Paying for Digital Health Interventions – What Evidence is Needed?

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Abstract: Digital health has accelerated, in part, due to the recent COVID-19 pandemic in terms of both implementation and acceptability. However, while digitalization in healthcare brings an opportunity to improve the quality of care, this creates a need for sustainability through funding of these technologies by healthcare payers. Traditional innovations such as pharmaceuticals are rigorously evaluated by health technology assessment (HTA) bodies in many countries to advise payers on how scarce funds can be efficiently distributed. The aim of this study was to review the HTA evidence frameworks being applied by HTA bodies or payers for the evaluation of digital health interventions. We reviewed recent literature and the websites of the leading payer and HTA bodies to understand the frameworks which have been used for the evaluation of digital health innovations. We found that 6 frameworks directly addressed digital health technologies for the purposes of pricing and reimbursement. Building on previous work, we reviewed the context and evidence domains of each framework. The evidence requirements of the included frameworks were diverse, and their

domains extended the European Network for Health Technology Assessment (EUnetHTA) Core HTA Model. Our research concluded that while some frameworks exist, they require additional refinement to ensure that the level of evidence is commensurate with the technology being assessed and that relevant stakeholders are included to more holistically assess the outcomes produced. Developers of digital health technologies need to be aware of the evidence requirements by payers or HTA bodies, which differ from HTA requirements for traditional health technologies and may represent additional hurdle before entering publicly financed healthcare markets.

Keywords: digital health; e-health; mHealth; telehealth; telemedicine; reimbursement; health technology assessment

1 Introduction

The growing life expectancy and medical needs of aging populations have made health care an important topic for many countries. Digital transformation has been promoted by the World Health Organization (WHO), Food and Drug Administration (FDA), and the European Commission (EC) to help improve health outcomes, advance the accuracy of healthcare analytics, enable greater patient engagement, and improve patient safety through enhanced monitoring, diagnosis and management [1-3]. However, to ensure sustainability, digital health interventions (DHI) require funding by payers, and evidence-informed decision and policymaking require an assessment of the impact on relevant outcomes vs. current healthcare practice. For traditional healthcare interventions this has been realized through health technology assessment (HTA). Using a multidisciplinary approach, HTA aims to produce scientific evidence about the efficacy, effectiveness, cost effectiveness of health technologies, and the organizational, ethical, legal, and social implications of their use [4]. In general, HTA applies frameworks that involve mostly quantitative intervention properties such as comparative effectiveness research and cost effectiveness analysis [5]. Various national and international organizations are engaged in HTA and involved in creating or guiding the development of standards for the evidence required, including it per digital technologies. While explicit frameworks serve as a beacon, diverse frameworks across jurisdictions may impede the cross-country navigation of developers and eventually may hamper the deployment of internationally integrated technologies. Previous research has shown that, despite their dynamic proliferation, definitions of major digital health-related terms used in evidence syntheses remained vague and diverse [6], suggesting the need for tighter guidance and standardization in the field.

Therefore, the aim of this rapid review was to explore the extent to which evaluation frameworks exist for DHIs, what are the main evidence domains requested by payer or HTA bodies and the extent of their adaptation to be suitable to support pricing and reimbursement decisions for different DHIs.

