸⁻⁶⁰. These attitudes significantly impact acceptability, consistent with a systematic review by Sekhon et al²⁷.

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3 1 Clinicians have expressed legitimate apprehensions about patient safety, data security, privacy and
4 2 efficiency⁶¹⁻⁶³. With the integration of digital health into perioperative pathways, the malfunction, or
5 3 failure of DHIs could have far-reaching ethical consequences and opportunity costs^{60 64 65}. Prior
6 4 research also relays the negative impact of these factors on care provision⁶⁶, exemplified by a
7 5 systematic review revealing that 67% of smart phone calculator apps placed diabetes patients at
8 6 serious risk of insulin overdose⁶³. Furthermore, as DHIs to diagnose melanoma were reported to be
9 7 inaccurate in 30% of cases, physicians continue to discourage their use⁶⁷. This lack of confidence in
10 8 DHI efficacy may arise from clinicians' continued safety concerns^{55 68}. Moreover, without a clear sense
11 9 of the benefits of new interventions, they may be more wary of risks.
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14 11 Clinicians' reluctance to embrace DHIs may also be attributed to their fear that these interventions
15 12 could exacerbate existing inequalities, compromising the quality of treatment available to patients
16 13 facing mental illness and socio-economic challenges^{69 70}. These concerns are in line with the 'inverse
17 14 care law,' which suggests that interventions may be least accessible to those who stand to benefit
18 15 the most from them⁷¹. For example, older populations are less able to use digital technology despite
19 16 requiring health monitoring the most⁷². The lack of benefit conferred by DHIs to older patients has
20 17 been acknowledged by both clinicians and patients alike⁷³. This digital divide could limit care to
21 18 patients marginalized by age, disability, low literacy, or lack of digital access⁶⁹. Our study also reflects
22 19 previously expressed concerns that the availability of DHIs on electronic platforms may undermine
23 20 patient privacy and data security^{72 74 75}. These sentiments are justified as cyber thieves have recently
24 21 targeted health insurance information, while millions of stolen phones put personal health records at
25 22 risk^{45 60 76}. Such third-party access to data may also lead to discrimination and profiling by marketing
26 23 agencies, causing psychological distress⁶⁸.
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30 25 Our results convey clinicians' belief that DHIs may undermine efficiency, despite their potential to
31 26 expedite care. This may be due to perceived difficulties in using technology, as previously highlighted
32 27 by a systematic review⁷⁷. Clinicians also considered cost, increased workload, and training
33 28 requirements as burdens associated with DHIs. Concerns about limited grant funding for DHIs have
34 29 been documented previously⁷⁸⁻⁸¹ and clinicians' perspectives on the financial implications of DHIs are
35 30 frequently overlooked^{55 82}. This is relevant as most universal healthcare systems such as the NHS
36 31 lack sufficient budgets for long-term DHI adoption⁷⁸. Perceived workload has been cited as another
37 32 barrier to DHI adoption^{54 74 75 79 80 83-86}. The need for training in the use of DHIs contributes to
38 33 perceptions of increased workload^{74 87}, as does low intervention coherence. This is an important
39 34 consideration, as subjective clinician perceptions of workload are a greater predictor of burnout than
40 35 actual workload^{88 89}. Addressing these challenges, the use of user-centred design principles has
41 36 proven effective in promoting simplicity and ease of use of DHIs. This, in turn, facilitates their
42 37 integration into existing workflows^{25 90}. Notably, perceived usability also plays a role in determining

whether an intervention meets the needs of patients or providers, influencing its acceptance⁹¹. These factors collectively shape perceptions about the pre-requisites for DHI use, their attainability and in turn clinicians' self-efficacy in engaging with DHIs⁹². Despite these concerns, clinicians value the role of DHIs in promoting patient autonomy through increased access to information and communication channels⁷⁶. These views are echoed by patients, who view DHIs as predominantly beneficial^{61 62}.

Strengths and limitations

This is the first study to assess the acceptability of a wide range of DHIs in perioperative care, offering a comprehensive synthesis of a diversity of perspectives. Our focus on clinicians is an important strength, given their essential role in implementing DHIs. The qualitative inductive-deductive approach draws out important themes, which may not have been captured in traditional quantitative analyses. This contributes to a more nuanced understanding of the factors influencing the acceptability of multiple DHIs across specialties and perioperative phases. The utilization of a validated framework (TFA) enabled a structured and systematic evaluation of the factors influencing DHI acceptability²⁷. This, alongside the rigorous methodology employed in screening, coding and synthesis maximized the objectivity and reliability of our findings. The inter-rater reliability of 0.81 suggests a high level of agreement among reviewers, indicating a consistent evaluation process. The ENTREQ checklist and PRISMA checklist for this work can be found in the supplementary material.

However, due to the heterogeneity of the data, variations in perspective based on intervention type and specialty may have been overlooked. Furthermore, disparities in methodology and methodological rigor among constituent studies may have limited the reliability of inter-study comparisons. The lack of a standardized approach to weighting the evidence across studies is another potential limitation. Additionally, the predominantly single-reviewer approach to screening, coding, and synthesis could also be a source of bias. Our database search was also restricted to studies published until March 6, 2023, which may limit the relevance of our findings to more recent developments in DHIs. Moreover, the absence of newer technology such as watch-based applications and wearable devices within our synthesis may have resulted in a narrower range of insights. The inclusion of only English-language studies also limits the relevance of the review to non-English cultural contexts. The overrepresentation of studies from high-income countries could also constrain the broader applicability of our findings.

