Digital Diabetes Index

Enhancing diabetes care through digital tools and services

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Future directions for digital diabetes care

The Digital Diabetes Index benchmarks the readiness of ten European countries to deploy digital interventions, focusing on digital technologies used to care and treat people with Type 1 and Type 2 diabetes. The findings of this research indicate five key enablers of access to digital diabetes tools, here we provide a summary of those enablers and how they can be leveraged to improve access to digital diabetes tools with the aim of improving outcomes for people with diabetes.

Figure 1: Future directions for digital diabetes care

Improving outcomes is the ultimate goal
Digital diabetes tools can help to improve the health and quality of life of people with diabetes, these are the future directions for developments in digital diabetes care.

Reimbursement pathways
Up-to-date reimbursement pathways that recognise the value of digital diabetes tools are needed, as they are a major facilitator for the uptake into the healthcare systems and care delivery pathways.

Assessment and evaluation processes
Fit-for-purpose assessment methodologies and frameworks are needed for digital diabetes tools and services in order to support their use and improve access.

Guidance and diabetes plans
Clinical guidelines and diabetes plans need to include specific recommendations about digital tools to support healthcare professionals in recommending them.

Training in digital diabetes tools
Training for healthcare professionals needs to be more widely available to raise awareness and confidence in using digital diabetes tools.

Turning policy into action
Policy is a crucial first step to achieving action, but funding, time and political will are required to ensure that policy is implemented.

Enablers of access to digital diabetes tools

Introduction

Diabetes is a condition in which the body struggles to regulate blood glucose levels. In Type 1 diabetes, the body does not produce insulin—the hormone that regulates blood glucose, while Type 2 diabetes is characterised by the body either not producing enough insulin, or of insulin not working effectively.[1, 2, 3]

Both types put people at risk of high blood glucose levels, which—if not effectively managed—can cause damage to the heart, eyes, feet and kidneys.[4] Around 10% of people with diabetes have Type 1 diabetes, which requires people to regularly test their blood glucose and inject themselves with a specific dose of insulin to control their blood glucose levels. Type 2 diabetes, which affects the majority of people with diabetes, can be managed by healthy eating and regular physical activity, but medication may be required to help the body utilise insulin.

Diabetes is a growing issue globally, with estimated prevalence among adults rising from 151 million in 2000, to 463 million in 2019.[5] In Europe one in 11 adults has diabetes and 296,500 children and young people have Type 1 diabetes—the highest number globally.[6] The number of children with diabetes is rising year-on-year, contributing in turn to increasing adult prevalence. There are also thought to be significant numbers of people with undiagnosed or "pre-diabetes"—where blood glucose levels are high but not yet past the threshold to diagnose diabetes. An estimated 41% of people with diabetes are undiagnosed, leaving them at risk of complications and increased healthcare costs.[7] Europe currently has the third largest diabetes-related expenditure globally—at 8.3% of total health budget.[8]

The combination of increasing numbers of people with diabetes and the high cost of diabetes care—due to complications and co-morbidities—creates an impetus for action.

Digital health: Leading the response to the diabetes explosion

For the purposes of this project we have used a broad definition of digital health that refers to all technologies and services involving the collection, exchange and analysis of information remotely including managing patient records online through electronic health records (EHRs), decision-support tools for health professionals, wearable devices that transmit data for analysis, and virtual consultations between people with diabetes and healthcare professionals (see Appendices 3, 4, 5).

Digital health uses information and communication technologies to support and promote health.[9, 10] It can be used across all aspects of heath and disease management.[11] Digital health also has the potential to not only replicate existing health services and interactions in digital form (such as remote monitoring and video appointments), but to enhance care, facilitate innovation and improve access.[12] Digital health offers the promise of greater efficiency, resource utilisation and better outcomes for all stakeholders.[10]

The WHO recommends a "coordinated approach to planning, implementation and evaluation" of digital health infrastructure.[13] Its eHealth survey identified that most countries within the European region had in place policies for implementing digital health (84%) and have dedicated funding streams (69%). However, long-term funding that is sustainable

and resistant to short-term changes in governmental priority, remains an important component of digital health implementation. The European Commission's first eHealth Action Plan was published in 2004, in its 2012 plan the Commission celebrated substantial progress, whilst acknowledging that further development was both possible and necessary.[14] The eHealth plans dovetail with the wider European Commission work to create a "digital single market", such as their interoperability framework covering all public services, including digital health.[15, 16]

Policy documents from various organisations highlight the potential for digital health to facilitate improved care in Europe.[17, 18, 19] Gaps in policy may also create perverse incentives. For example reimbursing healthcare providers at a lower rate for virtual versus face-to-face consultations does not incentivise providers to invest time and resource into implementing such technologies.[20] Fee-for-service, volume-based, systems may not be able to recognise the value of digital tools, especially where that value is reduced interactions with healthcare professionals or the avoidance of managing costly complications.[21]

Diabetes is particularly amenable to the use of digital health tools since management relies heavily on monitoring—requiring the generation and analysis of data to inform evidence based management of diabetes. People with diabetes are already accustomed to managing real-time data—regularly collecting data on their blood glucose levels and working out insulin doses, for instance.[22]

Digital technology provides an opportunity to better generate, store and leverage data. Despite the potential suitability of digital tools for managing diabetes more effectively, uptake has been variable.[23] Over half of people with Type 2 diabetes and a third of those with Type 1 diabetes reported using diabetes mobile apps—glucose monitoring apps in particular—to help manage their condition in a 2019 survey and the Google Play store listed 250 diabetes-related apps in January 2020.[24, 25, 26]

The ability to record and analyse this data manually or automatically using digital tools, provide insulin dosing recommendations, reminders to measure blood glucose, take medication etc., can empower people with diabetes to manage their condition more effectively, enhance healthcare professionals' input and potentially improve their health.[27, 28] Mobile health interventions targeting Type 1 and Type 2 diabetes include insulin management applications, wearable blood glucose meters, automated text messages, health diaries and virtual health coaching.[29] As with many digital tools, a key potential benefit of using digital health tools for people with diabetes is the convenience of reducing the number of face-to-face appointments.[30, 31] This in turn may help to connect with marginalised or hard-to-reach groups, including rural communities.[32, 33, 34]

So this begs the question: are health systems leveraging the opportunities that digital health offers to enhance diabetes care?

Statement of purpose

The Digital Diabetes Index benchmarks the readiness of ten European countries to deploy digital interventions, focusing on digital technologies used to care and treat people with Type 1 and Type 2 diabetes.

This report uses the phrase "digital diabetes tools" to refer to a range of tools and services that can be used to digitally manage diabetes. This includes diabetes-specific medical devices: closed-loop insulin delivery systems, flash glucose monitoring systems, insulin pumps, smart insulin pens and real-time glucose monitoring systems (see Appendix 4 for more details). Smartphone apps as a class of digital tools are not unique to diabetes, but they have significant applications in the digital management of diabetes, including linking with diabetes-specific medical devices (see Appendix 5 for more details).

Methodology

Digital diabetes tools and services are being continually enhanced and the portfolio of technology types is widening. This could radically improve outcomes for people with diabetes and bring efficiency gains for health systems. However, it also poses risks including product deficiencies (such as inaccurate readings or technical glitches), lack of uptake through inadequate provision of information, and incorrect usage by doctors or people with diabetes. To optimally support the development and utilisation of

digital diabetes tools thus requires a broad mix of policy supports from overall health data infrastructure to the inclusion of digital technology in national diabetes plans.

A literature review underpins the development of a policy Index framework to measure the level of readiness of countries in Europe to leverage digital health tools, specifically relating to diabetes care. A multi-disciplinary advisory board reviewed and provided feedback on the draft Index framework, which