2 Methods

As our research sought to identify and analyze frameworks for the evaluation of DHI used to inform payer decisions regarding reimbursement and / or pricing of these technologies in a healthcare setting, we focused on literature that had previously identified and compared evaluation frameworks [7-9]. An intensive individual investigation of the websites of leading payer and HTA bodies in European Economic Area member states, the International Network of Agencies for Health Technology Assessment (INAHTA) countries including Canada, Australia, and the USA was undertaken in September 2021 to identify new frameworks and any updated information. To extend our reach beyond the academic literature sources, we used a previously tested grey literature search workflow as follows [10]. A uniform Google search URL was constructed from the following keywords: *("digital health" OR "digital intervention" OR "ehealth" OR "mHealth" OR "mobile health") AND ("reimbursement" OR "health technology assessment") AND ("guideline" OR "framework" OR "white paper" OR "process" OR "regulation" OR "legislation" OR "pathway") AND [country name]*. URLs of retrieved search hits were transferred to a Microsoft Excel worksheet using the *"Get All Links"* function of the free DataMiner extension of Google Chrome. Results were transferred to Microsoft Excel, and a clickable hyperlink was generated. All retrieved hyperlinks were opened and examined, and potentially relevant websites or documents were translated via the DeepL Pro Translator to English [11]. Relevant documents, which contained DHI HTA frameworks published by payer or HTA organizations were retained for data extraction. Relevant links identified during the search were followed until source documents were found. As the objective focused on evaluation frameworks which were used across DHIs by a particular payer to support pricing and reimbursement decisions, we did not include individual case studies where DHIs had been assessed nor did we include regulatory frameworks for approval of DHIs such as the widely referenced FDA guideline "Software as a Medical Device (SAMD)" as this precedes payer decision regarding reimbursement [12]. Exclusions were also made for frameworks that assessed the feasibility or applicability of a DHI since these did not directly influence the decision for funding. For data extraction and evaluation of the published frameworks, we qualitatively described the background, general characteristics of the various frameworks. During data extraction we followed the evidence domains proposed in the 2020 systematic review of Kolasa et al. [7]. These include the description of the health problem and the intended use, safety (or risk assessment), clinical effectiveness, patient outcomes and social aspects, economic, legal, ethical, and organizational aspects as well as technical areas such as usability, data security, interoperability, and technical aspects or stability. Screening, selection of relevant documents and data extraction were distributed among the authors, all tasks were performed by single reviewers. Only positive search results were documented.

3 Results

3.1 Search Results

The three HTA reviews of DHIs [7-9] mainly included reports on case studies or frameworks that applied to quality dimensions or applications of DHIs. Frameworks from these papers which were from a payer viewpoint were identified as the Medical Device Evaluation by the CNEDiMTS (Medical Device and Health Technology Evaluation Committee at the Haute Autorité de Santé (HAS) in France [13], the Model for Assessment of Telemedicine Application (MAST) in Europe [14], and the frameworks from the National Health Service (NHS) and National Institute for Health and Care Excellence (NICE) in the UK [15]. The web searches provided four additional eligible frameworks. A presentation from the European Public Health Conference [8] described the German [16, 17] and Belgian [18, 19] frameworks. Furthermore, frameworks for Australia [20] and Finland [21] were identified via the web searches. We tabulated the evidence domains for the six DHI frameworks from payer and HTA bodies. Since we found only indirect reference to the use of the MAST framework by a Spanish HTA agency (AQuAS) [22], we provided only a brief qualitative description for this framework.

3.2 General Description of Frameworks

3.2.1 Australia

The Medical Services Advisory Committee (MSAC) framework was added as the evaluation criteria for funding DHIs in Australia [20]. MSAC provides advice to the Minister for Health about whether health technologies should be funded on the Medicare Benefits Schedule (MBS), which lists health professional services that the Australian Government subsidies. MSAC evaluation is mainly informed by the clinical need for the new health technology, improvements in health due to the health technology, often measured as longer life or better quality of life, or both, the cost of the health technology relative to how much it improves health (cost-effectiveness), and the cost of making the health technology available (financial impact). Other issues such as equity, the value of knowing, organizational issues, and ethical and social concerns are also considered.

3.2.2 Belgium

The Belgian framework applies a three-level evaluation pyramid for mobile health applications [18]. Level 1 (M1) requires that the application has a CE-mark, registered at the Federal Agency for Medicines and Health Products (FAGG), and complies with essential rules of the General Data Protection Regulation (GDPR).

Level 2 (M2) requires proof that the mobile application conforms to relevant data security and interoperability regulations and standards of the Belgian e-health sector. Interoperability can be tested on several official test-environments. HTA can be initiated if M1 and M2 criteria are met. The main aspects of the HTA evaluation include a description of the medical need, the target population, new care process, supporting evidence for the benefits, a detailed description of use dynamics, costs, budget impact, cost-effectiveness, and the legal aspects of introducing the new service. The application is evaluated by various Belgian National Institute for Health and Disability Insurance (RIZIV) expert committees. In addition to inclusion in the public health system, mobile health applications may be financed through other pathways, such as inclusion in-hospital services, out-of-pocket payments, or coverage by private insurance [19].