Clinical implications

The findings of this study provide useful information for the planning and development of DHIs as well as their incorporation into perioperative care pathways. Our narrative synthesis informs policymakers,

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3 1 service providers and DHI developers about the key factors influencing the acceptance of DHIs.
4 2 These insights can serve as a foundation for enhancing the short- and long-term impact of DHIs. They
5 3 may also guide the strategic involvement of clinicians in the design and deployment of DHIs. As such,
6 4 this study highlights the importance of the clinician's voice in DHI development. It emphasizes the
7 5 need for active clinician participation in co-creating solutions to address barriers underlying
8 6 intervention implementation.
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14 8 *Future research*

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17 10 Future research should investigate DHI preferences to achieve a better understanding of which
18 11 interventions are favoured by clinicians. Additionally, it would be valuable to explore the perspectives
19 12 of allied health professionals involved in the management of patients in the perioperative setting.
20 13 Future studies may also aim to include studies from a broader range of countries to enhance the
21 14 applicability of the results to diverse socioeconomic contexts. Conducting subgroup analyses could
22 15 allow for a deeper insight into perspectives by intervention type and specialty.
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28 17 **Conclusion**

29 18 In conclusion, this systematic review and narrative synthesis provides valuable insights into the
30 19 perspectives of clinicians regarding the use of DHIs during the perioperative period. Our results reveal
31 20 that clinicians' acceptance of DHIs was primarily driven by their perceived effectiveness. While
32 21 clinicians expressed optimism about the potential for DHIs to expedite and extend patient care beyond
33 22 hospital settings, ethical concerns surrounding patient safety and privacy, coupled with opportunity
34 23 costs, elicited apprehension and scepticism. This negatively influenced clinicians' intention to adopt
35 24 DHIs. These findings underscore the influence of clinicians' perceptions and their crucial role as
36 25 gatekeepers in the long-term acceptance and adoption of DHIs.
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44 27 **Contributors:**

45 28 EVC led the project, with CWH and AA contributing to review concept and design. AA and CWH
46 29 screened search results. AA independently coded records and extracted data from included studies.
47 30 AA, CWH and EVC contributed to data interpretation, analysis, and synthesis. AA prepared the first
48 31 version of the manuscript. EVC, YG and SA reviewed and revised the manuscript critically for content.
49 32 All authors (AA, CWH, EVC, YG and SA) edited and approved the final manuscript.
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55 34 **Data availability statement**

56 35 Additional data are available from Mendeley Data repository, [dataset] DOI: 10.17632/spy3gb757t.1
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Tables

Table 1: Characteristics of included publications

Author (Year), Country	Clinician participants	Data collection method	Type of digital health intervention	Research questions
Afable et al. (2018), United States [35]	Anaesthesiologists (n=10)	Semi-structured interviews	Electronic consultations	How does the uptake of e-consults relate to the different models in use for the provision of anaesthesiology services? What are stakeholders' perceptions of e-consults on workflow and patient-centeredness in anaesthesiology and operative care?
Brown-Johnson et al. (2021), United States [36]	Plastic surgeons (n=10)	Semi-structured interview	Telemedicine	How do plastic surgery providers, as well as patients and surgeons, perceive the adoption of video visits in terms of efficacy, ease of use, accessibility, and long-term viability? How can the proposed 'Bridge Tool for Video Visits in Plastic Surgery' be developed to determine the eligibility of patients for video consultations?
Byrnes et al. (2020), United States [37]	Colorectal surgeons (n=58)	Semi-structured interview	Telemedicine	What are colorectal surgeons' experiences with technical advancements, surgical coaching, and opportunities for continuous professional development? What are colorectal surgeons' perspectives on telemedicine consultations and their impact on patient care during the COVID-19 pandemic?
Chen et al. (2020), Taiwan [38]	Heart transplant physician (n=1), cardiac intensive care unit assistant head nurse (n=1), cardiac surgery nurse practitioner (n=1)	Semi-structured interviews	Mobile health application	What are heart transplant patients and their healthcare providers perspectives on the information needed in a self-management mobile health app for post-transplant care?
Cnossen et al. (2016), Netherlands [39]	Head and neck surgeons (n=2), oncology nurse (n=1), physiotherapist (n=1), dietician (n=1), psychologist (n=1)	Focus group interviews	Web-based programme	How can a web-based self-care program for post-laryngectomy patients be developed using a participatory design approach? What factors influence the usability and effectiveness of a web-based self-care program in addressing the needs of both patients and healthcare professionals?
Cottrell et al. (2017), Australia [40]	Directors of physiotherapy (n=4), clinical leaders (n=8), treating clinicians (n=14)	Semi-structured interview	Telemedicine	What are the views of Neurosurgical & Orthopaedic Physiotherapy Screening Clinic and Multidisciplinary Service providers on the barriers to patients accessing recommended healthcare for chronic musculoskeletal conditions, the potential of telerehabilitation to address these barriers, and the factors influencing its implementation?
Damery et al., (2021), United Kingdom [41]	Physicians (n=2)	Semi-structured interviews	Web-based software	What is the feasibility of using real-time remote consultations between patients and secondary care physicians for routine patient follow-up? Does patient satisfaction differ between those receiving remote consultations and those receiving usual care?
Dunphy et al. (2017), United Kingdom [42]	Physiotherapists (n=4)	Semi-structured interview	Web-based platform	What is the acceptability of TRAK-based blended intervention among physiotherapists and patients in post ACL reconstruction rehabilitation?
Elahi et al. (2020), Uganda [43]	Emergency medicine physicians (n=5), intern physicians (n=11), general surgeons (n=6), neurosurgeons (n=6)	Semi-structured interview	Mobile, web-based application	What is the feasibility and acceptability of implementing an SSA-based TBI risk calculator (decision support tool) at two referral hospitals in Uganda?

