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REVIEW

Adoption of Digital Therapeutics in Europe

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Abstract: Digital therapeutics (DTx) are an emerging medical therapy comprising evidence-based interventions that are regulatory approved for patient use, or are under development, for a variety of medical conditions, including hypertension, cancer, substance use disorders and mental disorders. DTx have significant potential to reduce the overall burden on healthcare systems and offer potential economic benefits. There is currently no specific legal regulation on DTx in the EU. Although European countries have similar approaches to digital health solutions, the adoption of DTx varies across the continent. The aim of this narrative review is to discuss the levels of adoption of DTx in Europe, and to explore possible strategies to improve adoption, with the goal of higher rates of adoption, and more consistent use of DTx across the continent. The article discusses the regulatory and reimbursement landscape across Europe; validation requirements for DTx, and the importance of co-design and an ecosystem-centric approach in the development of DTx. Also considered are drivers of adoption and prescription practices for DTx, as well as patient perspectives on these therapeutics. The article explores potential factors that may contribute to low rates of DTx adoption in Europe, including lack of harmonisation in regulatory requirements and reimbursement; sociodemographic factors; health status; ethical concerns; challenges surrounding the use and validation of AI; knowledge and awareness among healthcare professionals (HCPs) and patients, and data standards and interoperability. Efforts to improve rates of access to DTx and adoption of these therapeutics across Europe are described. Finally, a framework for improved uptake of DTx in Europe is proposed.

Keywords: digital health, regulatory, reimbursement, healthcare professionals, health inequalities

Introduction

Digital therapeutics (DTx) are an emerging medical therapy comprising evidence-based interventions, with clinically evaluated software programmes, often, but not necessarily, coupled with artificial intelligence (AI) techniques and machine learning systems,[1] to prevent, manage, or treat medical conditions.[2,3] DTx are a specific set of technology-enabled interventions within the broader digital health sphere intended to produce a measurable therapeutic effect.[4]

According to Wang et al, the use of DTx as a general medical component is ambiguous, and this ambiguity may be due in part to a lack of consensus on a definition.[5] To ensure industry and global alignment, the Digital Therapeutics Alliance (DTA),[1,6] a global non-profit trade association of industry leaders and stakeholders engaged in the advancement of evidence-driven DTx has adopted the definition of DTx specified by the International Organization for Standardization (ISO):[7] DTx are "health software intended to treat or alleviate a disease, disorder, condition, or injury by generating and delivering a medical intervention that has a demonstrable positive therapeutic impact on a patient's health". As the EU Medical Device Regulation (MDR) may apply to digital health product types, such as wellness apps, and monitoring, diagnostic or medication reminder tools,[6] DTx must always be classified as medical devices,[8] and are held to the same standards of evidence and regulatory oversight as traditional medical treatments,[1] requiring 'rigorous' clinical evidence,[1] including data from randomised controlled clinical trials.[8]

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Some challenges associated with real-life administration of pharmaceutical drugs and biologicals for chronic diseases (eg, medication non-adherence, adverse effects, toxicity, or inadequate efficacy) might potentially be mitigated by DTx.[9] According to the DTA, DTx are essential to healthcare delivery systems and might address critical gaps in care for underserved populations, regardless of patient age, language, culture, income, disease state or geography.[2] DTx fill gaps in care by increasing patient access to clinically safe and effective therapies; offering at-home convenience and privacy, thereby lowering stigma associated with the delivery of certain traditional therapies; extending clinicians' ability to care for patients; providing therapies in different languages, and providing meaningful results and insights on personalised goals and outcomes to patients and their clinicians.[2]

DTx are regulatory approved for patient use, or are under development, for a variety of medical conditions, including hypertension;[10–12] cancer;[13–15] gastrointestinal disorders,[16] such as irritable bowel syndrome[17–20] and inflammatory bowel disease;[21] insomnia;[22,23] asthma;[24,25] chronic obstructive pulmonary disease;[26] substance use disorders[27-30] and smoking;[31] obesity and eating disorders;[32–34] multiple sclerosis;[35] autism;[36] Alzheimer's disease, dementia, learning disabilities, and attention deficits.[1–3,9,37] Considerable research has been published on the use of DTx in diabetes, with most of this research outside Europe.[38–48] DTx are also being developed for mental disorders, such as depression. Depressive disorders represent the largest proportion of mental illnesses globally, and are expected to be the leading cause of disability-adjusted life years by 2030.[49] The urgency of implementing mental health services to address new barriers to care during the COVID-19 pandemic persuaded clinicians to explore DTx as potential tools for clinical intervention in patients with mental health disorders, including depression, anxiety and stress.[8,50–56]