3.2.3 England / Wales

During writing this review, the DHI evidence frameworks of England / Wales have been updated. The NHS Digital Technology Assessment Criteria (DTAC) [23] and the NICE Evidence Standards Framework (ESF) for DHIs [15] were published in 2022, and these frameworks, therefore, replaced those from previous papers evaluated in prior research.

The NICE ESF describes standards for the evidence that should be available or developed for Digital Health Technologies (DHTs) to demonstrate their value in the UK health and social care system. This includes evidence of effectiveness relevant to the intended use(s) of the technology and evidence of economic impact relative to the financial risk. Section A comprises evidence for effectiveness standards and reflects the functional classification that best describes the main function of the DHI. The first tier (A) is for DHIs with a system impact, e.g., those interventions which do not provide measurable patient outcomes, but which provide services to the health and social care system. Tier B is for DHIs, which provide information, resources, or activities to the public, patients, or clinicians, e.g., health diaries and general health monitoring using fitness wearables and simple symptom diaries or those that allow 2- way communication between citizens, patients, or healthcare professionals. Tier C covers interventions that influence behavior change for public health issues like smoking, eating, alcohol, sexual health, sleeping, and exercise, allows people to self-manage a specified condition or guides treatment through active monitoring, e.g., through using wearables to measure, record or transmit data (or both) about a specified condition including calculators that impact on treatment, diagnosis, or care. The highest levels of evidence are required for Tier C followed by Tier B, and similarly in Tier B more evidence is required than in Tier A. In the highest level of evidence (Tier C), information on effectiveness, reliability, usage, quality, credibility, relevance, acceptability, equity, and accuracy is required. However, the ESF is not intended to be used for evaluating the following types of DHT: 1) software that is integral to, or embedded in, a medical device or in vitro diagnostic (IVD), also called software in a medical device (SiMD), 2) DHTs

designed for providing training to health or care professionals (such as virtual reality [VR] or augmented reality [AR] surgical training), and 3) DHTs that facilitate data collection in research studies. NICE notes that the evidence standards are expected to be used alongside NHSX Digital Technology Assessment Criteria, which assesses clinical safety, data protection, technical assurance, interoperability, usability, and accessibility. As previously stated, we focused on the NICE Evidence Standards for our comparison since the DTAC criteria are not directly used to influence reimbursement decisions.

3.2.4 Germany

In Germany, Federal Institute for Drugs and Medical Devices (Bundesinstitut fur Arzneimittel und Medizinprodukte, BfArM) must positively assess an application for DHI to be listed in a Directory of Reimbursable Digital Health Applications (DiGA). The BfArM assesses the requirements set out in Section 139e Social Law Book 5th edition – Statutory Health Insurance (SGB V) and in the DiGA Regulation (DiGAV) for inclusion in the directory according to Section 139e Paragraph 1 SGB V as fulfilled [16, 17].

There are detailed DHI submission requirements and pre-submission consultations available to ensure the manufacturer submits all relevant information. DHI must-have CE mark allocated prior to submission, as well clinical trial demonstrated positive healthcare effect. In case a positive healthcare effect is found insufficient, a new application with new evidence of positive healthcare benefit may be submitted, but only after one year has elapsed from the BfArM decision. DHIs can also apply additionally for new indications, with which a new DIGA listing will be obtained. As of September 2021, there is a total of 20 DHTs successfully reimbursed and DIGA available in Germany [16].

3.2.5 France

CNEDiMTS is a specialist committee of the HAS which gives guidance on the requests for inclusion or renewal of inclusion of medical devices on the listing of services and products reimbursed (LPPR) [13]. In concert with other technologies assessed, the evaluation focuses on the assessment of the actual benefit (AB) and, if the latter is sufficient, on the assessment of added clinical value (ACV). AB is specific to an indication and evaluated through the risk/benefit ratio, the role of the device within practice and its wider benefit to public health. The requirements include clinical criteria (mortality, morbidity, compensation for a disability, reduction in undesirable effects), quality of life, and convenience of use with a clinical benefit to the patients.