Eno et al. (2019), United States [44]	Transplant surgeons(n=2), clinical care supervisors (n=1), donor medical directors (n=1), clinical transplant director (n=1), consultant (n=1)	Semi-structured interviews	Mobile health application	What are the perceived patient- and center-level facilitators and barriers to implementing an mHealth system for living kidney donor follow-up?
Feinberg et al. (2019), United States [45]	Obstetrics and gynaecology resident physicians (n=33)	Survey with open-ended questions	Mobile application	What is the perceived impact of the new text messaging system on patient care and workflow in obstetrics at Yale-New Haven Hospital, and how can these findings inform guidelines for future implementations in emergent settings?
Gilbert et al. (2022), United Kingdom [46]	Physiotherapists (n=14)	Semi-structured interview	Telemedicine	What are orthopaedic and musculoskeletal clinicians' views and the regarding legal, safety, safeguarding, and security issues associated with the use of virtual consultations during the COVID-19 pandemic?
Heller et al. (2020), Canada [47]	Physicians (n=10)	Semi-structured interview	Real-time location system mobile application, software	What are the perceived pros of physicians and family members regarding the functionality and efficiency of the Real-Time Location System (RTLs) in the perioperative environment?
Joughin et al. (2021), United Kingdom [48]	Geriatricians (n=3)	Survey with open-ended questions	Telemedicine	What is the level of access to technology and digital literacy among older patients for virtual consultations, What are the barriers and facilitators to these consultations? How satisfied are patients and clinicians with the mode of delivery and outcomes of the virtual consultations?
Miller et al. (2020), United Kingdom [49]	Medical (n=5), nursing (n=3) and pharmacy (n=1) professionals	Semi-structured interview, focus group	Digital monitoring application	How can a digital remote monitoring application be designed and developed to support and improve patient care during the first 30 post-operative days following colorectal cancer surgery?
Park et al. (2019), United Kingdom [50]	Perioperative nurses (n=4)	Semi-structured interview, focus group	Smartphone application	How can a commercially available smartphone application be used to address the information needs of scrub nurses in orthopaedic surgery?
Rothgangel et al. (2019), Netherlands [51]	Therapists (n=10)	Semi-structured interviews	Telemedicine	Was traditional mirror therapy delivered according to the established clinical framework? To what extent did patients use the digital exercise programs in the novel teletreatment? What were the acceptance levels and experiences of both patients and healthcare professionals regarding the novel teletreatment?
Sauro et al. (2016), Canada [52]	Adult neurologists (n=2), adult neurology residents (n=2), paediatric neurologists (n=3), paediatric neurology residents	Semi-structured interview, focus groups	Web-based clinical decision tool	What are the barriers and facilitators to the usability of an online tool for epilepsy surgery evaluation, and what strategies can be used to increase its dissemination and adoption in clinical practice?

Table 2: Themes extracted from included publications with exemplar quotes.

Construct	Theme	Frequency (n)	Exemplar quote
<i>Perceived effectiveness</i>	Potential utility	18	"This tool would be useful to frontline health workers because they activate neurosurgery teams. If there is uncertainty, the frontline workers may take their time before calling the neurosurgery team, causing a delay. This could help reduce that time to activate [the neurosurgery] team" [43]
	Observed success	15	"Where is my patient?" because it's so often wrong that there's no point in me going to the board [to find] where my patient is" [47]
	Patient accessibility	12	"I mean, you got like a 75-year-old guy with colon cancer, and he can't like get on MyChart and figure, he doesn't have a smart phone to use and all this different stuff" [37]
<i>Affective attitude</i>	Optimism	15	"I think it could really benefit and help us be compliant..." [44]
	Open-mindedness	4	"[W]ould certainly be willing to give it a go" [40]
	Scepticism	8	"I think less than 10% of my patients would I be able to do anything. I'd think, worthwhile with telemedicine" [37]
	Apprehension	10	"I thought they were in this place and I thought they were doing this and exercise z and I saw them and they were worse than I thought they were. That has also frightened people— therapists I guess, thinking that, oh I thought they were better" [46]
	Indifference	1	"I'm not hurt by not getting the text message. It doesn't change anything. It's like extra peas for dinner; if it's there, it's there; if not, it's fine" [47]
<i>Opportunity costs</i>	Efficiency	15	"It's faster, it's efficient, we use less resources than clinic..." [36]
	Patient safety	9	"Most worrisome is how long it some- times takes for messages to be delivered—it has caused many mis- communications, arguments, and delays in care" [45]
	Data privacy and security	5	"I think there would be a part of just assuring that it was all HIPAA-compliant and that there weren't any concerns about...information being able to be hacked" [44]
<i>Ethicality</i>	Beneficence	9	"You can better supervise patients' self-management on the long-term, remind them what they can do themselves and control their training" [51]
	Non-maleficence	7	"In addition, the inability to carry out a heart and lung examination and take specific patient measurements were also considered limiting factors that could create problems during surgery" [36]
	Autonomy	6	"We are giving back that locus of control to the patient" [42]
	Justice	6	"There was a recognition that different individuals would have different access to resources" [46] "Potential for elderly/low socioeconomic groups to have difficulty with technology..." [49]
<i>Burden</i>	Cost	7	"Well for both the hospital and the client it would be financial, so cost input would be a key consideration" [40]
	Increased workload	6	"I think e-consultations are helpful, but when they add to the workload and we get ten per week, then we have to assign someone to do them because [it is] too much work for those at the clinic" [35]
	Need for user training	6	"It's not just as easy as sitting in front of camera and both ends and away you go, there's probably a significant amount of learning on how to do that effectively" [40]
<i>Intervention coherence</i>	Simplicity of intervention	12	"The clarity and brevity of the tool was a facilitator to its use in clinical practice" [52]
<i>Self-efficacy</i>	Prerequisites for use	10	"I need to work with it more regularly to get more confident" [51]

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Figures

Please see attached files.

File name: A Ahmed Acceptability of DHIs – Figure 1

Figure 1: Table displaying results from CASP assessment. Key = Green for "Yes," (criteria met), Red for "No," (criteria not met) and orange for "Can't Tell" (uncertain if criteria met).

File name: A Ahmed Acceptability of DHIs – Figure 2

Figure 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram illustrating study selection process and outcomes.