DTx have significant potential to reduce the overall burden on healthcare systems, such as by preventing hospital visits by improving self-management or providing therapy remotely.[57] DTx interventions also offer potential economic benefits;[58] however, there are limited studies on the cost-effectiveness of DTx, with several of these from Asia[12,31,58–61] and the USA.[27,28,46] Furthermore, economic analyses on DTx often have important methodological shortcomings.[58] Importantly, DTx can greatly impact the patient experience, and are a potential option to provide tailored interventions according to the patient's needs.[32,62,63]

The aim of this narrative review is to discuss the levels of adoption of DTx in Europe, and to explore possible strategies to improve adoption, with the goal of higher rates of adoption, and more consistent use of DTx, across the continent.

Regulatory and Reimbursement Landscape Across Europe

Europe is currently uniquely positioned to be one of the pioneers for DTx clear market access pathways into the public health systems, with regulations currently in Germany, France, Belgium and Austria,[64] and DTx policy pathways evolving throughout Europe.[65] There is currently no specific legal regulation on DTx in the EU; national regulatory frameworks regulate the use of DTx, with country-specific regulatory standards and requirements.[66] Therefore, although European countries have similar approaches to digital health solutions, there is a lack of alignment,[67] hence, the regulatory and reimbursement landscape for DTx varies across the continent.[37,64,67,68] The systems in place in a few example countries are described as follows.

Germany is the leading country in Europe in terms of DTx legislation, through the Digital Care Act (Digitale-Versorgung-Gesetz [DVG]), which came into force in December 2019.[37,69] Germany has an active fast-track model for digital health applications (DiGA), enabling doctors to prescribe reimbursed DTx to publicly insured patients,[70] and is generally recognised as a pioneer of access to and reimbursement of DTx.[37,64,71]

France is introducing a similar reimbursement model to Germany.[72,73] The Prise en Charge Anticipée (PECAN), which includes fast-track reimbursement, has been implemented and enables quick market access and quick access to patients.[64]

In 2021, the INAMI-RIZIV in Belgium announced a reimbursement scheme for DTx that are CE-marked medical devices, with close alignment to the fast-track process for DTx in Germany.[70] Although these regulations are in place, no DTx have reached the highest level of the mHealthBelgium validation pyramid that guarantees government funding.[74]

In the 2023 Digital Austria Act (DAA),[75] the government parties proposed the introduction of quality approved DiGA.[64]

Despite the National Institute for Health and Care Excellence (NICE) evidence standards, there is no centralised reimbursement model for DTx in England, with decision making by clinical commissioning groups.[70] Similarly, there are no reimbursement or financing regulations in place for DTx in the public health system in Spain.[64]

With regard to the widespread use of DTx, Italy has been described as "on the starting blocks" compared with other countries.[37] The Parliamentary Intergroup Digital Health and Digital Therapeutics in Italy was set up in May 2023 and introduced an initial bill on DTx the following month.[37]

Countries such as Luxembourg and the Netherlands have no formal classification for DTx, which generally fall under the medical device category and are not subject to a distinctive product category.[65]

These examples clearly show the varied regulatory and reimbursement landscape in Europe.

Although there has recently been considerable progress in reimbursement schemes in Europe, particularly in Germany, Belgium and France, there remain significant barriers to reimbursement across the continent.[66] Each country in Europe is unique, and the reimbursement framework must fit in with existing national systems.[66] The requirements for reimbursement for DTx in a sample of European countries is shown in Figure 1.

Validation Requirements for Digital Therapeutics

The therapeutic functionality ("active ingredient") of DTx corresponds to the component that shows a therapeutic effect, and the efficacy of this component requires validation.[76] The therapeutic effects of DTx have been evaluated through validated endpoints in conventional randomised clinical trials; however, the use of real-world data and digital endpoints is gaining interest.[76,77] The user interface ("excipient") of DTx maximises the efficacy of the therapeutic functionality,[78] and should also be considered when establishing global standards for DTx.[76]

The DTA reports that there is a lack of frameworks for DTx defining what "good" looks like, so many healthcare decision makers have had to develop their own methods to evaluate DTx products.[79] Following this observation, the DTA created an initial framework to assess DTx products, including their value and impact in real-world settings.[79]