Assessment of ACV requires data vs. a comparator (a product, procedure, or service) considered the gold standard according to current scientific data or absence of treatment if the need for treatment is unfulfilled. Randomized clinical trial

information is preferred. An economic assessment can be requested but is not required.

3.2.6 Finland

The Finnish Coordination Centre for Health Technology Assessment (FinCCHTA) at the University of Oulu has developed and applied the Digi-HTA framework for the evaluation of DHIs [21]. This framework has been proposed to evaluate of DHIs in the domains of mHealth, artificial intelligence, and robotics. The assessment process builds on a preliminary assessment of data security and protection upon the guidelines of the National Emergency Supply Agency (Data Security and Protection Preliminary Task Information Security and Data Protection Requirements). The HTA evaluation includes the following domains: company and product characteristics, costs, effectiveness, safety, technical stability, usability and accessibility, interoperability, and specific criteria related to artificial intelligence or robotics applications. Finally, the FinCCHTA makes a recommendation towards decision-makers in the Ministry of Health or the Hospital District.

3.2.7 Model for Assessment of Telemedicine Applications (MAST)

The Model for Assessment of Telemedicine Applications (MAST) [14] defines a three-phased assessment of (i) preceding considerations to determine the relevance of an assessment, (ii) a broad range of outcomes structured in seven domains, and (iii) transferability to understand the potential for scaling-up or -out. For phase one, issues regarding relevant regulatory aspects (financial, maturity, and potential use) are assessed, addressing questions about the purpose, alternatives, required level of assessment (international, national, regional, and local), and the maturity of the eHealth service. Phase two is based on the EUnetHTA Core Model [24], covering seven domains: (i) the health problem targeted, (ii) clinical and technical safety, (iii) clinical effectiveness, (iv) patient perspectives, including satisfaction, acceptance, usability, literacy, access, empowerment, and self-efficacy, (v) economic evaluation addressing costs, related changes in the use of health care, and a business case, (vi) organizational aspects including procedures structure, culture MS management aspects, and (vii) further socio-cultural, ethical, and legal issues. The third phase focuses on assessing the potential to effectively transfer the eHealth service to other healthcare systems and its scalability in terms of throughput and costs.

3.3 Summary of Evidence Domains

3.3.1 Differences between Countries in the Adaptation of Evidence Domains

The criteria for the six frameworks from payer or HTA bodies were reviewed and are presented in Table 1.

In addition to the nine evidence domains of the European Network for Health Technology Assessment's (EUnetHTA) Core Model [24]: current use, safety, clinical effectiveness, patient and social aspects, economic, legal, ethical, organization and technical aspects, for the assessment of DHIs evidence was required in three additional domains. Three countries (Australia, Germany, Finland) required evidence on usability, while four countries (Belgium, Australia, Germany, Finland) on data security as well as interoperability. From the EUnetHTA Core Model, all six countries demanded evidence on current use (e.g., the health problem and comparator), safety, clinical effectiveness, patient, and social and economic aspects. However, only four countries (Australia, Belgium, England / Wales, Germany) requested evidence on legal and ethical aspects another four (Australia, Belgium, Germany, Finland) on organizational and another four (Australia, Germany, France, and Finland) on technical aspects and stability. Australia and Germany required evidence in all 12 domains, followed by Belgium and Finland requiring evidence in different 10 domains. The UK framework required evidence in 7 and the French in 6 domains.