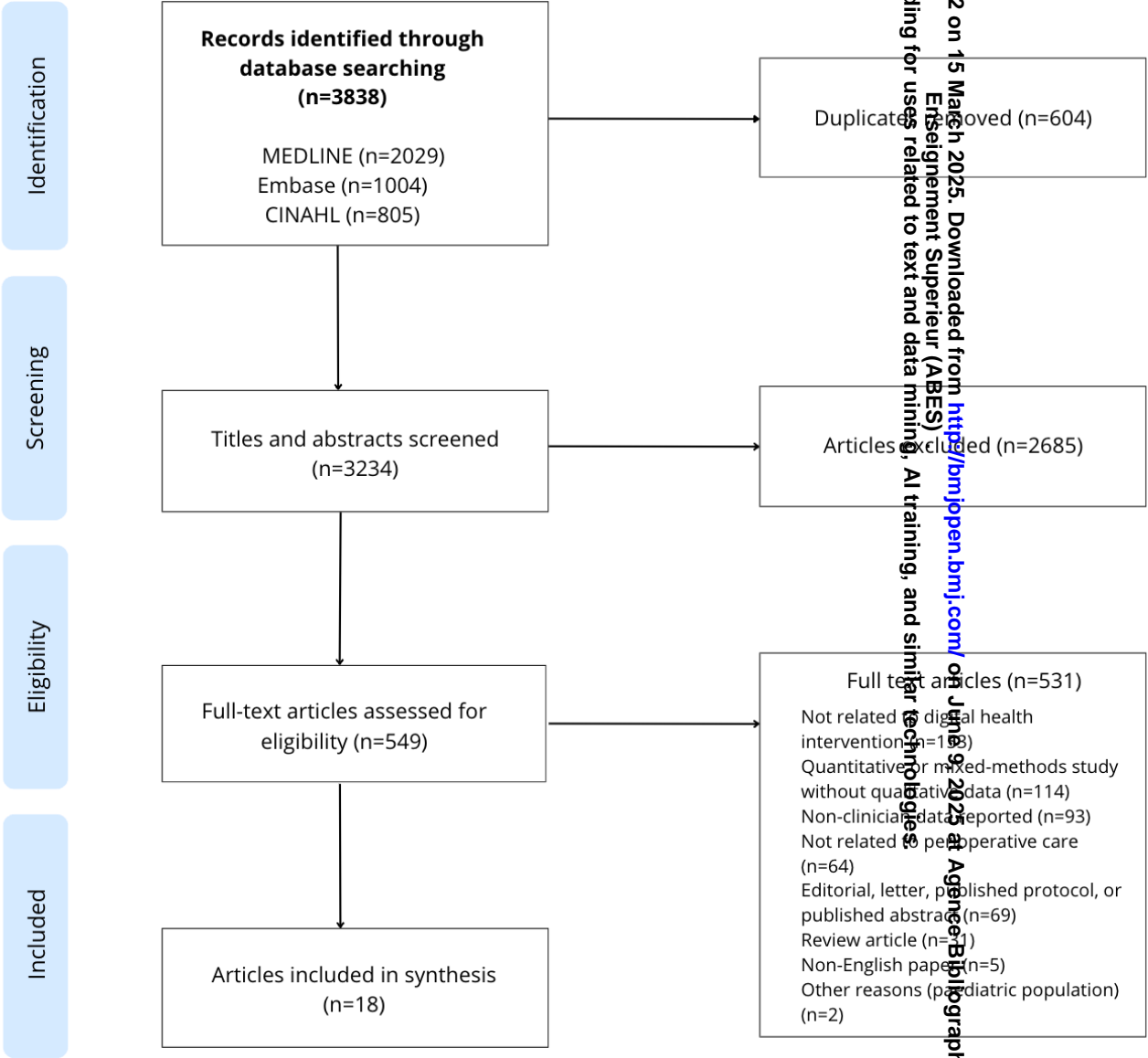
File name: A Ahmed Acceptability of DHIs – Figure 3

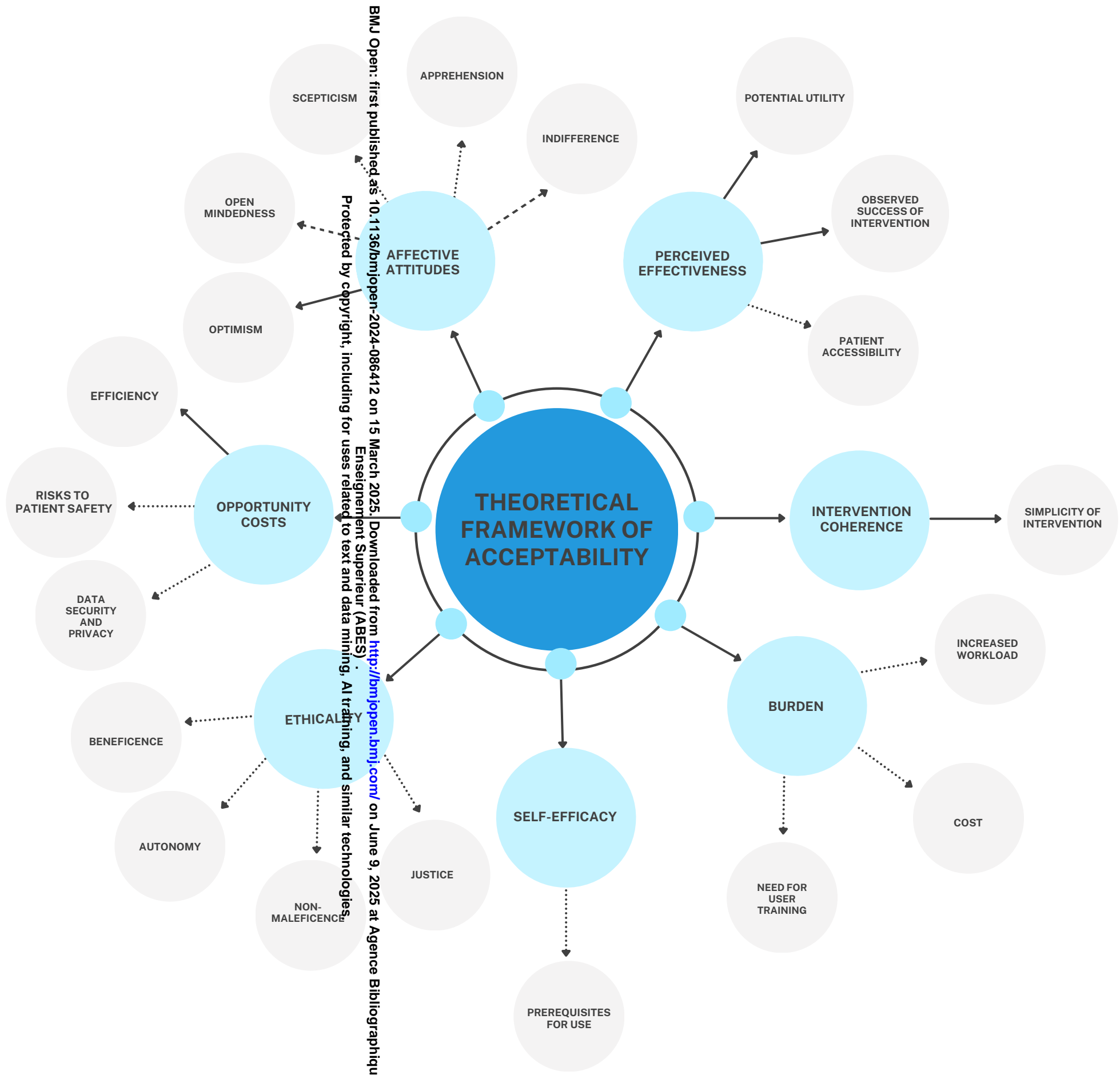
Figure 3: Thematic map illustrating themes extracted from publications and corresponding TFA constructs; The seven constructs of the TFA are represented in blue, while themes identified in our study are depicted in grey. The lines between construct and theme represent the frequency of each theme across included publications, with solid lines used for themes found in n > 12 publications, dotted lines for themes in n=5-12 publications, and dashed lines for themes in n<5 publications.