Figure 2: Project overview

01
Index development
– Literature review
– Interviews
– Advisory board

02
Findings and Analysis
– Index population and QA
– Analysis

03
Presenting Results
– Index workbook
– White paper
– Digital hub
(www.digitaldiabetesindex.eiu.com)

PROJECT OVERVIEW
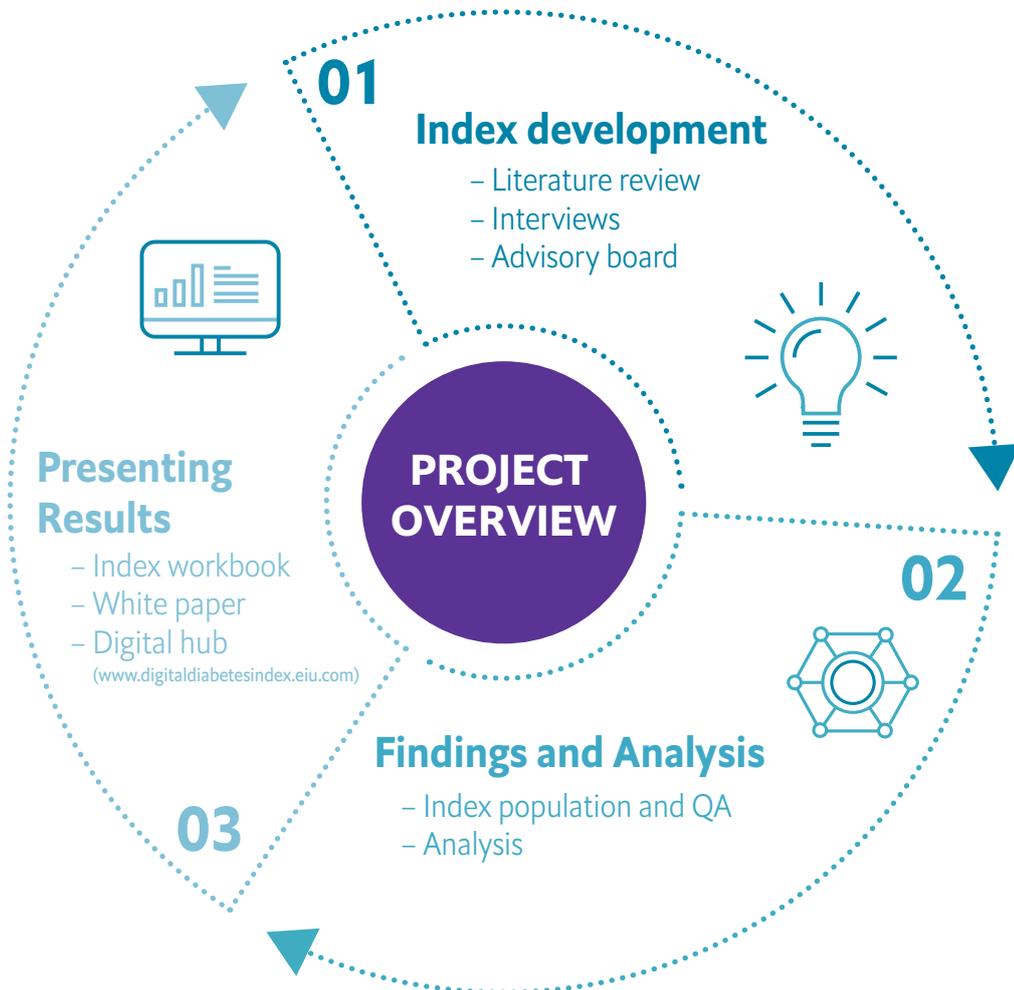
was revised based on their input. The Index was populated using data from a variety of sources to benchmark countries against each other. The Index findings, combined with the literature review and some key informant interviews inform this report. See Figure 2 for an overview of the project. The Index focuses on assessing readiness through the presence of and contents of policy documents. Policy does not always translate into implementation, where possible insights about implementation have been incorporated from the literature and expert interviews. However, this is an acknowledged limitation of the Index.

This project uses a broad definition of "digital diabetes tools and services" to refer to a range of tools that can be used to digitally manage diabetes, including diabetes-specific medical devices and smartphone apps that are not diabetes-specific as a class but have significant uses in the digital management of diabetes. See Appendices 4 and 5 for more details.

Index development

Literature review

The process begins with a rapid, fit-for-purpose review of the literature to formulate a draft Index framework. The advisory board was presented with this draft Index framework to provide their input into the design and focus of the research.

A focused search of the Embase.com (which incorporates Embase and Medline) bibliographic database identified articles relating to digital health and diabetes using a combination of free text terms and subject headings. The Embase.com search strategy is included in Appendix 1.

The search retrieved 230 review articles published in English since 2015, which were filtered according to relevance to diabetes and focusing on those reporting quantitative results, leaving 28 review articles. The literature review focused on global reviews of the literature and was not limited to European articles. The decision to include review articles only was a pragmatic one, based on the volume of material available. In such a fast-moving area this means that some specific technologies may not have been fully covered by the review articles. However, these were covered through grey literature searching and the advisory board. Grey literature searching focused on identifying policy papers in Europe, to understand the current state of digital readiness and diabetes care within Europe.

Index country selection

Country selection was made with input from experts to provide a sample of ten key European countries at varying stages of digital health maturity.

The Index focuses on 10 European countries:

1.   Belgium

2.   Denmark

3.   England

4.   France

5.   Germany

6.   Italy

7.   Netherlands

8.   Portugal

9.   Slovenia

10.   Spain

Developing the Index framework

An Index framework was designed for the included countries, based on the findings of the literature review and advisory board input. The framework includes 25 indicators relating to its core domains: Readiness for digital healthcare, Readiness for digital diabetes care and Digital diabetes care incentives and payments. A further 18 background indicators are also included.

Advisory board

The EIU convened an advisory board of 7 members to guide the development of the research methodology. The panel consisted of key stakeholders with both national and regional-level perspectives on digital health and diabetes in Europe. The advisory board meeting discussed the relevance of the framework towards its objectives, commented on the draft framework and advised on the Index design (e.g. suitable indicators) and scoring rationale. It was moderated by the Economist Intelligence Unit (EIU). The information obtained from the literature review and the advisory board was used to refine the Index framework.

1. Chris Aldred, Patient Representative to multiple diabetes organisations and person living with Type 1 diabetes.
2. Anne-Mette Bang, Managing Director, Cambio Denmark (healthcare system software developers).
3. Carl Brandt, Visiting Researcher, KI, Steno Diabetes Center Odense, research specialist in eHealth.
4. Montserrat Carmona Rodriguez, Researcher, Institute of Health Carlos III (Spanish public health research institute).

5. Nick Guldemond, Senior researcher at the Leiden University Medical Center and Visiting Professor at I.M. Sechenov First Moscow State Medical.
6. Jeannette Soderberg, Director, European Research at JDRF International.
7. Henk Veeze, Founder and General Manager, Diabeter specialist clinic for Type 1 diabetes in children and young people.

Index framework

The final set of indicators aim to measure and benchmark the ten included countries.

To measure progress towards an optimal policy framework, The Digital Diabetes Index analysed ten European countries across three domains, each of which is built on the previous (see Figure 3):

- Readiness for digital healthcare—focusing on broad digital health infrastructure, such as electronic health records and telemonitoring
- Readiness for digital diabetes care—focusing in on digital diabetes infrastructure, such as coverage of digital diabetes in diabetes policy
- Digital diabetes care incentives and payments—focusing on how digital diabetes tools are funded and whether incentives are in place to encourage their use by healthcare professionals and people with diabetes

Digital health infrastructure is the fundamental foundation upon which digital diabetes services are built. However, this has been covered by existing research and Indexes. Therefore this Index will focus on the readiness for digital diabetes care and the digital diabetes incentives and payments components as these are comparatively understudied and highlighted by our advisory board.

Figure 3: Digital Diabetes Index Framework
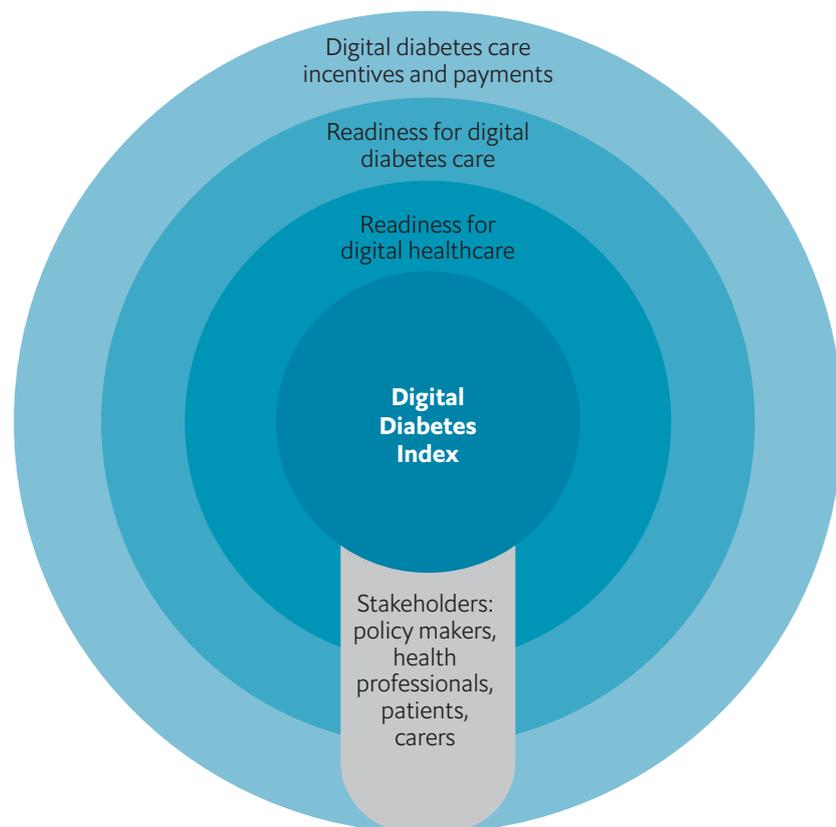
The full list of indicators included in the Index is in Appendix 1. Further economic, digital and diabetes-related background indicators are included in the Index workbook, downloadable via the Digital Diabetes Index website. Available at: www.digitaldiabetesindex.eiu.com

Findings and analysis

Data collection and scoring

The data collection process involves an objective assessment of the evidence base, including:

- Review of national policies, plans and strategies

- Review of specialised healthcare literature

- Utilisation of quantitative and qualitative information from international databases (such as the EIU, WHO and European Commission)

- Interviews to corroborate and/or supplement desk research

Some countries have health systems that are highly regionalised or access is insurer-led, for example Italy, the Netherlands and Spain. This means that there is within-country variation in provision of and access to services, medicines and devices. For the purposes of this index, we have sought national-level information

wherever possible. Scoring for some countries in some indicators is based on subnational information and/or policy. Therefore a positive answer for an indicator means that a policy or provision is in place within a region of said country but does not mean this is in place nationwide. Explanations of scoring decisions are given in the Index workbook, downloadable via the Digital Diabetes Index website. Available at: www.digitaldiabetesindex.eiu.com

Quality assurance processes involved a thorough sense-check and review of data/ scores by internal and external colleagues. Finalised scores were fed into an Excel dashboard displaying overall results and allowing users to manipulate the data. Scores were normalised to give a total score of up to 100. Weightings between categories were based on the objectives of the study to focus on digital diabetes care and incentives as a means of improving adoption. The readiness for digital healthcare domain contributes 10% to the overall score, readiness for digital diabetes care 50% and digital diabetes care incentives and payments 40%.