A "fit-for-purpose" assessment of biometric monitoring technologies (BioMeTs) approach for DTx includes verification, analytical/statistical validation and clinical validation.[80] Verification establishes whether the DTx product meets the intended purpose; analytical/statistical validation ascertains whether the DTx product accurately and reliably generates the intended output, and clinical validation determines whether the output is clinically meaningful in the defined condition.[81]

Country	BELGIUM	GERMANY	FRANCE	ITALY	NETHERLANDS	SPAIN	SWEDEN	UNITED KINGDOM
National value assessment framework	DTx clinical and/or socioeconomic value evaluated through Validation Pyramid	DIGA process: Standalone DTx evaluated by BfArM	PECAN formal framework for digital therapeutics	X	X	X	X	NICE has developed evidence standards framework for digital health technologies
National reimbursement pathway	Apps in Level M3 of Validation Pyramid reimbursed by payers	DIGA process: All listed DIGA are reimbursed	5 year national listing	X	X	X	X	X
Available funding mechanisms	Centralised funding for mHealth apps	GKV-SV centralised funding for DIGA	Covered by public health insurance	X	Covered by individual health insurers	Evidence of limited regional reimbursement	X	Can be funded locally by an Integrated Care System

Figure 1 Requirements for reimbursement for digital therapeutics in a sample of European countries.
Notes: Data collected from the official websites of national regulatory agencies.
Abbreviations: BfArM, Bundesinstitut für Arzneimittel und Medizinprodukte (Federal Institute for Drugs and Medical Devices); DiGA, digital health applications; DTx, digital therapeutics; GKV-SV, GKV-Spitzenverband; NICE, National Institute for Health and Care Excellence; PECAN, Prise en Charge Anticipée.

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The Importance of Co-Design and an Ecosystem-Centric Approach in the Development of Digital Therapeutics

Many digital health interventions are failing to effectively engage patients and the public.[82] One solution that has been proposed is to directly involve patients and the public in the design of these digital health interventions.[82] Sanz et al describes co-design as key to delivering patient-centred care as it allows involvement of stakeholders in the development of digital health solutions.[83] Co-design in the development of DTx involves engaging with, and listening to, patients and other stakeholders, including clinicians and other healthcare professionals (HCPs), carers and policy makers, to ensure that the therapeutics meet the needs and preferences of end-users and healthcare systems, as well as having a positive impact on patients' lives.[62,84] Bird et al suggest that involving individuals from the healthcare community and members of the public with personal healthcare experience into the process of designing new health systems, products or services helps to drive improvements that are useful and relevant.[85] Silvola et al consider that the involvement of users is essential to provide a clear understanding of the real needs and desires of patients; however, an efficient co-design process requires patients to be provided with the tools necessary to enable them to collaborate effectively and express their opinions.[86] According to O'Kelly, stakeholders who clearly see the benefits of a digital solution, including how it potentially makes their lives easier, are more likely to engage and embrace new digital models of care.[84]

As indicated by Mesko et al, a co-design approach could lead to a range of short-term benefits, such as improved knowledge of patient needs; original ideas from diverse perspectives and priorities; more efficient decision making, and reduced development times.[87] There are also potential long-term benefits of such collaboration, including greater patient satisfaction, and increased support and enthusiasm for innovation.[87]

Voorheis et al noted that although there is consensus on the value of patient and public involvement in digital health design, there is little guidance on how to maximise the worth of the collaborative design work.[82] Co-design has historically focused on improving the digital health product itself; however, these authors reported that patients and the public also have crucial insights on implementation planning, as well as how collaborative design can be used as its own empowering intervention.[82]

Adoption of Digital Therapeutics

Although there has been progress in DTx in terms of clinical validation, regulatory clarity and reimbursement, DTx innovators are now facing the challenge of bringing these therapeutics to patients at scale.[88]

DTx are used to successfully treat a range of clinical conditions; however, the adoption of these therapeutics in health systems in Europe remains limited,[57,72,89,90] with progress in integrating DTx into access and care pathways in only a few countries.[57] In addition, adherence rates are low.[91–96] As there are currently few DTx approved in practice, there is resistance towards clinical acceptance and organisational change;[97] therefore, the diffusion and usage of DTx are fragmented across Europe.[98]

Germany is a pioneer for apps on prescription;[72] however, few physicians in the German healthcare system prescribe DTx.[37] Furthermore, a survey conducted in Germany in 2023 showed that over 60% of participants had never heard of digital health applications,[72] and around 5% of DTx prescriptions were not picked up.[72] In addition, a survey of urology patients in Germany revealed that certified DTx apps were used by only 7.3% of patients aged <65 years, and 5.4% of those aged ≥65 years.[99] In line with these observations, Courtet et al noted that despite the efficacy of digital interventions (in this case, for depression) demonstrated in clinical trials, many of these tools never reach real-life patients.[8]