Supplementary Files

The search strategy, supplementary figures 1 and 2, supplementary table 1, ENTREQ checklist and PRISMA checklist can be found in the file: A Ahmed Acceptability of DHIs – Appendix 1.

Study	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issue?	Is the relationship between researcher and participants been fully considered?	Have ethical issues been taken into consideration?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?
Afable et al. (2018) ³⁵									
Brown-Johnson et al. (2021) ³⁶									
Byrnes et al. (2020) ³⁷									
Chen et al. (2020) ³⁸									
Cnossen et al. (2016) ³⁹									
Cottrell et al. (2017) ⁴⁰									
Damery et al. (2021) ⁴¹									
Dunphy et al. (2017) ⁴²									
Elahi et al. (2020) ⁴³									
Eno et al. (2019) ⁴⁴									
Feinberg et al. (2019) ⁴⁵									
Gilbert et al. (2022) ⁴⁶									
Heller et al. (2020) ⁴⁷									
Joughin et al. (2021) ⁴⁸									
Miller et al. (2020) ⁴⁹									
Park et al. (2019) ⁵⁰									
Rothgangel et al. (2019) ⁵¹									
Sauro et al. (2016) ⁵²									





Appendix 1

Search strategy

Ovid (MEDLINE, EMBASE)

- 1 Computer Communication Networks/
- 2 Local Area Networks/
- 3 Internet/
- 4 Internet-Based Intervention/
- 5 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) adj3 (care or deliver* or healthcare or health care or consult* or counsel* or interven* or monitor* or psychiatr* or rehab* or service? or treat* or therap*)).tw,kf.
- 6 Smartphone/
- 7 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) adj3 (app or apps or application?)).tw,kf.
- 8 (mobile adj3 (app or apps or application?)).tw,kf.
- 9 (digital* adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 10 ((technology-based or technology-facilitated) adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 11 (video* adj3 (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*)).tw,kf.
- 12 Patient Portals/
- 13 (patient? adj2 (portal or portals)).tw,kf.
- 14 ((health information or medical information or clinical information) adj3 (portal or portals)).tw,kf.
- 15 ((health data or medical data or clinical data) adj3 (portal or portals)).tw,kf.
- 16 health portal?.tw,kf.
- 17 Electronic Mail/
- 18 (electronic mail* or email* or e-mail*).tw,kf.
- 19 exp Telephone/
- 20 (telephon* or tele-phon* or phone or phoned or phones or phoning or answering service? or telefacsimile* or tele-facsimile* or FAX).tw,kf.
- 21 exp Television/
- 22 (televis* or tele-vis* or TV or TVs or videorecord* or video-record* or videotap* or video tap*).tw,kf.
- 23 Videoconferencing/
- 24 (videoconferenc* or video-conference* or videophon* or video-phon*).tw,kf.
- 25 Electronic Health Records/
- 26 electronic health record?.tw,kf.
- 27 (EHR or EHRs or EMR or EMRs or PHR or PHRs).tw,kf.
- 28 Telecommunications/
- 29 (telecommunicat* or tele-communicat*).tw,kf.
- 30 exp Telemedicine/

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- 31 Telenursing/
- 32 (ehealth or e-health or mhealth or m-health or mobile health).tw,kf.
- 33 (telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*).tw,kf.
- 34 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
- 35 exp Medical Informatics Applications/
- 36 medical informatics applications/ or exp decision making, computer-assisted/ or exp decision support techniques/ or exp "information storage and retrieval"/ or exp information systems/ or exp medical informatics computing/
- 37 34 or 35 or 36
- 38 (doctor* or clinician* or practitioner* or health professional* or health personnel or provider* or physician* or GP or GPs or nurs* or allied health* or psychologist* or counsellor* or counselor* or social work* or therapist* or psychiatrist* or emergency medical technician* or paramedic* or ambulance or ((healthcare or health care) adj2 (worker* or personnel))).mp,kw.
- 39 37 and 38
- 40 exp Specialties, Surgical/
- 41 specialties, surgical/ or exp colorectal surgery/ or exp general surgery/ or exp gynecology/ or exp neurosurgery/ or exp obstetrics/ or exp ophthalmology/ or exp orthognathic surgery/ or exp orthopedics/ or exp otolaryngology/ or exp surgery, plastic/ or exp surgical oncology/ or exp thoracic surgery/ or exp traumatology/ or exp urology/
- 42 exp Surgical Procedures, Operative/
- 43 Perioperative Medicine/ or Perioperative Care/ or Perioperative Period/
- 44 Preoperative Care/
- 45 Preoperative Period/
- 46 Postoperative Care/
- 47 Postoperative Period/
- 48 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47
- 49 39 and 48
- 50 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide) adj2 (interview* or discussion* or questionnaire)).tw,kw.
- 51 (focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key informant").tw,kw.
- 52 interviews as topic/ or focus groups/ or narration/ or qualitative research/
- 53 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or indepth or "face-to-face" or structured or guide or guides or follow up or self report) adj3 (interview* or discussion* or questionnaire)).tw.
- 54 (focus group* or advisory group* or qualitative or ethnograph* or fieldwork or field work or key informant or thematic analy* or grounded theor* or phenomenolog* or discourse analy* or content analy* or narrative* or observational method* or open ended evaluation* or action research or inductive analy* or emic or etic or hermeneutic* or constant compar* or grounded theor* or lived experience* or life experience* or theoretical sampl* or purposive sampl* or quasi-experiment* or (case adj2 stud*)).tw.
- 55 50 or 51 or 52 or 53 or 54