3.3.2 Elaboration of Payer Evidence Needs by Domain

The requirements within each evidence domain differed between the six countries. While the *description of health problem and comparator* usually pertained to the target population, intended use and standard of care, the Belgian framework also requested local epidemiological data about the target condition, description of the medical need and estimates about use dynamics. The *safety* domain involved heterogenous approaches from the declaration of CE conformity to specific inquiries about risks and undesirable effects associated with the regular use, misuse or overuse of the product, reported adverse events, risk to health care personnel, risks of misinformation, risks of performance failure as well as electrical safety and information security. For *clinical effectiveness* several countries requested or strongly suggested the demonstration of clinical benefit over existing alternatives, while reports on patient-reported outcomes (PRO), patient reported experiences (PRE), feasibility, analytical validity, accuracy and post-market experience were also required. England / Wales applies risk-based tiers to specify minimum evidence needs, while this was less clearly articulated in other countries. The *patient and social aspects* domain also covered broad range of approaches from the provision of supporting documents from patient-organizations to reports on educational needs and support for users, equity (including applicability by disabled or disadvantaged populations), access, confidentiality, or the impact on the relationship between patients and healthcare professionals and the way user's health behaviors are influenced by the DHI. The *economic* aspects usually covered cost effectiveness and budget impact and detailed analyses of costs for patients (including in-app purchases), and various costs for the healthcare system (e.g., set-up, maintenance). The *legal* domain covered confidentiality, general data protection, professional liability, and potential interference with existing care processes. Partly overlapping

with the patient and societal as well as ethical domains, the *ethical* domain requires reports concerning privacy, equity or access-related issues, and provisions about the use of the DHI in clinical care or clinical trials. Also, with some overlap with other domains, *organizational* aspects covered how care processes, health care professionals' (HCP) roles and responsibilities and training needs as well as the health system would be impacted by the DHI. The *usability* domain concerned if the needs of disabled populations are accommodated, as well as testing in various user groups. The evidence needs in the *data security* and *interoperability* domains also varied from the demonstration of compliance with applicable standards to the demonstration of performance in prescribed use cases. Finally, the *technical aspects and stability* domain included inquiries about experiences with product dysfunctions, the applied programming principles, data management and communication protocols and processes for error handling.

Table 1
Assessment Criteria used in Digital Health Evaluation Frameworks

	Belgium RIZIV	Australia MSAC	England / Wales NICE
Health problem and comparator	- Eligible users (patients or caregivers) - Clinical picture - Epidemiology (local data) - Medical need - Intended use - Substantiate the number of users (target group) - DHT description	- Define target population - Define Standard of Care - Intended use	- Define target population - Define Standard of Care size of DHTs - Demonstrate effectiveness in the studies
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Target population identification using specific ICD-10 code and age group	- Assessment of medical devices	- Intended use - Intended user groups - The problem in healthcare system to be solved - Replaced health care service by the DHT if any - Product characteristics and company information

	Belgium RIZIV	Australia MSAC	England / Wales NICE
Safety	- Precondition of HTA: CE Conformity Declaration and FAGG	- Assess risk of misinformation	- DHT performance failure impact on patient

	authorization (M1 of the validation pyramid)	- Information safety / security	- Is DHT used in combination with HCP? - Risk implication of DHT high use
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- SGB V requires proof of safety of the device and its suitability for use as part of the application procedure - CE Conformity Declaration is a submission prerequisite	- Directives in place which lay down the principal of collection of clinical data during marketing to confirm performance and safety of use	- Risks, possible side effects, or other undesirable effects associated with using the product - Reported adverse events - Risks from misuse - Risks to health care personnel (for robotics) - Adverse event handling / post marketing surveillance - Electrical safety
Clinical effectiveness	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Added value over existing alternatives (effectiveness, quality of care, quality of life) - Minimum one comparative study needed - Description of PROMs, PREMs - ongoing and planned studies	- Analytical validity - Accuracy - Effectiveness - Post market effectiveness and surveillance	- Four tier system -Tier 1: potential system benefits - Tier 2: inform, simple monitoring, communicate healthy living or about illness - Tier 3: prevention and managing diseases along treatment - Tier 4: active treatment, diagnosis, and monitoring
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Per section 139e SGB V of the law, clinical study with well-defined PICO required for consideration	- The clinical phases comprise feasibility studies (safety and performance) and studies that provide evidence of clinical benefit	- Benefits (clinical, health behavior, organizational) - Supporting evidence - Ongoing studies - Recommendations by institutions / guidelines
Patient and social aspects	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Supporting document of patient-associations (optional)	- Digital health literacy (training, education required for users)	- Enable preventive behavior change, two-way communication between HCPs and patients and citizens.