In a study in France, 35.3% of patients, 30.4% of public participants, and 15.8% of HCPs reported willingness to take digital pills.[100] This willingness was associated with male sex and the current use of a connected device to record health settings.[100] The prospective acceptability of and willingness to take digital pills were limited by clinical and ethical concerns both at the individual and societal level.[100]

Drivers of Adoption of Digital Therapeutics

HCPs have a key role in prescribing and influencing uptake of DTx, as well as optimising patient care during use of DTx, and are central to DTx adoption.[88] Nurses have a potentially important role in DTx adoption as they work closely with

patients and gain unique insight into the patient perspective, which helps nurses to understand how patients think, what is important to them, and why they behave in certain ways.[101] This knowledge enables and motivates nurses to drive change and make improvements for patients through digital technology.[101] Primary research involving general practitioners (GPs) and specialists in Germany, Belgium, Sweden and the UK showed that key drivers to HCP adoption are to improve patient outcome, access and experience; to increase HCP efficiency and support organisational goals, and a personal interest in DTx.[88] Further drivers of HCP adoption of DTx include the ability to continuously monitor and engage patients, adjust treatment plans remotely in real time and provide personalised care.[102]

If DTx are reimbursable and are prescribed, the last barrier to adoption lies with the patient.[91] Price is an obvious barrier to adoption by patients – reimbursement models that require patients to pay substantial amounts for DTx will hinder adoption of these tools.[91] Another driver of adoption for patients is the time-saving aspect of DTx. These tools enable data collection in real-time, thereby potentially reducing the number of face-to-face healthcare appointments needed.[4] A further driver of patient adoption of DTx is the possibility to address co-morbidities of chronic disease,[103] such as depression[104] and fatigue,[105] particularly for patients who feel that their physician does not take the time to tackle these issues.

Prescription Practices for Digital Therapeutics

Prodan et al observed that there is scarce information on DTx prescription practices as the phenomenon is rather new.[97] In Germany, DiGA are prescribed on paper by primary care physicians and psychotherapists; however, these paper prescriptions complicate the general workflow of the prescription process.[97] The prescription system utilises a bottom-up approach, in which developers directly target patients, who usually then ask their physicians for a prescription, or pursue direct reimbursement from the statutory health insurance companies.[97] In France, physicians can prescribe DTx that are included in the List des Produits et Prestations Remboursables (LPP), and in Belgium, medical doctors are allowed to prescribe DTx to targeted broad patient groups.[97] In the UK, DTx can be prescribed by GPs provided the therapeutics have been commissioned by the relevant clinical commissioning group/NHS trust group.[97]

Carl et al, in the US, noted that "applying the traditional prescription-based medical approval paradigm to DTx for mental health could ultimately undermine and limit the broad accessibility of these software-based innovations that have been explicitly designed to expand the accessibility of care". [106]

Patient Perspectives on Digital Therapeutics

A US study of patient perspectives on app-based digital treatments for drug use disorders showed that participants preferred to have app-related conversations incorporated into their existing healthcare appointments, rather than attending additional visits to facilitate the use of the apps.[107] Nearly all participants favoured receiving support from a clinician rather than no support for using the apps, as well as follow-up support via low-burden methods, such as phone calls or secure messaging.[107]

In a US questionnaire-based study of older adults with hearing loss, half the participants reported that DTx helped them to adjust to their new hearing aids.[108]

Willingness to use (WTU) and willingness to pay (WTP) for digital health interventions are key concepts that need to be quantified and understood in the quest to expand digital healthcare in different patient populations.[109–114] A study by Lee et al in Korea showed that the WTU and WTP for digital health interventions differed based on the individual's demographics, health status and previous experience with healthcare services.[114] Lupiáñez-Villanueva et al reported that recommendations for DTx by doctors was associated with an increase in both WTU and WTP in Germany and the Netherlands.[110]

Wang et al suggested that changes in values, culture and customs over time may change patients' perception of the same digital content, which could lead to changes in the efficacy of DTx.[5] These authors commented that DTx require periodic verification, even after approval, to address the theoretical DTx "expiration date".[5]

Factors That Potentially Impact Adoption of Digital Therapeutics

DTx uptake is suboptimal even in Germany, a pioneer of DTx prescription, access and reimbursement, where there are reports of almost two-thirds of patients being unaware of DTx.[72] Potential factors that may contribute to such low rates of

DTx adoption include lack of harmonisation in regulatory requirements and reimbursement; sociodemographic factors; health status; ethical concerns; challenges surrounding the use and validation of AI; knowledge and awareness among HCPs and patients, and data standards and interoperability. These are described in the following sections.