56 49 and 55

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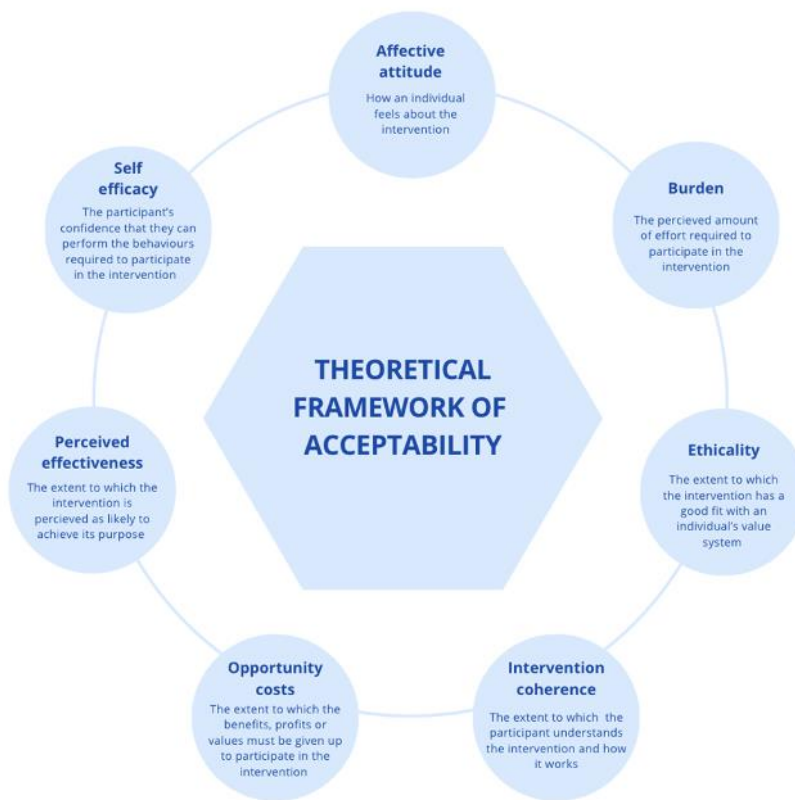
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- 2 (MM "Local Area Networks")
- 3 (MM "Internet")
- 4 (MM "Internet-Based Intervention") OR (MM "World Wide Web Applications") OR (MM "World Wide Web")
- 5 "((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) N (care or deliver* or healthcare or health care or consult* or counsel* or interven* or monitor* or psychiatr* or rehab* or service? or treat* or therap*))"
- 6 (MM "Smartphone") OR (MM "Mobile Applications") OR (MM "Computers, Hand-Held+") OR (MM "Cellular Phone+") OR (MM "Text Messaging")
- 7 ((internet or online or web or web-based or web-site or website or www or cyber* or smartphone* or smart phone* or iphone* or i-phone* or ipad or i-pad or ipads or i-pads) N (app or apps or application?))
- 8 (mobile N (app or apps or application?)).
- 9 (digital* N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 10 ((technology-based or technology-facilitated) N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 11 (video* N (care or healthcare or health care or interven* or consult* or counsel* or monitor* or psychiatr* or rehab* or treat* or therap*))
- 12 (MM "Patient Portals")
- 13 (patient? N (portal or portals))
- 14 ((health information or medical information or clinical information) N (portal or portals))
- 15 (MH "Health Information Systems+") OR (MM "Integrated Advanced Information Management Systems") OR (MM "Management Information Systems") OR (MM "Appointment and Scheduling Information Systems")
- 16 ((health data or medical data or clinical data) N (portal or portals)).
- 17 (MM "Routinely Collected Health Data") OR (MM "Clinical Data Repository") OR (MM "Electronic Data Interchange") OR (MM "Public Reporting of Healthcare Data")
- 18 health portal?
- 19 (MM "Email")
- 20 (MM "Telephone+") OR (MM "Cellular Phone+")
- 21 (telephon* or tele-phon* or phone or phoned or phones or phoning or answering service? or telefacsimile* or tele-facsimile* or FAX)
- 22 (MM "Telephone Consultation (Iowa NIC)")
- 23 Television
- 24 (MM "Television")
- 25 (televis* or tele-vis* or TV or TVs or videorecord* or video-record* or videotap* or video tap*)