Implementation context

Interviews were also conducted with experts to understand the impact of covid-19 on diabetes services and to understand the practical implementation of digital diabetes, where possible. The Index focuses on assessing readiness through the presence of and contents of policy documents, which does not always translate into implementation. This is an acknowledged limitation of the Index. Recently, covid-19 has impacted on diabetes care, creating some opportunities for increased digital care and negatively impacting on services for some users. It remains to be seen whether the increased digital activity

brought about by covid-19 will translate into permanent infrastructure and services. Therefore the Index focuses on permanent service provision.

The following people were interviewed:

1. Chris Aldred, Patient Representative to multiple diabetes organisations and person living with Type 1 diabetes.
2. Professor Nick Guldemond, Senior researcher at the Leiden University Medical Center and Visiting Professor at I.M. Sechenov First Moscow State Medical.
3. Bastian Hauck, Board Member IDF Europe, Patient Advocate, CEO and person living with Type 1 diabetes.
4. Dr Chantal Mathieu, President of the European Diabetes Forum (EUDF).
5. Dr João Filipe Raposo, Clinical Director at the Portuguese Society of Diabetology.

Presentation

The Index results are presented in the following formats:

- This white paper, that presents the results of the Index.

- An interactive dashboard in Excel presenting the results in a user-friendly, graphical manner. This includes a series of analytical tools to compare and manipulate the data.

- A digital hub presenting key Index findings, the dashboard in digital format, the Excel dashboard and the accompanying white paper. Available at: www.digitaldiabetesindex.eiu.com

Note that while the EIU worked closely with MedTech Europe and its diabetes sector group, as well as the EIU-convened Expert Advisory Group, the EIU retained full editorial control.

Covid-19 and diabetes: when two major health challenges collide

With an estimated 59 million people living with diabetes in the European region, the disease has been of central relevance to the pandemic crisis.[35] Emerging evidence suggests that people with Type 1 and Type 2 diabetes are at increased risk of developing complications and potentially dying as a result of covid-19.[36, 37, 38] The Economist Intelligence Unit spoke to a number of experts in diabetes—people with diabetes and healthcare professionals—about the impact of covid-19 on diabetes services, especially as it has necessitated a move away from many face-to-face appointments.

Feeling "vulnerable"

People living with diabetes have reported increased anxiety as a result of being classified as "vulnerable", according to Bastian Hauck, a patient advocate with Type 1 diabetes. The diabetes community has made great progress in changing perceptions and language so that people living with diabetes are no longer defined as "patients" or "diabetics". But Mr Hauck said that he felt the crisis had "brought diabetes to the forefront" in his life, rather than something he manages well on a daily basis.

The covid-19 pandemic has created stress and anxiety for everyone as the world has adapted to control measures like mass population lockdowns and quarantines. Confusing and alarming messages about the risks that people with diabetes faced exacerbated this because they are not necessarily experts in reading and interpreting the emerging evidence. There was also a feeling from experts we spoke to that diabetes patient organisations could have better supported people with diabetes by being quicker to reassure them about the risks by directly countering these messages. Diabetes UK, for example, has a number of on-going campaigns to influence government to

provide clear advice to people with diabetes, ensure their safety at work and access to food and priority deliveries.[39] Diabetes Professional Care, an advocacy group, provides another example of covid-initiated innovation by creating an online portal offering webinars and training for health professionals to support the mental health of people with diabetes, who are more likely to suffer anxiety related to the pandemic due to their increased risk.[40]

Impact on access to care

Lockdown measures can limit access to services, insulin, medications and blood glucose monitoring equipment. In countries without e-prescribing services, people with diabetes still had to visit their doctor's surgery to fill their prescriptions for insulin or medication, despite advice to stay in their homes and avoid contact with others. For people with diabetes there was a contradiction between covid-related advice and the necessities of physically accessing services to manage their diabetes, which access to online services could have alleviated. In Belgium, the health authorities reacted swiftly to approve e-prescriptions and remote consultations, according to Professor Chantal Mathieu, President of the European Diabetes Forum.

The impact of covid-19 on treatment-seeking have varied. Mr Chris Aldred—a patient representative to multiple diabetes organisations and person living with Type 1 diabetes—described how some people have avoided healthcare settings to try to reduce their risk exposure. Whereas others sought more support from their healthcare teams who have acted like a "blanket around our patients", as Professor Mathieu put it. In Denmark a survey reported that one third of people with diabetes were worried about

not being able to manage their condition if they became infected.[41] Denmark was able to implement two new video consultation tools for primary and specialist care within a fortnight thanks to its strong underlying digital healthcare infrastructure.[42]

Increased digital diabetes services

The early days of the pandemic in Europe saw a huge rise in the number of teleconsultations, for example up from 40,000 a month to 486,369 in France, supported by temporary full reimbursement.[43, 44] However, there have been concerns about the sustainability of some generic videoconferencing software because of questions about compliance with the European General Data Protection Regulations (GDPR).[45] Experts have observed that continuity of care has been achieved in the main thanks in part to increased use of teleconsultations.[46] This serves as a stark reminder that digital technology is not just a luxury, but a vital infrastructure to deliver and maintain services.

The experts we spoke to—people with diabetes and healthcare professionals alike—reported that the biggest increase was actually in telephone consultations. This was largely due to concerns around digital exclusion and not wanting to leave any people with diabetes behind because of a lack of access to technologies such as laptops and smartphones. In the Netherlands, Pharos (the Dutch Centre of Expertise on Health Disparities) has provided advice and support on accessibility to digital tool developers to address the health inequalities that digital tools can create and/or exacerbate.[47]

In countries where real-time and flash glucose monitoring systems are widely adopted, healthcare professionals can monitor people's condition with limited physical interaction. Under "normal" circumstances this is more convenient for people with diabetes and during covid-19 it has been important for reducing infection risks (in both directions).[48] Automated tools to assess insulin requirements and administer dosing could improve disease management and ensure resilience to health system shocks in the future, as well as reducing anxiety in people with diabetes by relieving them of some decision-making and monitoring responsibilities.[49] In response to the covid-19 crisis, NHS England launched a digital education service that lets people manage their condition online, through online videos and training for children and adults.[50]

Professor Mathieu commented that "this happening now, versus five years ago is a different world" because of technological advances and the "game changing" effect of full reimbursement of flash and real-time monitoring systems, enabling her to provide remote consultations that are almost as good as face-to-face. However, experts are also advocating for more involvement of people with diabetes as new digital platforms are developed and implemented, including user training. Where covid-19 has presented opportunities to reduce red tape, Ms Liz Perraudin, Senior Policy Officer at Diabetes UK says that "what we've lost in that process is user involvement and co-production."

What might we be missing?

As discussed, there has been a general avoidance of healthcare settings amongst some people with diabetes. Screening is important for the early detection and treatment of diabetes complications, for example eye and foot care. Experts report that screening isn't getting done or is "severely compromised" according to Professor Nick Guldemond, Senior researcher at the Leiden University Medical Center and Visiting Professor at I.M. Sechenov First Moscow State Medical. There could be serious consequences for health systems and people with diabetes if complications go untreated.

Mr Aldred pointed out that—as someone whose Type 1 diabetes is managed in specialist care—his long-standing appointments were easily switched to telephone consultations. However, he and others have raised concerns for people who are newly diagnosed or struggling with managing their diabetes, so would require more support.[51] Ms Perraudin also warned that healthcare providers are uneven in their appetite for using digital technology. In England, some have moved quickly to use new digital platforms with others yet to even transition to telephone appointments. This experience highlights the importance of engaging healthcare professionals to empower them to act as enablers of digital implementation.

The level of access to digital diabetes tools prior to covid-19 also impacts on overall experience of care. Those who already had access to such tools can be effectively remotely monitored, whereas those not using these tools may feel less well supported if they have not received support in adapting to greater reliance on self-monitoring. [52]

Looking to the future

Digital diabetes tools can be seen as important means to improve health system resilience to future pandemics, by improving people's ability to self-manage their condition. Given the number of viruses in circulation with the potential to cause a pandemic, the risk of future pandemics should be viewed almost as an inevitability.[53]

Covid-19 has created opportunities for increased use of digital diabetes tools and services. At present, it is unclear how much of these service changes—accommodating social distancing and isolation/quarantine requirements—will translate into permanent service provision. There is also a need to consider how the pandemic crisis has highlighted existing issues in digital health infrastructure, such as how the highly regionalised system in Italy experienced issues due to a lack of connectedness between systems.[54] Similarly in Spain, experts have suggested that a more centralised approach to digital healthcare could support innovation, implementation and reduce variation.[55] In Slovenia, experts have pointed to an opportunity to update the eHealth strategy based on lessons learned during the covid-19 pandemic and increased digital health use.[56]

Experts we've spoken to agree that digital tools and services have been important in maintaining services to people with diabetes. In particular they would like to see the greater role of teleconsultations continue beyond the immediate covid-19 crisis to become an integrated part of the package of services offered. Finance is a key component in incentivising the continuation of digital diabetes care. Belgium was quick to respond to the changing demand brought

about by covid-19 by introducing a consistent reimbursement fee for teleconsultations across specialties, but at around a third the value of a face-to-face consultation. In countries with a fee-for-service model, such discrepancies may prove a disincentive to continuing digital services. Reimbursement has been highlighted by experts as a key mechanism for improving access to and uptake of digital health tools because "everything is guided by reimbursement" and its ability to guide behaviour amongst health professionals and people with diabetes alike, according to Professor Mathieu.