Lack of Harmonisation in Regulatory Requirements and Reimbursement

There are several key challenges in adoption of DTx in Europe at country level. Although DTx are governed by the EU MDR, these regulations are interpreted differently by different countries, leading to a lack of harmonisation in regulatory requirements, evidence requirements and value assessment processes.[57] Inadequate funding and the absence of standardised or specific reimbursement pathways for DTx in most countries are also likely to impact the adoption of DTx in Europe.[57]

The outlook for DTx is changing as these tools become more technologically advanced, and some countries are adapting their device classifications depending on specific features.[73] As well as the variation in the overall reimbursement landscape, there are differences in definitions, terminology and payment approaches.[73] This complex scenario demonstrates how fragmented the regulatory systems for DTx are across Europe and is expected to have a direct impact on the commercialisation of and access to DTx.[73] The harmonisation of the Health Technology Assessment Regulation (HTAR), which entered into force in January 2022 and applies as of January 2025,[115] might partly address the lack of harmonisation. There are joint consultation opportunities among the HTA stakeholder network in different member states that also apply for DTx that are "high risk" medical devices according to the MDR.

Sociodemographic Factors

At the societal level, not all communities or populations have the resources or infrastructure to take advantage of digital tools.[116] Social factors that potentially impact adoption of DTx include the geographical location of patients, with those in rural locations likely to have less access to internet infrastructure, and slower or more unstable internet services, compared with those in urban locations.[117] Patients from deprived areas may also be more likely to lack access to DTx and the internet at home.[117] There is also evidence to indicate that populations who are already subject to disadvantage and worse health outcomes are also subject to digital exclusion, but the relationship is complex.[117]

Patient characteristics are also likely to influence DTx adoption rates. Age is an important factor, as older individuals may be less likely to own a smartphone or use the internet.[117] A study in Belgium on an app to examine medication adherence highlighted age as a barrier to the uptake of digital tools, with a large subset of older patients unwilling to participate in the study or to use the app.[118] Income is also an important consideration: individuals with lower income may be less likely to have a smartphone or access to the internet at home.[117] There are few studies on ethnicity and digital exclusion, with differences in internet access explained by the age and income profile of the different ethnic groups.[117]

A snapshot of attitudes towards health digitisation among internet users selected from the general population in Germany in 2020 showed that the majority of participants expected digitisation to affect healthcare; however, the interest in and use of digital technologies for health-related purposes was not yet widespread.[119] Age, education, and household income were associated with digital technology use.[119] Younger, more educated and wealthier participants were more likely to use digital technologies for health-related purposes and reported higher digital literacy.[119]

Interim analysis results from the study of real-life acceptability of an online blended psychological treatment (deprexis)[120] for patients with depression in France (DARE study)[121] showed that only 33.9% of patients accepted the idea of a DTx like deprexis, with financial issues (83.3%), digital reluctancy (33.3%), and other issues, such as loneliness and lack of interest in therapy (19.9%) cited as reasons for refusal.[122] Marital status, along with Patient Health Questionnaire-9 (PHQ-9)[123] score, was linked to acceptability of this DTx.[122] The significance of marital status in adoption of DTx challenges the impact of social context and indicates that acceptability of DTx may be influenced more by human characteristics and circumstances than clinical profile.

Health Status

An interview-based study to explore DTx-acceptance in patients with mild or moderate depression in Germany showed that patients did not perceive DTx as a substitute for face-to-face treatment, and difficult stages of depression or long-time experience of the disorder were perceived as hurdles for DTx use.[124] Furthermore, recommendations for DTx by GPs were only partly relevant for patients.[124]

Ethical Concerns

Implementing DTx across healthcare systems raises a number of ethical concerns,[1] including safety and oversight, accountability, privacy, confidentiality, data protection, transparency, consent, access, and bias and fairness.[1,116,125–127] Furthermore, clinical trials to assess DTx pose new logistical, statistical and ethical challenges.[1] Harnessing the full potential of DTx must be paralleled by the ethical and equitable implementation of these therapeutics.[128]