		- Equity (user disability, language, age, socio-economic status) - Access - Confidentiality - Will the relationship between patient and health care professional be affected and how?	
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Target patient population disabilities (hearing, vision, motor skills) must be DHT supported - Operating instructions must not cause disturbances or impair the use	-Desire to improve the health status of patients and to shorten hospital stays by encouraging patients to return home. -The aim is to be able to make properly evaluated medical devices available to patients as soon as possible and to respond to the challenges of the medicine of the future.	- User support - User training -Social: N/A
Economic	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Detailed pricing, costs of care with / without the new DHT - Budget impact - Cost effectiveness (local or international adapted to local context)	- Economic (unit cost and in-app purchases cost) - When applicable, cost of the system, platform, attachable hardware, or licensing	- Economic (budget impact, cost effectiveness, equity) analysis required for Tier 3 & 4
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Economic analysis - Manufacturer can charge premium to patient, over the reimbursement amount (in-app purchases are not advertised on DIGA	- Economic analysis performed in selected cases only	- Costs for the customer - Costs for the healthcare system (set-up, maintenance) - If free service, income sources of the provider - Frequency of software / device renewals -Uncertainty of cost estimates
Legal	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Inference with the care process regulations, - Data security risks, - Impact on professional liability insurance	- How would insurance for all stakeholders be impacted - Litigation risk of misinformation	- Compliance to GDPR / Data Protection Act 2018 - Legal aspects of processing confidential

	- Other risks	- Confidentiality of patient information - Clarity of data ownership (which party) - Clarity of medical advice provider (is it DHI or health care professional?)	patient information to be observed
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Confidential information in the application procedure which may not be made public due to legal requirements is not to be disclosed, e.g., business secrets, personalized 3rd-party data protection	- N/A	- N/A
Ethical	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Deontological rules or advice regarding the use of the DHT	- Presence and content of privacy policy - Equity concern - Access concern (cost of platform, in-app purchases, geographical location, and internet availability)	- UK government Data Ethics Framework is to be observed
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- DHT Clinical study that incorporates physician involvement must observe ethical principles of the Declaration of Helsinki	- N/A	- N/A
Organizational	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Care process with / without the DHT - Involved health care providers, roles, responsibilities	- Continual professional development courses for health care professional per DHT use and recommendation - Presence and content of privacy policy	- N/A
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- BfArM assessor for successful DIGA directory DHT inclusion	- N/A	- Changes to the premises, information systems, or care processes

			- Healthcare system implementation plan
Usability	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- N/A	- DHT should address user disability	- N/A
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Target population must be fully accommodated (e.g., disabilities) in accordance with their conditions	- N/A	- Considerations of and testing with different user groups - Process for evaluating and developing usability and accessibility - Compatibility with available usability guidelines
Data security	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Precondition of HTA: Meeting M1 and M2 standards of the validation pyramid (general and specific data security rules applicable for the Belgian eHealth platform)	- Presence and content of privacy policy	- N/A
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- Full implementation of Management System for Information Security includes encryption, penetration testing, 2-factor authentication - Data cannot leave for another country without an adequacy decision (e.g., USA)	- N/A	- Criteria of the Cybersecurity Centre of the Finnish Communications Regulatory Authority apply (Data Security and Protection Preliminary Task and Information Security and Data Protection Requirements)
Interoperability	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- Precondition of HTA: compliance with M2 standards of the validation pyramid	- How does it integrate with other software - Need for security updates, so that DHT can be used alongside other systems, applications or in operating environments	- N/A
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA

	- Must be interoperable with e-health insurance card, e-personal health record, the health insurers digital platforms and telemedicine - Insured person ability to: export therapy-relevant extracts of the data collected, or data from DIGA in a machine-readable, interoperable format, or acquire medical sensor data	- N/A	- Connections with other software, sites, services, devices, electronic health records - Data formats for usage / transfer / storage / export - Compatibility with ISO/IEEE 11073 Personal Health Data Standards
Technical aspects and stability	Belgium RIZIV	Australia MSAC	England / Wales NICE
	- N/A	- DHT operating systems - DHT operating platforms - DHT adherence to robust programming principles - Formalized and safe methods implemented to convert, transmit, and / or store DHT data - DHT ability to communicate relevant information (i.e., data quality, network availability, correct installation)	- N/A
	Germany BfArM / DiGA	France HAS	Finland FinCCHTA
	- DHT data transaction must be complete, no transmission errors, loss of data or interference is allowed	- The life cycle can be very short because of the rapid technical development or lifetime of a digital technology	- Processes for testing and handling error messages - Previous reported downtime or impairment in the use of the product

BfArM - Federal Institute for Drugs and Medical Devices (Bundesinstitut fur Arzneimittel und Medizinprodukte).
CE - Conformité Européenne (European Conformity)
DHT - Digital Health Technology
DHI – Digital Health Intervention
DIGA - Directory of Reimbursable Digital Health Applications.
FinCCHTA - Finnish Coordination Centre for Health Technology Assessment.
FAGG - Federal Agency for Medicines and Health Products.
GDPR – General Data Protection regulation

HAS - Haute Autorité de Santé.
HTA – Health Technology Assessment
IEEE – Institute of Electrical and Electronics Engineers
ISO – International Standards Organization
MSAC - Medical Services Advisory Committee.
N/A - Not Applicable.
NICE - National Institute for Health and Care Excellence.
SGB V - Social Code Book V.
PICO - Population, Intervention, Comparator, Outcomes.
PROM – Patient Reported Outcome Measure
PREM – Patient Reported Experience Measure
RIZIV - National Institute for Health and Disability Insurance.

4 Discussion

This rapid review demonstrated the broad range of evidence that is required by payers for financing decisions of DHIs. The evidence requirements of the existing DHI HTA frameworks are diverse, and their domains extend the EUnetHTA Core HTA Model, which is routinely applied for the assessment of traditional health technologies. Furthermore, while building on the body of evidence required for product authorizations [25], payer organizations usually require a broader set of evidence, which should be considered during the product development phase.

Greater awareness needs to be present for IT developers and engineers when developing digital health technologies. This is most notable in case of German DiGA, whereby as of September 2021, 91 DiGA DHT applications have been submitted to BfArM: 44 have later been withdrawn by the provider, 23 are still under evaluation, 4 have been rejected and 20 have been approved [16]. The main reason for such a low rate of acceptance is due to the simple fact that the provider development team (IT developers and engineers) was not aware of all the requirements needed to successfully launch their product.

Undertaking “light” HTA in the adoption of low-risk digital interventions such as proposed by NICE [15] seems a viable approach to ensure that decision makers can be adequately informed for reimbursement when resources are constrained. However, for high-risk interventions such as those that predict outcomes or would be used to change health care practice, a full analysis should be expected. The EUnetHTA Core Model includes nine different domains to be assessed under a HTA process [24]. A recent systematic review from von Huben et al. evaluated 44 HTA evaluation frameworks for DHTs that manage chronic noncommunicable diseases along the nine different domains of the EUnetHTA Core Model [26]. From 145 issues listed in the Core Model, the included reports proposed 28 DHT-specific aspects and further 22 DHT-specific issues were recommended, which are not covered by the Core Model. Most of the 44 assessed frameworks were theoretical

papers, and only four included frameworks were formally used for reimbursement decisions (England / Wales, France, Germany, Australia) [26].