The experts we spoke to were keen that the temporary changes to service delivery introduced in response to covid-19 be capitalised upon to achieve long-term shifts in how services are delivered. Decision-making on the most appropriate medium to use for individual appointments would be based on clinical considerations and the preferences of the person with diabetes. The voice of people with diabetes will play a key role in pushing for the continuation of digital diabetes care, but this depends on strong advocacy groups for people with diabetes, which are lacking in some countries says Mr Hauck.

A question for policy makers might be, why did it take a pandemic to shift to digital services? And how can we translate short-term workarounds and policies to a permanent change in service delivery?

Findings

Index overview

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Table 1: Index summary

	Overall score (100%)	Digital readiness (10%)	Digital diabetes readiness (50%)	Digital diabetes incentives and payments (40%)
Belgium	Medium	High	Low	High
Denmark	High	High	High	High
England	High	High	High	High
France	Medium	High	Low	Medium
Germany	High	High	High	High
Italy	High	High	High	High
Netherlands	Medium	High	Medium	Medium
Portugal	Medium	High	Medium	Medium
Slovenia	Medium	High	Medium	High
Spain	Medium	High	Medium	Medium

● High (score 66.1-100)   ◓ Medium (score 33.1-66)   ○ Low (0-33)

The key findings reported here reflect the findings of desk research and interviews with experts. The overall score is made up of the scores for the three domains. Scores were normalised to a 0-100 scale for the overall and individual domain scores. The domains have been weighted according to their relative significance to the research topic. Readiness for digital healthcare reflects the broad digital healthcare infrastructure that provides a foundation upon which digital diabetes can be built; as such, it represents 10% of the total score. Readiness for digital diabetes care reflects the digital diabetes-specific policy and infrastructure, representing 50% of the score as this is central to the focus of the research on the provision of digital diabetes tools. Digital diabetes care incentives and payments represents 40% of the overall score to reflect the central role that these play in facilitating the use of and access to digital diabetes tools by people with diabetes.

Scoring is primarily based on national-level information and policy. In countries with highly regionalised or insurer-led systems, such as Italy, the Netherlands and Spain, some indicator scoring is based on subnational

or insurer-level information and/or policy. Therefore a positive answer for these indicators means that a policy or provision is in place within a region of said country but does not mean this is in place nationwide. In particular this applies to indicators relating to reimbursement as this varies between regions. Explanations of scoring decisions are given in the Index workbook, downloadable via the Digital Diabetes Index website. Available at: www.digitaldiabetesindex.eiu.com.

Reimbursement is an important enabler of access to digital diabetes tools

- **Germany and Italy lead the region in digital diabetes policy.** Whilst Germany scored the lowest of all ten countries for the domain evaluating overall readiness for digital healthcare, its strong performance in the digital diabetes readiness and incentives domains ensured its high overall score. Its score was bolstered by the adoption in July of a national diabetes strategy that includes digital components; however, it should be noted that the recent adoption of this strategy means that implementation will currently be limited. Italy scored consistently well across the three domains, indicating a balanced and co-ordinated approach that combines high-level strategy with specific operational enablers, although its regional health system means services and access may vary.

- **The reimbursement of key digital diabetes technologies varies across the region,** the main gap being a lack of reimbursement for newer digital diabetes tools such as closed-

Table 2: Digital diabetes incentives and payments domain summary (40% of overall score)

Digital readiness (10%)

Belgium	●
Denmark	●
England	●
France	◒
Germany	●
Italy	●
Netherlands	◒
Portugal	◒
Slovenia	●
Spain	◒

● High (score 66.1-100)
◒ Medium (score 33.1-66)
○ Low (0-33)

loop insulin delivery systems in most countries (7/10) and smart insulin pens (6/10). Unlike pharmaceuticals, **there is no evidence of alternative funding models for reimbursement to provide access to newer technologies**.

- Across Europe, there is a **lack of incentives** to encourage the use of key digital diabetes tools and services beyond reimbursement. In England, for instance, access to digital technology is unequal even in the presence of reimbursement, because of regional service commissioning

and differences in prescribing rights, with tools like real-time glucose monitoring systems only available via secondary care. Belgium provides an eHealth financial premium that pays general practitioners a bonus depending on the level of eHealth service they provide. Germany and England incentivise the use of digital diabetes tools and services through awareness raising and education. The recommendation of digital diabetes tools in clinical guidelines provides an incentive for use in England, Germany, Italy and Spain.

- Italy, the Netherlands and Spain, have highly regionalised health systems with most reimbursement decisions taking place at a regional or insurer, rather than national level (see Table 3).. A positive score for reimbursement in the Index indicates that the selected digital diabetes tool is reimbursed in a minimum of one region within the country, but does not mean this is true nationwide. As such, this indicator gives an optimistic view of reimbursement in those countries. Explanations of scoring decisions are given in the Index workbook, downloadable via the Digital Diabetes Index website. Available at: www.digitaldiabetes.eiu.com.

Table 3: Reimbursement for key types of digital diabetes tools

	Real-time glucose monitoring systems	Flash glucose monitoring systems	Insulin pumps	Closed-loop insulin delivery system	Smart phone applications (apps)	Smart insulin pen
Belgium	National reimbursement	National reimbursement	National reimbursement	No	National reimbursement	No
Denmark	Regional reimbursement	Regional reimbursement	Regional reimbursement	Regional reimbursement	Regional reimbursement	Regional reimbursement
England	National reimbursement	National reimbursement	National reimbursement	National reimbursement	National reimbursement	No
France	National reimbursement	National reimbursement	National reimbursement	No	No	No
Germany	National reimbursement	Insurer-level reimbursement	National reimbursement	National reimbursement	National reimbursement	National reimbursement
Italy	Regional reimbursement	Regional reimbursement	Regional reimbursement	No	Regional reimbursement	Regional reimbursement
Netherlands	National reimbursement	National reimbursement	National reimbursement	No	No	No
Portugal	National reimbursement	National reimbursement	National reimbursement	No	No	No
Slovenia	National reimbursement	National reimbursement	National reimbursement	No	No	National reimbursement
Spain	National reimbursement	Regional reimbursement	Regional reimbursement	No	No	No

■ High (score 66.1-100) ■ Medium (score 33.1-66) ■ Low (0-33)

Digital infrastructure is in place, but there are opportunities to collect and leverage more data

- **European countries overall have the basic enablers for digital diabetes care.** All countries have in place the foundations on which digital diabetes care can be built—and without which it could not operate. National eGovernment policies are in place in all ten countries; these can promote the uptake of digital technology in public services and improve citizen-government digital interactions. The continent's performance has been catalysed in part by pan-European initiatives like the Tallinn Declaration of 2017, which provided significant momentum towards the rolling out of digitally oriented public services.[57] Digital diabetes needs to be linked to the wider digital inclusion agenda, to ensure that a lack of access to digital technology such as mobile phones does not negatively impact access to healthcare services whilst recognising the role of digital health to widen access to some communities (e.g. rural communities).

- **All countries have a specific institution, or set of institutions, charged with leading digital transformation in healthcare, and all have an eHealth policy in place.** In addition to the legal framework that the EU General Data Protection Regulation (GDPR) provides, all countries have legislation governing data-sharing between private companies and the public sector, which is crucial as commercial enterprises

Table 4: Digital readiness domain summary (10% of overall score)

Digital readiness (10%)

	Digital readiness (10%)
Belgium	●
Denmark	●
England	●
France	●
Germany	●
Italy	●
Netherlands	●
Portugal	●
Slovenia	●
Spain	●

● High (score 66.1-100)

◒ Medium (score 33.1-66)

○ Low (0-33)

play a larger role in the development of digital health in the future. All countries address interoperability in systems and data through specific national strategies or as part of their broader digital health plans.

- **Electronic health records (EHRs) and diabetes registries can co-ordinate care and support clinical research; while all countries except Germany have a national EHR system, only half have a diabetes registry.** Diabetes is a data-rich condition, with a wealth of routinely collected information including average

blood glucose, foot health, eye health, cardiovascular health and renal health. There has been a surge in publications exploring beneficial interactions between EHRs and diabetes care, coinciding with the wider adoption of EHRs following the US HiTech Act and the EU Innovative Medicines Initiative.[58] Diabetes-specific registries are only present in half of countries. Diabetes registries have demonstrated improved care, processes and outcomes. One estimate suggests that $14.5 billion in diabetes healthcare expenditure could be saved over ten years through increased compliance with guidelines, more efficient information-sharing across healthcare professionals, and automated reminders and scheduling systems.[59] Registries can also facilitate clinical research, such as easing the progress of cohort selection for trials.[60] European countries could leverage

even greater benefits from individual data registry efforts as the continent moves towards seamless cross-border health data exchange under the eHealth Digital Service Infrastructure initiative which is expected to become operational across 22 member states by 2021.[61]

• **The European Union can play an important role in supporting digital diabetes care in member states.** While member states maintain their own health regulatory authorities, the European Commission can complement national policies and ensure health protection according to EU standards. Relevant interventions for supporting digital diabetes care include the EU's Regulations for medical devices (MDR) and in vitro diagnostic medical devices (IVDR).[62]