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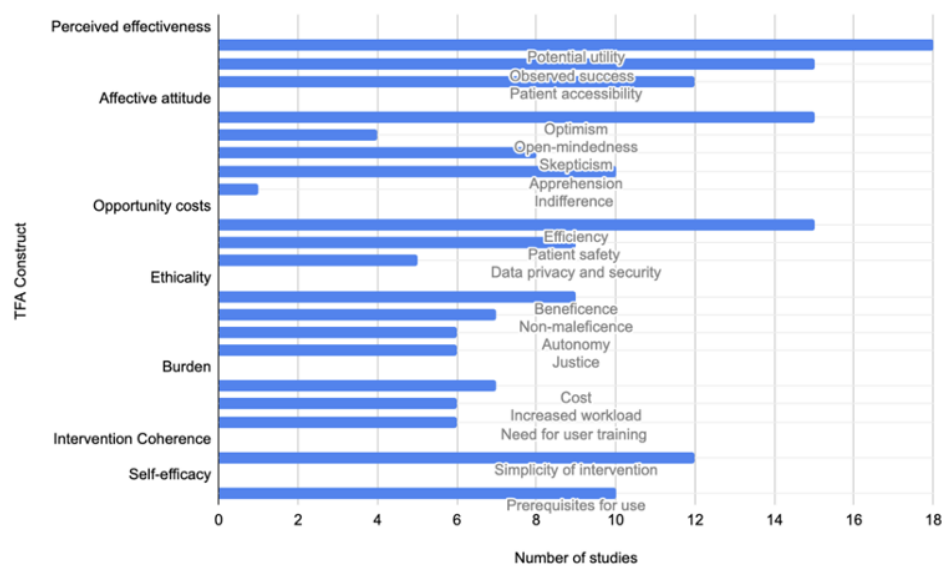
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- 29 (MM "Patient Record Systems") OR (MH "Medical Records, Personal") OR (MM "Electronic Data Interchange") OR (MH "Health Information Management Personnel") OR (MM "Medical Records")
- 30 (EHR or EHRs or EMR or EMRs or PHR or PHRs)
- 31 (MM "Telecommunications")
- 32 (telecommunicat* or tele-communicat*)
- 33 (MH "Telemedicine+") OR (MH "Telehealth+") OR (MM "Telerehabilitation")
- 34 (ehealth or e-health or mhealth or m-health or mobile health)
- 35 (MH "Telehealth+") OR (MM "Telemedicine") OR (MM "Telenursing") OR (MM "Telepsychiatry") OR (MH "Teledentistry")
- 36 "(telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*)"
- 37 "(telecare or tele-care or teleconsult* or tele-consult* or telecounsel* or tele-counsel* or telehome* or tele-home* or telemed* or tele-med* or telemonitor* or tele-monitor* or telenurs* or tele-nurs* or telepsychiatr* or tele-psychiatr* or telerehab* or tele-rehab*)"
- 38 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37
- 39 (MM "Medical Informatics")
- 40 (MH "Decision Making, Computer Assisted+") OR (MM "Diagnosis, Computer Assisted") OR (MM "Therapy, Computer Assisted") OR (MM "Data Analytics") OR (MM "Virtual Reality") OR (MM "Remote Access to Information") OR (MM "Artificial Intelligence")
- 41 S38 OR S39 OR S40
- 42 (MH "Health Personnel+") OR (MM "Allied Health Personnel") OR (MM "Alternative Health Personnel") OR (MM "Case Managers") OR (MM "Community Health Workers") OR (MM "Coroners and Medical Examiners") OR (MM "Expert Clinicians") OR (MM "Faculty, Nursing") OR (MM "Health Facility Administrators") OR (MM "Health Personnel, Infected") OR (MM "Health Personnel, Minority") OR (MM "Home Health Aides") OR (MM "Medical Staff") OR (MM "Midwives") OR (MM "Multiskilled Health Practitioners") OR (MM "Nurses") OR (MM "Nursing Home Personnel") OR (MM "Operating Room Personnel") OR (MM "Personal Trainers") OR (MM "Personnel, Health Facility") OR (MH "Pharmacists") OR (MM "Physicians") OR (MM "Podiatrists") OR (MM "Rapid Response Team") OR (MM "Registry Personnel") OR (MM "Rural Health Personnel") OR (MM "Transplant Coordinators") OR (MM "Information Technology Personnel")
- 43 (doctor* or clinician* or practitioner* or health professional* or health personnel or provider* or physician* or GP or GPs or nurs* or allied health* or psycholog* or counsellor* or counselor* or social work* or therapist* or psychiatr* or emergency medical technician* or paramedic* or ambulance or ((healthcare or health care) N (worker* or personnel)))

- 44 S42 OR S43
- 45 (MH "Specialties, Surgical+")
- 46 (MM "Specialties, Surgical") OR (MM "Gynecology") OR (MM "Neurosurgery") OR
(MM "Obstetrics") OR (MM "Ophthalmology") OR (MM "Orthopedics") OR (MM
"Surgery, Plastic") OR (MM "Thoracic Surgery") OR (MM "Traumatology")
- 47 (MH "Surgery, Operative+") OR (MH "Surgical Count Procedure")
- 48 (MM "Perioperative Care") OR (MM "Perioperative Care (Iowa NIC)") OR (MM
"Perioperative Medicine")
- 49 (MM "Preoperative Care") OR (MM "Preoperative Period") OR (MM "Teaching:
Preoperative (Iowa NIC)") OR (MM "Preoperative Education")
- 50 (MM "Postoperative Care") OR (MM "Postoperative Complications") OR (MM
"Postoperative Pain")
- 51 (MM "Postoperative Period") OR (MM "Intraoperative Period")
- 52 S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
- 53 (MM "Semi-Structured Interview") OR (MM "Unstructured Interview") OR (MM
"Structured Interview")
- 54 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or
indepth or "face-to-face" or structured or guide) N (interview* or discussion* or
questionnaire*))
- 55 (focus group* or qualitative or ethnograph* or fieldwork or "field work" or "key
informant")
- 56 (MM "Fieldwork") OR (MM "Focus Groups")
- 57 (MH "Qualitative Studies+") OR (MM "Action Research") OR (MM "Phenomenological
Research") OR (MM "Naturalistic Inquiry") OR (MM "Ethnonursing Research") OR (MM
"Ethnographic Research")
- 58 interviews as topic/ or focus groups/ or narration/ or qualitative research/
- 59 (("semi-structured" or semistructured or unstructured or informal or "in-depth" or
indepth or "face-to-face" or structured or guide or guides or follow up or self report) N
(interview* or discussion* or questionnaire*))
- 60 (focus group* or advisory group* or qualitative or ethnograph* or fieldwork or field work
or key informant or thematic analy* or grounded theor* or phenomenolog* or discourse
analy* or content analy* or narrative* or observational method* or open ended
evaluation* or action research or inductive analy* or emic or etic or hermeneutic* or
constant compar* or grounded theor* or lived experience* or life experience* or
theoretical sampl* or purposive sampl* or quasi-experiment* or (case N stud*))
- 61 S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60
- 62 S41 AND S44 AND S52 AND S61

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Supplementary figure 1: An illustration of the seven components of the TFA based on the model by Sekhon et al. [27]



Supplementary figure 2: The frequency distribution of themes categorised by TFA construct across studies (n=18). Themes are displayed in grey below each bar.