Our paper provides an overview of six frameworks used by payer or HTA bodies for decision-making on the public reimbursement of DHIs. In-line with previous studies, below we highlight some areas of concern for evidence generation strategies in the context of DHIs. The choice of the comparator is one aspect that requires additional consideration as it determines the incremental benefit or advantage that DHIs can offer [7]. This can also pose the question of the unmet need and the risk associated with the use of the technology. Our research indicates that while effectiveness is often well addressed there are questions regarding the inclusion of diverse perspectives where benefits may be conferred other than clinical outcomes. Similarly, economic impact outside of the health care system such as the reduced travel time for patients or staff training required are not consistently addressed. Other domains are less focused, e.g., ethical, organizational, social, and legal. Ethical issues that might arise with a digital health technology may include the use of data and privacy, informed consent, dependence on technology, self-management of health, as well as the technology gap (between those who have the technology and skills to use it and those who are marginalized due to the lack of technology or knowledge). Organizational aspects consider the resources needed for implementing a health technology, and what changes or consequences in the organization might be further induced by the health technology itself. In many instances, DHIs' implementation's success depends entirely on the healthcare system's capacity to adopt innovation. Therefore, it is key to accurately quantify the needs of both investment and disinvestment, including staff training, delivery arrangements, and technical requirements to ensure interoperability between systems. The social domain incorporates the patients', caregivers', or societal perspectives which can provide unique insight when considered and reinforces the need to bring all stakeholders to the table when evaluating these technologies. Finally, given the increasing regulation of DHIs and guidance for integration within current systems, an acknowledgment that these aspects are covered in the legal domain is increasingly likely.

We note that several countries included digital health technologies in public coverage via mechanisms that were not preceded by state-of the art HTA assessment. After extensive scientific assessment, the US extended the Medicare coverage of prescription digital therapeutics used for the treatment of mental health or substance use disorders upon FDA approval [27]. Furthermore, the Medicare Coverage of Innovative Therapies (MCIT) program allows the coverage of technologies upon approval by FDA's Breakthrough Devices Program [28]. Several European countries have developed free digital health services from governmental or European Union funds such as the extension of the Greek National Network of Telemedicine to the Attica region [29], or included telemedicine services in the general package, leaving the procurement of technologies for healthcare institutions or private health service providers [30]. The emergency situation of the COVID

pandemic also fueled the inclusion of digital health technologies among the publicly financed health services, such in the case of Romania, where telehealth and a range of related services were defined and added to the public health service by an emergency resolution (Law no. 185/2017) on November the 18th, 2020 [31].

Limitations of our research include the fact that we restricted our analyses to those frameworks which were currently in use by payers and HTA agencies. Given the highly evolving nature of this area, there are several experiments and white paper proposals which should also be mentioned. These include the "Promising Care subsidy scheme" in the Netherlands [32] which is for treatments that seem promising but are not yet reimbursed from the basic health insurance package with explicit call outs for anonymous 'e-mental health'. The Austrian HTA (AiHTA) published a pilot framework, which recommends a graduated approach depending on the risk class of the digital application in order to determine the relevant HTA domains which are similar to the NICE Evidence Standards [22]. Furthermore, general HTA frameworks applicable for the evaluation of medical devices including DHIs such as those of Norway [33] or Poland [34] have been omitted from our analysis.

A further limitation of our study arises from the applied grey literature search method. Structured searches in academic databases usually deliver a set of records, out of which a subset of eligible full-text documents can be selected via predefined rules. Although still in its infancy, this process can be supported via automation using natural language processing and machine learning techniques [35-37]. Despite the use of structured keywords in our web search, the identification of relevant documents often required the manual pursuit of reference chains of varying length, the application of flexible rules and translation between many languages. While steps of this process could be aided by technology, it was mostly based on manual work and domain expertise, with potential omissions of relevant hits and gaps in the full and transparent documentation of the entire search process.

Conclusions

While DHIs are increasingly used in health, HTA agencies and payer bodies are struggling to adapt to assess these technologies. Due to the multidisciplinary nature of digital health (combination of health care and technology), and the speed and dynamic of innovations in this area, an approach based upon the risk assessment posed by the technology seems reasonable. In this way, more effort should be tailored to interventions which seek to influence care or predict outcomes rather than those tailored to increased awareness of the patient about their condition.

Digital health developers need to be aware of these reimbursement hurdles, and to address the continuously evolving DHT evidence standards during the development cycle, to ensure they will meet HTA requirements for product reimbursement as they reach the last and most important hurdle before entering publicly financed healthcare markets.

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