According to Martinez-Martin: "There will be continuing tension between the accessibility afforded by digital technology, the potential exposure of patient data through these tools, and appropriate balancing of accountability and liability concerns." [116]

Challenges Surrounding the Use and Validation of Artificial Intelligence

Challenges surrounding the use and validation of AI include lack of understanding, which impedes the development of reliable and accurate AI systems; processing power requirements, leading to high infrastructure costs; limited data availability or lack of access to the required volume or quality of data; unreliable results due to factors such as biased or incomplete datasets and algorithmic limitations; lack of trust for AI systems; unclear objectives and key performance indicators, and complexities of implementation.[129] The use of AI is a relevant issue for DTx as some therapeutics are coupled with AI techniques for their functioning.[1]

A study conducted by Petersson et al comprising semi-structured interviews with healthcare leaders highlighted several implementation challenges in relation to AI.[130] These included conditions external to the healthcare system, specifically addressing liability issues and legal information sharing; complying with standards and quality requirements, and integrating AI-relevant learning in higher education for HCPs.[130] Challenges in capacity for strategic change management were also cited, including developing a systematic approach to and ascertaining resources for AI implementation; involving staff throughout the implementation of AI systems, and developing new strategies for internal and external collaboration.[130] Transformation of healthcare professions and practices were also pinpointed, in terms of managing new roles in care processes and building trust for acceptance of AI systems in clinical practice.[130]

Knowledge and Awareness Among Healthcare Professionals and Patients

A paucity of scientific information on DTx may impact HCPs' confidence to prescribe these therapeutics and could contribute to low adoption rates.[37] In a review of studies from Europe and North America, Morita et al identified knowledge gaps and the lack of collaboration across disciplines as barriers to adoption of digital tools, stating that "Technological development dominates over the human-centric part of the equation."[131]

A study in England highlighted barriers to adoption of DTx, including user perception (ie, the perception that digital is not for everyone, with older age, learning or language difficulties or lack of access to technology proposed as potential barriers), absence of formulary for digital solutions and "initiative fatigue" for HCPs.[132] Issues surrounding implementation included lack of expertise among HCPs for promoting digital health and limited funding for promotional activities, as well as the absence of established models for digital implementation.[132] Potential issues around adherence to DTx included the concept that, unlike medicines, there are no clearly defined points, such as the ordering of repeat prescriptions, to prompt review or indicate to the clinician that a course of treatment had been completed.[132] For some patients, the resulting increased responsibility placed on them may be empowering, for others, it may lead to poor adherence to DTx.[132]

Data Standards and Interoperability

Interoperability in healthcare refers to timely and secure access, integration and use of electronic health data so that it can be used to optimise health outcomes for individuals and populations.[133] The benefits of interoperability in healthcare include better care coordination and data-driven improvements in patient care.[133] Electronic health information, including from electronic health records, is needed to develop digital health tools. The seamless flow of data and the realisation of the opportunities arising from digital health innovations require data standards and interoperability.[134,135]

Lehne et al discerned that most medical data currently lack interoperability, with data hidden in isolated databases, incompatible systems and proprietary software.[136] This impedes data exchange, analysis and interpretation, and prevents DTx, which rely on these data, from being implemented at scale and used to their full potential.[136,137]

HCPs may be reluctant to adopt digital tools that are not integrated with electronic health records.[138]

Improving Adoption of Digital Therapeutics in Europe

The healthcare sector in Europe has been struggling to accelerate digital adoption.[139] Europe would benefit from a unified market for DTx and digital health solutions in general.[67] Efforts to improve access to DTx across Europe could include harmonisation of regulatory requirements; collaboration between countries to enable harmonisation of clinical evidence requirements; value assessment processes that are tailored for DTx; clear and transparent national pathways for DTx pricing and reimbursement, and explicit and budgeted funding, with no or limited financial burden on patients.[57]

Developers, researchers and clinicians need to consider the usability and accessibility of DTx for culturally diverse populations and marginalised groups.[116,140] DTx should be evaluated on how applicable they are to diverse populations (eg, individuals from different age groups, ethnicities, linguistic backgrounds and disability statuses).[116] If DTx are to fulfil the promise of increased access to healthcare, improvements are needed in infrastructure, training, and availability of clinician oversight to better serve low-income demographics.[116]