Policy and guidelines focused on digital diabetes care are lacking

- **All countries have national diabetes plans, but only three explicitly include digital components.** National diabetes plans provide overarching guidance on direction and strategy for all stakeholders involved in diabetes care, including policy makers, healthcare professionals and people with diabetes. Positively, all countries have an operational plan for diabetes. However, only Denmark, Germany and Italy explicitly include digital diabetes in their national plans. Denmark's engagement is reflective of its strong engagement with digital healthcare more broadly in recent years; it has been early to adopt technical standards for telehealth devices for instance and has rolled out digital health pilots for conditions including cancer, blood pressure and diabetes.[63] The International Diabetes Federation has previously highlighted that the implementation of national diabetes plans requires effort and resource, so the presence of policy does not necessarily lead to action and implementation.[64]

- **Only four countries specifically reference digital diabetes tools in their national clinical guidelines.** While clinical guidelines are not always followed, they remain an important tool to harmonise treatment, diffuse best practices and adjust norms in accordance with emerging evidence and technologies.[65] Only four countries—England, Germany, Italy

Table 5: Digital diabetes readiness domain summary (50% of overall score)

Digital diabetes readiness (50%)

Belgium	○
Denmark	●
England	●
France	○
Germany	●
Italy	●
Netherlands	◑
Portugal	◑
Slovenia	◑
Spain	◑

● High (score 66.1-100)

◑ Medium (score 33.1-66)

○ Low (0-33)

and Spain—currently include digital diabetes tools in their respective guidance documents. Since 2015, England has recommended the use of insulin pumps and real-time glucose monitoring systems specifically. Spain's guidelines reference the value of smart pens for proper dosing and confirming adherence and Italy's also stipulate the important role of training people with diabetes in self-monitoring systems. Countries can also leverage existing guidelines and models as templates.

For example, guidelines issued by the International Society for Pediatric and Adolescent Diabetes (ISPAD) are used as reference points in some countries without their own guidelines, offering guidance on issues like the applications and benefits of insulin pumps and the need for early recognition of infusion set failures.[66] Countries can also leverage recommendations from institutions such as the American Diabetes Association, including best practices like the need for on-going evaluation of techniques for self-monitoring of blood glucose.[67]

Digital regulation, lack of reimbursement and healthcare professional awareness can impact access

- **All countries include digital technology in reimbursement systems, and most have adapted Health Technology Assessment (HTA) protocols to accommodate new technologies. However, only some digital diabetes tools are reimbursed.** While all countries include at least some coverage of digital diabetes tools, some are more comprehensively supported than others—with closed-loop insulin delivery systems, smart insulin pens and smartphone applications the least embraced. This is likely as a result of being newer technologies and—in the case of apps—having traditionally been consumer-facing products that have only been classified as medical devices more recently. There is evidence from experts that closed-loop systems are indirectly reimbursed through the fragmented reimbursement of the individual components, but they are not generally reimbursed as an entity. Smartphone apps are an area of growing importance as technology companies continue to push into healthcare. Denmark, England, Germany and Italy have the widest coverage for digital diabetes tools reimbursement, followed by Belgium and Slovenia. Belgium, Denmark, England, Germany and Italy offer reimbursement for smartphone applications, while Denmark, Germany, Italy and Slovenia have reimbursement pathways for smart insulin pens. One significant policy development is Germany's recent law (November 2019) allowing doctors to prescribe digital tools, including health apps, that are CE (Conformité Européenne) marked and meet certain criteria, with costs reimbursed by insurers. Experts advise that reimbursement decisions often act as a de facto guidance to health professionals on what to use, meaning that decisions made in this domain profoundly influence the uptake of digital diabetes tools and therefore access. Reimbursement can also guide the behaviour of people with diabetes, as experts report their lack of willingness to pay out of pocket for non-reimbursed treatments and tools.

- **Regulations need to 'catch up' with the boom in smartphone apps.** Apps can be classified either as medical devices or health and wellbeing apps,

which affects the level of regulation they are subject to. Regulations are in place to provide apps that are considered a medical device with a CE marking, indicating that they are safe and perform as intended.[68] Key policy issues relating to apps include improving the evidence on app accuracy and clinical validity, training provision, interoperability and standardisation, and data security.[69] Belgium has implemented a three-tier validation process for apps that is linked to its reimbursement process.[70] The first tier is that the app is classified as a medical device with a CE marking. Second tier are apps submit a risk assessment and meet technical requirements, as well as fulfilling tier one criteria. The third tier requires first and second tier fulfilment, then provides evidence of added socio-economic value linked to a request for funding. Apps can also be funded via local healthcare financing or by individual health insurance companies. Health systems must also help healthcare professionals navigate the landscape of diabetes apps as more products come to market. The UK's NHS Apps Library stands out as a tool useful for indicating which apps are reimbursed and have been evaluated for quality and reliability. The library covers a variety of factors including product availability (e.g. on the Apple App Stores), interoperability standards, clinical safety and security. A total of 17 disease conditions are included in the library, with 16 diabetes-specific products, 11 of which are reimbursed.

- **Digital diabetes training for health professionals is not yet comprehensive.** Health professionals need training in how to utilise digital diabetes tools, both as part of their initial qualification and in on-going professional development, to be kept abreast of new developments. All countries currently include general eHealth training for health professionals pre- and post-qualification, but training for digital diabetes tools is uneven both across the group and for key professionals (GPs, endocrinologists and diabetes nurses). Spain, England, Germany and Italy are the top-scoring countries for digital diabetes training overall. It is included in initial and on-going training phases in all three specialisms in Spain and mostly present in Germany, Italy and England. Overall, there is limited inclusion of digital diabetes instruction in initial training, but more comprehensive coverage in on-going professional development. Examples of on-going training include short-form practical training and summer schools (such as those led by Denmark's Steno Diabetes Center Copenhagen) and programmes run by scientific societies and diabetes associations. Companies also play a role; Novo Nordisk, for instance, runs Novo Akademie in Germany, which offers certified further education and seminars about digital diabetes tools for GPs, internists, diabetologists, diabetes advisors and diabetes assistants, as well as cardiologists, nephrologists, gynaecologists, paediatricians and psychologists.

Covid-19 has impacted digital services and people living with diabetes

- **Covid-19 could quicken the adoption of digital technology in diabetes case, but the long-term implications are unclear.** The pandemic has increased engagement with digital technology, teleconsultations and e-prescription. People with diabetes and their healthcare professionals have learned to use new technologies and come to appreciate their benefits; however, this may not lead to lasting change. In some contexts like Belgium, payments for teleconsultations are lower than in-person, so may not incentivise continued use of teleconsultations in the longer term. Experts also worry that the economic impact of covid-19 could stall discussions on widening or increasing reimbursement for digital diabetes tools. They also advocate for more involvement for people with diabetes in the co-design of new platforms and tools which are being rolled out at pace and with limited user participation so far.

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The Economist INTELLIGENCE UNIT

Country profiles

Overview

The following country profiles represent a deeper dive into the digital readiness of individual countries as assessed by the Digital Diabetes Index.

It should be noted that scores on digital readiness were tightly clustered within 13.6 points out of a total score of 100. The main differentials in scoring came in the domains addressing readiness for digital diabetes care and digital diabetes care incentives and payments

Diabetes is a challenge now and on the horizon

Diabetes prevalence in the adult population aged 20 to 79 years varies between the countries included in the Index. Germany's diabetes prevalence is almost three times that of the UK, with the average within the sample countries at 9.3% (see Figure 5).

Figure 4: Digital Diabetes Index overview

High (score 66.1-100)
Medium (score 33.1-66)
Low (score 0-33)
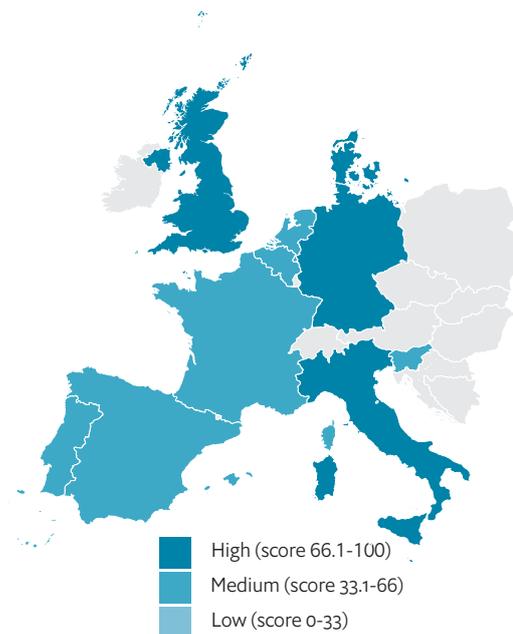
Figure 5: Diabetes prevalence
(20-79 y), %
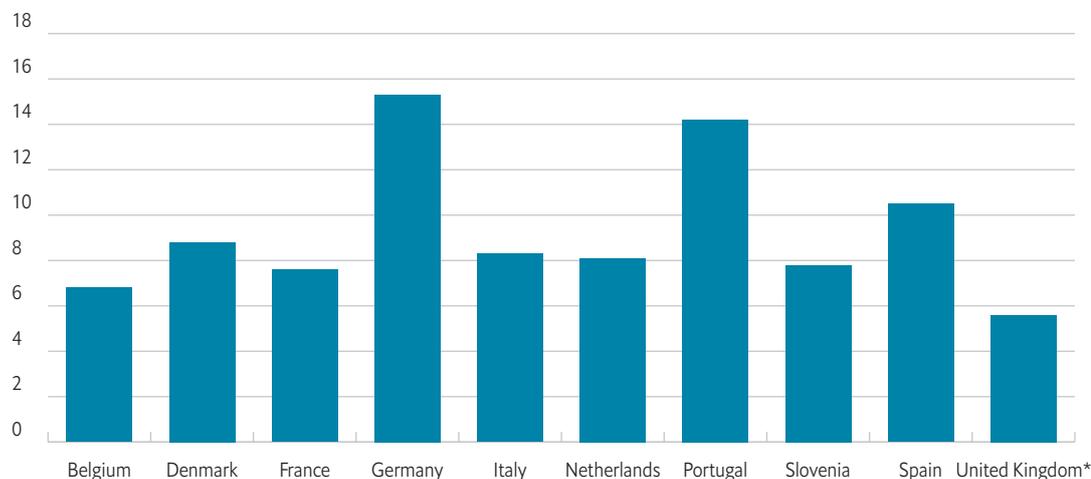
*Prevalence figures are for the United Kingdom, whereas this index focuses on England

Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Figure 6: Undiagnosed diabetes or prediabetes
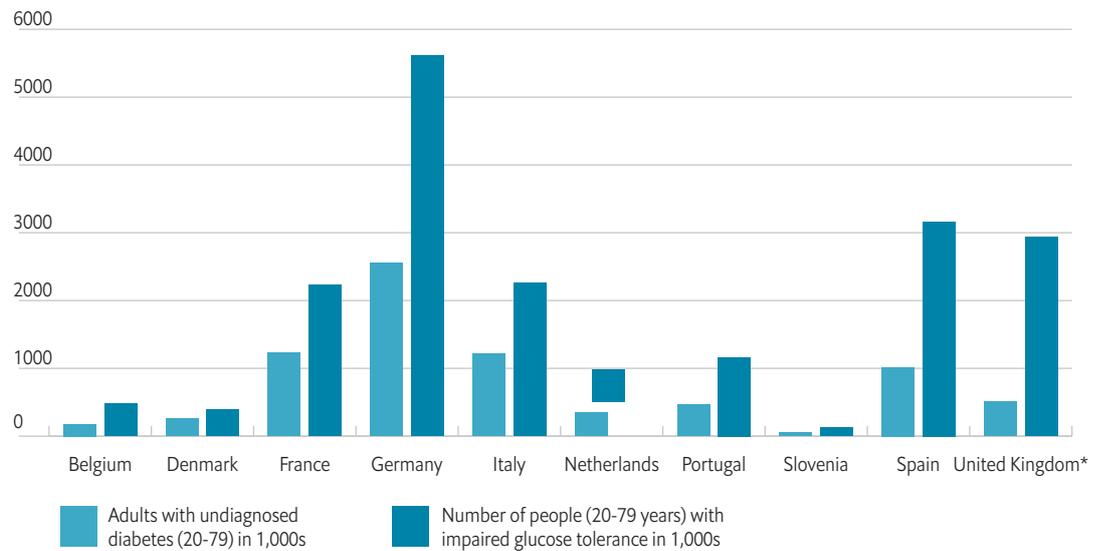
*Prevalence figures are for the United Kingdom, whereas this index focuses on England

Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

These estimates of undiagnosed diabetes and pre-diabetes suggest that diabetes presents a significant current and future challenge to the included countries.

Estimates of undiagnosed diabetes suggest that there are a significant number of people who have not been diagnosed (Figure 6). The rate is highest in Germany.

There are also high estimated rates of pre-diabetes, defined as impaired glucose tolerance (Figure 6). Again Germany's rates significantly exceed that of other countries. Impaired glucose tolerance that is not addressed can develop into diabetes.

The prevalence of diabetes and overall scores on the Index do not show a clear pattern of correlation (see Figure 7). This suggests that digital tools are not necessarily being thought of as a key part of diabetes policy and response.

Figure 7: Diabetes prevalence and Digital Diabetes Index overall score
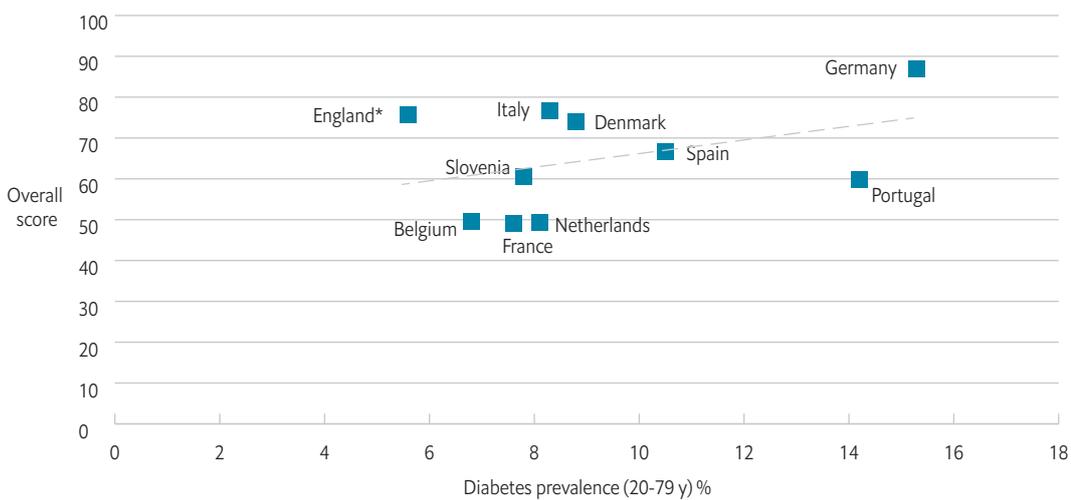
*Prevalence figures are for the United Kingdom, whereas this index focuses on England

Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Country profile: Belgium

Actively enhancing national eHealth through electronic prescriptions, a digital health portal and health data system interoperability measures. The lack of a national diabetes registry holds back data analysis and the country has yet to include digital diabetes in clinical guidelines.

Belgium
Medium (score 33.1-66)

Background trends

Belgium has an adult diabetes prevalence of 6.8%, although official sources indicate over one in three people with the conditions could be undiagnosed.[71] Disease risk is geographically uneven, with higher rates in the regions of Wallonia and Brussels compared to Flanders, and for people of lower socioeconomic status generally.

The country has achieved some improvements in diabetes management, with the risk of undergoing lower-extremity amputations, for instance, declining between 2009 and 2013.[72]

Belgium has a strong commitment to digitalising its economy and government services. Its digital health infrastructure includes EHRs and some tasks such as reimbursement are digitalised across the health system. Belgium has introduced an assessment pyramid for mobile apps that enables approval with a CE marking, through to reimbursement where socio-economic benefit is demonstrated.[73] As of late-July 2020, Belgium reimbursed its first mobile application—moveUP Coach, designed to support rehabilitation for people undergoing total hip or knee replacement—demonstrating that this is a fast- and ever-changing area of policy.[74]

Belgium rapidly introduced standardised reimbursement for teleconsultations, with experts reporting that pre-existing widespread use of real-time glucose monitoring systems enabled high quality remote consultations.

Figure 8: Diabetes prevalence in Belgium
(20-79 y), %
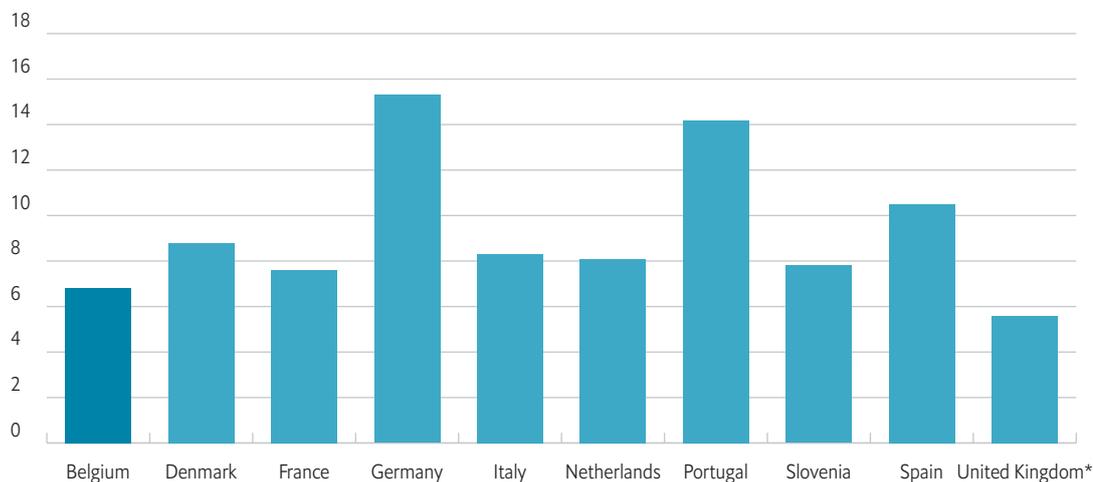
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Policy progress

Digital infrastructure

- Digital Belgium (2015-present) is the country's national agenda, spanning five domains: infrastructure, confidence and security, government, economy and skills.[75] There are differences in digital skills and literacy, with the north ahead of the rest of the country, indicating geographic unevenness that could impact digital health and diabetes uptake.

Digital health

- Belgium has a national eHealth policy, launched in 2013, which was refreshed in 2015 to take account of mobile health—missing in the original plan— this enabled health apps to become an official part of the healthcare

system.[76] Between 2019 and 2021, further enhancements will include obligatory electronic prescriptions and the expansion of the healthcare portal, MaSante, which offers a one-stop digital health portal for citizens.

- Multiple institutions are involved in digital health, rather than a single overarching agency: they include the Federal Public Service Health, Safety of the Food Chain and Environment, the Federal Agency for Medicines and Health Products, the Federal Agency for Nuclear Control and the National Institute for Health Insurance Disability.