Specialty	Frequency of studies, n%
Orthopaedic surgery	4 (22.2)
General surgery	4 (22.2)
Colorectal surgery	3 (16.7)
Neurosurgery	2 (11.1)
Vascular surgery	1 (5.6)
Urology	1 (5.6)
Plastic surgery	1 (5.6)
Cardiothoracic surgery	1 (5.6)
Anaesthesia	1 (5.6)
Otolaryngology	1 (5.6)
Obstetrics and gynaecology	1 (5.6)
Neurology	1 (5.6)
Geriatrics	1(5.6)

Supplementary table 1: Medical specialties represented across included publications (n=18)

ENTREQ Checklist

No	Item	Guide and description	Completed	Location in document
1	Aim	State the research question the synthesis addresses.	X	Pg 5, lines 23-25
2	Synthesis methodology	Identify the synthesis methodology or theoretical framework which underpins the synthesis and describe the rationale for choice of methodology (e.g., meta-ethnography, thematic synthesis, critical interpretive synthesis, grounded theory synthesis, realist synthesis, meta-aggregation, meta-study, framework synthesis).	X	Pg 5, lines 9-13, 21-15
3	Approach to searching	Indicate whether the search was pre-planned (comprehensive search strategies to seek all available studies) or iterative (to seek all available concepts until they theoretical saturation is achieved).	X	Pg 5, lines 28-35
4	Inclusion criteria	Specify the inclusion/exclusion criteria (e.g., in terms of population, language, year limits, type of publication, study type).	X	Pg 6, lines 1-10
5	Data sources	Describe the information sources used (e.g., electronic databases (MEDLINE, EMBASE, CINAHL, psycINFO, Econlit), grey literature databases (digital thesis, policy reports), relevant organisational websites, experts, information specialists, generic web searches (Google Scholar) hand searching, reference lists) and when the searches conducted; provide the rationale for using the data sources.	X	Pg 5, lines 31-32
6	Electronic Search strategy	Describe the literature search (e.g. provide electronic search strategies with population terms, clinical or health topic terms, experiential or social phenomena related terms, filters for qualitative research, and search limits).	X	Appendix
7	Study screening methods	Describe the process of study screening and sifting (e.g. title, abstract and full text review, number of independent reviewers who screened studies).	X	Pg 6, lines 12-19
8	Study characteristics	Present the characteristics of the included studies (e.g. year of publication, country, population, number of participants, data collection, methodology, analysis, research questions).	X	Table 1

9	Study selection results	Identify the number of studies screened and provide reasons for study exclusion (e.g. for comprehensive searching, provide numbers of studies screened and reasons for exclusion indicated in a figure/flowchart; for iterative searching describe reasons for study exclusion and inclusion based on modifications to the research question and/or contribution to theory development).	X	Figure 3
10	Rationale for appraisal	Describe the rationale and approach used to appraise the included studies or selected findings (e.g. assessment of conduct (validity and robustness), assessment of reporting (transparency), assessment of content and utility of the findings).	X	Pg 7, lines 3-16
11	Appraisal items	State the tools, frameworks and criteria used to appraise the studies or selected findings (e.g. Existing tools: CASP, QARI, COREQ, Mays and Pope [25]; reviewer developed tools; describe the domains assessed: research team, study design, data analysis and interpretations, reporting).	X	Pg 7, lines 3-12
12	Appraisal process	Indicate whether the appraisal was conducted independently by more than one reviewer and if consensus was required.	X	Pg 7, lines 14-16
13	Appraisal results	Present results of the quality assessment and indicate which articles, if any, were weighted/excluded based on the assessment and give the rationale.	X	Figure 2
14	Data extraction	Indicate which sections of the primary studies were analysed and how were the data extracted from the primary studies? (e.g. all text under the headings "results /conclusions" were extracted electronically and entered into a computer software).	X	Pg 6, lines 21-22, 24-25
15	Software	State the computer software used, if any.	X	Pg 6, lines 22, 24
16	Number of reviewers	Identify who was involved in coding and analysis.	X	Pg 6, lines 24-31
17	Coding	Describe the process for coding of data (e.g. line by line coding to search for concepts).	X	Pg 6, lines 26-27

18	Study comparison	Describe how were comparisons made within and across studies (e.g. subsequent studies were coded into pre-existing concepts, and new concepts were created when deemed necessary).	X	Pg 6, lines 26-28
19	Derivation of themes	Explain whether the process of deriving the themes or constructs was inductive or deductive.	X	Pg 6, lines 26-28
20	Quotations	Provide quotations from the primary studies to illustrate themes/constructs, and identify whether the quotations were participant quotations of the author's interpretation.	X	Table 2
21	Synthesis output	Present rich, compelling and useful results that go beyond a summary of the primary studies (e.g. new interpretation, models of evidence, conceptual models, analytical framework, development of a new theory or construct).	X	Pg 8, line 1 - Pg 13, line 12

Adapted from Tong A, Flemming K, McInnes E, Oliver S, Craig J (2012). Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. BMC Medical Research Methodology. 12(1):181. doi: 10.1186/1471-2288-12-181



PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	4,5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study characteristics and comparing against the planned groups for each synthesis (item #5)).	N/A
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A



PRISMA 2020 Checklist

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Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7, Figure 2
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	N/A
Study characteristics	17	Cite each included study and present its characteristics.	7, Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	7, Figure 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	7, Figure 1
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7-13
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	13-15
	23b	Discuss any limitations of the evidence included in the review.	15
	23c	Discuss any limitations of the review processes used.	15,16
	23d	Discuss implications of the results for practice, policy, and future research.	15,16
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	3
Competing interests	26	Declare any competing interests of review authors.	3
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	16

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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