DTx have a potentially important role in supporting conventional medicine and reducing health inequalities across Europe;[2] however, lack of access, skills and motivation for using digital technologies, ie, digital exclusion, could lead to worse health outcomes.[117,141] Investment in digital inclusion, such as addressing barriers of access and skills, as well as trust and privacy concerns, and designing DTx to address the specific needs of disadvantaged groups, is essential to mitigate against widening health inequalities with the use of these therapeutics.[117,141]

As DTx become more popular, it is important to consider how they can be integrated into healthcare in an ethical manner.[116] This requires continued attention to appropriate oversight, models of care and data protection.[116] For the effective and safe proliferation of DTx, public institutions at all levels should create appropriate frameworks that ensure data privacy and protection.[1,71]

HCPs require complete and correct information about DTx to address knowledge gaps[37,131] and to enable them to educate their patients about these tools.[90] Ideally, HCPs should receive specific training on the use, value and potential limitations of DTx to inform them how to properly prescribe these therapeutics to their patients.[1,64,142] Digital technologies that reduce clinician burden and are easily interpretable have been suggested to have the greatest likelihood of uptake.[143] Developers of DTx should always consider how the novel technology will be introduced into the clinical workflow,[144] and during which type of touchpoints with patients, as well as creating specific, informative material to facilitate onboarding of patients on these tools.

The integration of DTx into healthcare and adoption of these therapeutics by patients, requires a cooperative, interdisciplinary approach between researchers, manufacturers, governments and HCPs to ensure technologies are effective and regulated, and systems are in place to drive change management[97] and overcome engagement barriers.[5,57,131,145] Cripps and Scarbrough, in England, recommend shifting the focus from the DTx technology to considering the motivations of users and constraints within specific contexts.[146] These practitioners advocate for a wider approach to integration of DTx that incorporates clinical and behavioural insights, process engineering and knowledge management.[146]

A further consideration is that clinical studies of DTx often lack rigor and inclusivity.[11,76,147] Robust clinical trials with objective endpoints are needed to evaluate these interventions.[11] Furthermore, improved sociodemographic representation is needed in DTx clinical trials, particularly for underserved populations typically underrepresented in clinical trials.[148]

The potential benefits of DTx might extend beyond improvements to the patient's clinical condition and quality of life and into the dimension of health economics; for example, enabling the patient to return to work, and reducing the duration and cost of sick leave. Stakeholders' needs and perspectives may differ on this point, with employers potentially more interested than payers in the ability of DTx to help a patient return to work.[149] As noted by Bullard, economic evaluation of DTx is critical to payer reimbursement and provider adoption, and conducting a comprehensive and reflective economic evaluation of DTx requires a broader assessment of costs and outcomes that includes clinical and non-health benefits, as well as opportunity costs and gains.[150] Development of the ideal framework for DTx to drive adoption should include consideration of the health economic aspect of these therapeutics, and how they might contribute to reduced health economic burden.

Proposed Framework for Improved Uptake of Digital Therapeutics in Europe

A proposed framework for improved uptake of DTx in Europe, showing the approach from development to launch and through follow-up of DTx, is shown in Table 1.

Table 1 Proposed Framework for Development, Launch, and Follow-Up of Digital Therapeutics in Europe