- Several entities are collaborating to support health data interoperability, principally the Ministère fédéral de la Santé and the secrétariat d'État à l'Informatique. The action plan of 2019-2021 includes provisions on inter-federal cooperation, with initiatives including the creation of a laboratory of interoperability, and test centres to validate software to ensure compatibility with eHealth standards.

- Belgium is the only country included in the Index to provide a financial incentive to encourage a move towards eHealth through its integrated practice bonus.[77] The premium increases based on the number of e-service parameters in use within a general practice.

Table 6: Index summary, Belgium

Overall score (100%)	◐
Digital readiness (10%)	●
Digital diabetes readiness (50%)	○
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	◐

● High (score 66.1-100)

◐ Medium (score 33.1-66)

○ Low (0-33)

Digital diabetes

- Belgium has several diabetes policies, plans and recommendations. An early development was the Zoet Zwanger project launched by the Flemish diabetes league in October 2009, which aimed to promote regular blood glucose screening of pregnant women in primary care and lifestyle changes in women with previous gestational diabetes.[78] Today, national-level plans include the National Nutrition and Health Plan (PNNS) 2011-2015 and the eHealth action plan (2019-2021). These plans have included the launch of over 20 projects in mobile health since 2017, three of which concerned diabetes.

- There is a national health information system (HIS) policy (dating from 2008), with legislation governing its use, which is absent in many countries in this Index. Belgium's integrated health data system was developed to facilitate data exchange between healthcare professionals and researchers.[79]

- Belgium lacks a specific diabetes registry. The InterMutualistic Agency (IMA-AIM) platform gathers data from seven health insurance funds which can be used to track treatment trends.[80] There is also the Initiative for Quality Improvement and Epidemiology in Diabetes (IQED), which tracks key diabetes-related metrics to assess the quality of care and advise centres on improvements.[81] The country does not include digital diabetes tools in its national clinical guidelines.

- There are reimbursement pathways for smartphone applications, real-time and flash glucose monitoring systems and insulin pumps; closed-loop insulin delivery and smart pens are not covered. Belgium's app "validation pyramid" is an interesting model, providing differentiated levels of approval for apps based on their use. The lowest approval indicates that the app is a medical device with CE certification, the second indicates integration with existing eHealth systems and the highest assessment level indicates socio-economic benefit and is linked to a national reimbursement pathway.[82]

- Belgium uses a joint HTA to assess real-time glucose monitoring and flash glucose monitoring as personal, standalone systems.

- GPs receive initial and on-going training in digital diabetes tools; endocrinologists/diabetologists receive on-going training but not initial training; diabetes nurses appear to receive no training on digital diabetes tools.

- Covid-19 led to far more rapid decision-making in Belgium, in enabling tele- and video-consultation and allowing the sending of prescriptions via email or SMS. However, there are concerns about whether these changes will persist beyond the immediate response to covid-19.

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Country profile: Denmark

A strong overarching digital health strategy and an early adopter of electronic health records. Denmark includes digital technology in the national action plan for diabetes, but not in the latest clinical guidelines, leading to variable uptake across regions.

■ Denmark
High (score 66.1-100)
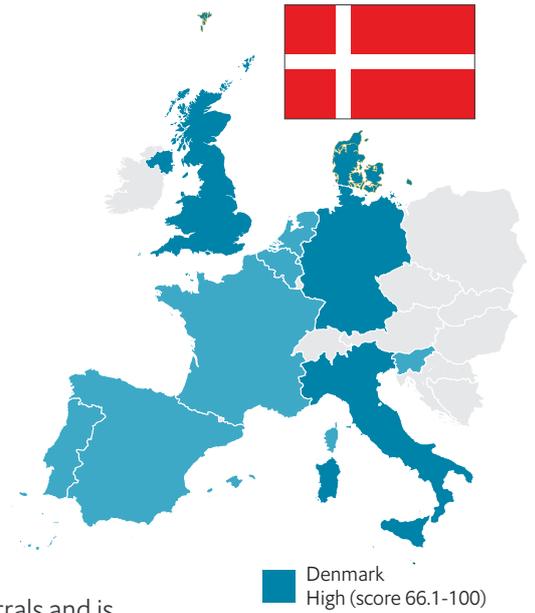
Background and disease trends

Denmark has an 8.8% diabetes prevalence rate, and prevalence more than doubled between 2000 and 2016. By 2030 the number of projected cases will be 430,000, and an estimated 60,000 people will have undiagnosed Type 2 diabetes and 300,000 will have pre-diabetes. The disease costs an estimated 31.8 billion DKK.[83] Incidence is geographically uneven, with the highest annual rate in the towns of Sønderborg and the municipality of Norddjurs.[84]

An early adopter of eHealth, Denmark launched its online health portal in 2003.[85] It offers a central reference point for citizens and health professionals to view medical records. As well as storing test results and other clinical

data, the system enables referrals and is integrated across different areas of the health and social care system. Uptake of eHealth is strong in Denmark with auto-enrolment onto the online health portal at birth and 80-99% of key interactions within the health system (referrals, prescriptions, reimbursement, lab results) shared electronically.[86]

Denmark has a decentralised system that gives its five regional authorities great autonomy in setting policy and decision-making. Most medical devices are purchased via tenders through a regional partnership organisation, Amgros.[87] Reimbursement is based on the Social Service Act, with responsibility for reimbursement shared between regional and

Figure 9: Diabetes prevalence in Denmark
(20-79 y), %
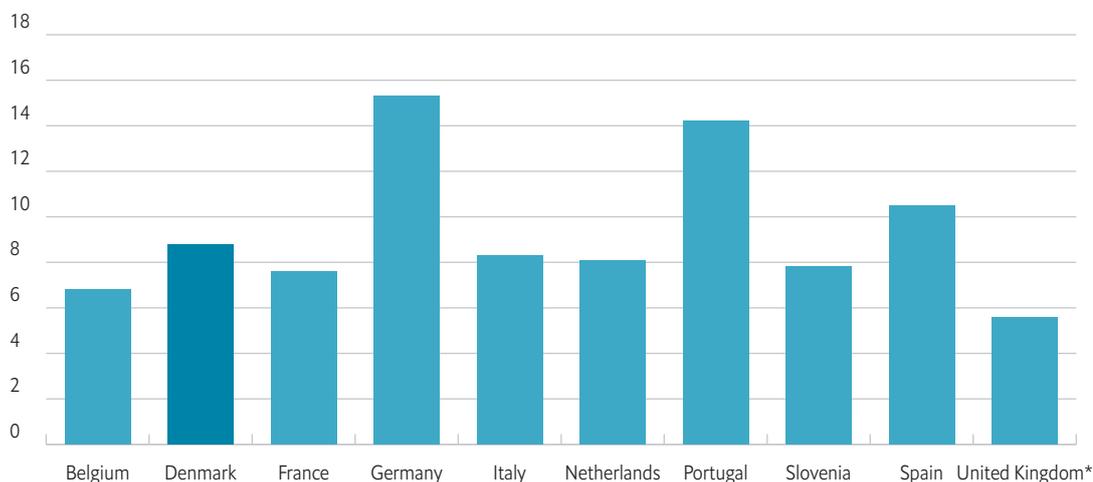
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

municipal authorities. This leads to variation in the availability of and access to digital tools across the country. The Index is firstly based on national-level policy, with evidence of positive regional policy enabling scoring. Therefore answers indicate the existence or availability of policy within Denmark, but do not reflect the variations that may exist between regions.

A survey of people with diabetes in Denmark indicated that a third of them were worried about not being able to manage their diabetes if they became infected with covid-19. However, Denmark was able to rapidly introduce video consulting software into primary and specialist care thanks to its strong underlying digital health infrastructure.

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Table 7: Index summary, Denmark

Overall score (100%)	●
Digital readiness (10%)	●
Digital diabetes readiness (50%)	●
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	●

● High (score 66.1-100)

◒ Medium (score 33.1-66)

○ Low (0-33)

Policy progress

Digital government

- Denmark's public sector digitisation strategy (2016-2020) covers multiple domains including administrative procedures, user experience for citizens and businesses, and data-sharing.[88]

Digital health

- The country has an overarching digital health strategy, covering the 2018-2022 period and led by the Ministry of Health, Ministry of Finance and local and regional governments. Provisions include guidance to develop a common IT infrastructure that interconnects the health system to allow flexible incorporation of local IT solutions. It also calls for a rethink of collaboration across the health system's segments. The strategy's follow-up is anchored in the National Board for Health IT which reviews initiatives related to the strategy.

- Denmark was an early adopter of a national electronic health records system—its National eHealth Portal, called *sundhed.dk*, was launched in 2003 and upgraded in 2009. It provides information for citizens and health professionals, including access to directories of health institutions. The portal brings together information from across the health service, offers a shared communication platform, and provides healthcare providers access to clinical information and medical history.[89]

- The government has put in place eHealth training for medical professionals since its first eHealth action plan.

- The Danish Health Authorities stopped performing national-level HTA for medical devices in Denmark in 2012, moving towards a regional level evaluation as part of procurement protocols. National-level HTA is only used for pharmaceuticals, carried out by Medicinrådet and Amgros. These institutions have stated plans to use HTA for medical devices, leading to the the creation of a Treatment Council at regional level that assesses the cost and clinical benefit of medical devices.[90,91]

Digital diabetes

- Denmark published a national action plan for diabetes in 2017 to improve preventive efforts and early detection and ensure adults and children receive individually targeted treatment. It includes a recommendation for doctors to prepare a "course plan" (Forløbsplan) for people with diabetes; an electronic tool used to jointly organise the individual treatment and rehabilitation process. The plan also states that all children and young people with diabetes have the right to use flash glucose monitoring systems.