1. Development of the Digital Therapeutic	2. Stakeholder Engagement	3. Regulation and Compliance	4. Clinical Trials and Validation	5. Marketing and Launch	6. Reimbursement Strategies	7. Implementation and Scaling	8. Ongoing Support and Quality Assurance	9. Continuous Improvement and Adaptation	10. Long-term Impact Assessment
Needs Assessment: Conduct thorough market and medical research to identify unmet needs in the healthcare system that digital therapeutics can potentially address. **Product Co-Design**: Utilize user-centred design principles and input from stakeholders/ target users to ensure the digital therapeutic is effective, user-friendly, and tailored to the needs of both patients and healthcare providers.	**Identify Stakeholders**: Key groups include healthcare providers, key opinion leaders/ experts, patients, regulators, policy makers, insurance companies, and technology partners. **Engagement Strategy**: Develop clear messaging that highlights the benefits, risks, efficacy, and safety of the digital therapeutic. Conduct workshops, seminars, and direct consultations to gather feedback and build relationships.	**Understand Regulatory Requirements**: Navigate the EU's regulatory landscape, particularly the Medical Device Regulation (MDR) and the General Data Protection Regulation (GDPR). **Compliance Strategy**: Establish protocols to ensure ongoing compliance with all relevant regulations, including data security and patient privacy standards.	**Trial Design**: Design robust clinical trials to validate the efficacy and safety of the digital therapeutic, and to assess compliance and cost-effectiveness. Plan trials that include minority and underrepresented patient populations. **Partnerships**: Collaborate with academic institutions, healthcare facilities and key opinion leaders/experts for trial implementation and to gain further clinical insights.	**Marketing Strategy**: Develop a marketing plan that includes digital marketing, traditional advertising, publications and congress material, and engagement with professional medical communities. **Launch Planning**: Plan a phased launch that starts in key markets or with key demographics to build momentum and gather real-world data.	**Insurance Collaboration**: Work closely with insurance companies to ensure that the digital therapeutic is covered under health insurance plans, enhancing accessibility for patients. **Economic Evidence**: Provide clear evidence of the cost-effectiveness of the digital therapeutic, including potential savings for healthcare systems.	**Pilot Programmes**: Initiate pilot programmes with healthcare providers to refine the implementation process and gather feedback. **Scaling Strategy**: Develop a scaling plan that considers different healthcare infrastructures across Europe, socioeconomic disparities, demographics, differences in regulatory requirements and ethical concerns.	**Customer Support**: Establish a robust support system for users, including training for healthcare providers and support resources for patients. **Quality Monitoring**: Implement continuous monitoring mechanisms to track the performance and impact of the digital therapeutic. Use data analytics to identify areas for improvement.	**Feedback Loops**: Create mechanisms to continuously gather user feedback and rapidly incorporate this into product updates and improvements. **Adaptation to Technological Advances**: Develop close links with technology partners and stay abreast of technological advancements that can enhance the digital therapeutic, ensuring it remains at the cutting edge. **Validation of Adaptation**: Ensure that any adaptation of the digital therapeutic in terms of content or reformulation of text undergoes clinical study and validation.	**Impact Studies**: Assess the long-term impact of the digital therapeutic on health outcomes, patient satisfaction, and cost savings. **Periodic Verification**: Changes in values and culture over time may change patients' perception; digital therapeutics require periodic verification, even after approval, to address the theoretical digital therapeutic "expiration date". **Sustainability Measures**: Develop strategies to ensure the long-term sustainability of the digital therapeutic, including alignment with evolving healthcare policies.

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Future Prospects and Conclusions

DTx are an evolving medical therapy that can support conventional medicine to address gaps in patient care, and potentially reduce current healthcare burden and health inequalities across Europe. Integrating DTx alongside conventional medicine into healthcare systems enables HCPs to deliver more personalised treatment for patients, thereby contributing to improved overall health outcomes. This integration requires equity, accessibility, and education of HCPs and patients on these therapeutics. The intrinsic value of DTx depends on their capacity to be safe, effective and convenient for patients and society.[1] Provided access and ethical challenges can be addressed, DTx could provide innovative and equitable healthcare.[116]

The adoption of DTx in Europe is limited and fragmented across the continent. Potential reasons for this include the lack of regulatory alignment for DTx between countries, sociodemographic factors, such as age, education and income, and knowledge gaps among HCPs. Strategies that could improve access and adoption across Europe include harmonisation of regulatory requirements and reimbursement pathways, infrastructure and clinician oversight to better serve low-income demographics, and education and training on DTx for HCPs. Investment in digital inclusion is essential to mitigate against widening health inequalities with the use of DTx. Finally, to reduce the risk of non-adoption or abandonment of new DTx, it is critical to authentically engage HCPs and patients upfront in the design of healthcare solutions for the future.[145] An ecosystem-centric approach for the development of DTx is vital to ensure holistic integration and sustainable adoption of these therapeutics within healthcare systems. This approach involves engaging a wide range of stakeholders, including healthcare providers, patients, regulators, policymakers, insurers, and technology developers, from the early stages of development through to implementation and scaling. Implementing an ecosystem-centric approach ensures that DTx are designed to meet the diverse needs of all stakeholders, facilitating smoother integration into existing healthcare workflows, improving patient outcomes, and ensuring long-term viability and acceptance.

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Disclosure

Dr Shaantanu Donde reports being an employee of Viatris Inc, and holds stock options of Viatris and some other pharma companies. Ms Tonya Winders reports personal fees from AstraZeneca, personal fees from Sanofi Regeneron, personal fees from GSK, personal fees from Insmed, personal fees from Chiesi, personal fees from Roche, personal fees from Novartis, personal fees from MSD, outside the submitted work; Mr Joris van Vugt reports being an employee of Viatris. The publication of this article was funded by Viatris. Dr Amelie Fassbender reports being an employee of Viatris. The authors report no other conflicts of interest in this work.

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