- There is no single, national standardised reimbursement pathway for digital diabetes tools, as the healthcare system is decentralised with regional hospitals making choices on whether to subsidise therapies. Based on current legislation, it is unclear whether regions or municipalities are mandated to cover a certain tools. Evidence suggests that regions reimburse digital diabetes tools that show significant impact on an individual's functioning at home or work. For each tool, people with diabetes can send in an application via borger.dk, which is a digital gateway for citizens to communicate with the state and local authorities. Each municipality offers products and tools from a specific supplier.

- The latest national clinical guidelines for Type 2 diabetes, published in 2015, do not mention digital diabetes tools and the interpretation of the Social Services Act varies across municipalities. The penetration and popularity of digital diabetes tools thus differs across regions.

- Denmark is in the minority of countries in the Index with a diabetes registry, to which all outpatient clinics have been obligated to report since 2004 (see box 1).[92] The Danish Adult Diabetes Registry (DADR) provides data from primary and secondary (specialised outpatient clinics) providers to assess treatment quality. It is funded by the Danish Regions and administered by the Danish Clinical Registries (Regionernes Kliniske Kvalitetsudviklings Program).[93] The registry is run by a steering committee drawn from both primary and secondary sectors from the country's five regions, and from the Danish Diabetes Association. Another data initiative, the Danish Centre for Strategic Research in Type 2 Diabetes (DD2) project, was established in 2010

to provide an international resource for diabetes research through establishing a nationwide data-rich cohort and a linked biobank of DNA, blood and urine.[94]

Box 1: The Steno Centres – testing grounds for digital innovation

The five Steno Diabetes Centres (SDC) were established as the result of a public-private partnership between the Danish health system and the Novo Nordisk Foundation. The Steno Diabetes Centre Copenhagen opened in 2017. Its state-of-the-art facilities and active clinical research efforts are supported through a mix of public and private funding, with the aim of continually improving the quality of diabetes care the centre provides.

There are strong digital components to the SDC approach. In the North Jutland centre, 25% of treatments are based on digital health and telemedicine, and digital health is explored as an option in all treatment and prevention programmes where possible.[95]The Steno Diabetes Centre Odense includes in its blueprint plans for developing digital meeting infrastructure to foster collaboration with regional and external partners and to contribute to data-sharing among hospitals, municipalities and general practice, such as through creating joint diabetes databases.

Steno personnel are also contributing to academic literature on optimal product design in digital diabetes; one published case study explored the benefits of 'design thinking' – which more actively integrates user feedback – into the development of a mobile app for self-management for people with newly diagnosed diabetes.[96]

The SDC is also contributing to capacity-building globally, such as a project with the Malaysian Ministry of Health to educate primary care doctors and nurses on the fundamentals of clinical diabetes care using a competency-based approach that blends e-learning and classroom-based instruction and which could serve as a foundation for more e-learning and continuous education of diabetes professionals as a whole.[97] The Steno approach shows that targeted funding can help create test beds to explore and utilise digital diabetes tools to then share practices, tools and insights within the country and beyond it.

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Country profile: England

NHS England has a strong digital health institutional capacity, proactive diabetes data collection efforts through a national audit initiative. Digital diabetes tools are recommended in clinical guidelines and broadly reimbursed, improving uptake and access.

England
High (score 66.1-100)
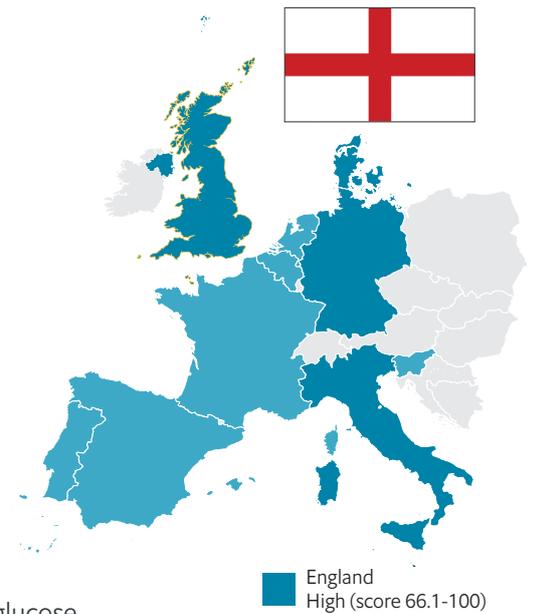
Background trends

England is the largest of the four devolved nations of the United Kingdom (UK). The UK has an adult diabetes prevalence of 5.6%, which is the lowest of all the European countries in this study. Diabetes is the most common reason for end stage kidney disease and the most common cause of blindness in people of working age in the country. There are also challenges in managing higher Type 2 diabetes risk in south Asian and black communities where incidence is higher.[98] Hospital activity related to diabetes treatment costs an estimated £3.5 billion per year, over 10% of the NHS hospital budget.[99] Every week, diabetes leads to over 160 amputations, 680 strokes, 530 heart attacks, almost 2,000 cases of heart failure and more than 500 premature deaths.[100]

NHS England approved flash glucose monitoring systems for use in 2017, but the charity Diabetes UK discovered that people with diabetes were having difficulty accessing this technology.[101] Mobilising thousands of people with diabetes to contact their member of parliament and local NHS managers led to NHS England rolling out national access with detailed eligibility criteria linked to funding, thus improving access to this digital tool for people with diabetes. The UK's NHS Apps Library evaluates health-related apps to point healthcare professionals and the public to apps that meet their quality standards and indicates which are reimbursed. The library is structured around 17 key diseases, including diabetes. In August 2020 there were 16 diabetes-specific
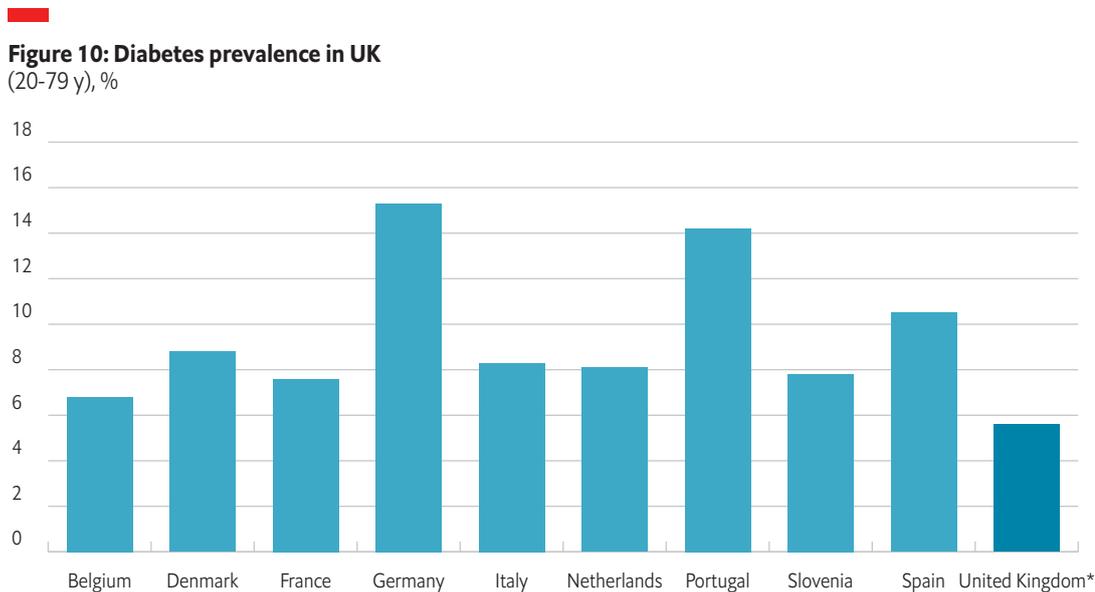
Figure 10: Diabetes prevalence in UK
(20-79 y), %

*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

products, 11 of which are reimbursed. While the library stands out for its comprehensive standards, there is not enough awareness among those in the diabetes community about the platform, according to experts.

England continues to be hard hit by covid-19. Experts indicate uneven engagement with digital technology, with some providers quickly adopting new digital platforms and tools, and others yet to introduce telephone consultations. Routine eye screening and foot checks have been postponed in many areas, meaning that complications could arise further down the line.

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Table 8: Index summary, England

Overall score (100%)	●
Digital readiness (10%)	●
Digital diabetes readiness (50%)	●
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	●

● High (score 66.1-100)

◗ Medium (score 33.1-66)

○ Low (0-33)

Policy progress

Digital infrastructure

- The UK Government Transformation Strategy (2017-2020), building on a previous plan dating to 2012, aims to strengthen the country's digital capabilities by improving citizen-facing services and government administration.[102]

- England is one of the top three performers of the Index group in terms of the extent of the provision of eHealth training for diabetes-related professionals, both pre and post-qualification.

Digital health

- England adopted a national digital health strategy in 2012 and a national health information system (HIS) policy in 2014.[103] The country has a mixed record in digitisation overall. The GP sector in England, for instance, began digitising in the 1980s and was nearly 100% digital by the mid-2000s, but an ambitious effort to digitise secondary care, launched in 2002, was shut down in 2011 having failed to achieve its goals.[104] The infrastructure and IT backbone used by the NHS is also still liable to glitches and crashes, according to experts.

- The general public do not have comprehensive access to their EHRs, which are also not fully integrated across primary and secondary care, leading to frustration for people with diabetes, such as having to answer the same questions about their care and condition.

- NHS Digital is the entity charged with driving technological transformation of health and social care and promoting the use of digital technology in the NHS and NHSX is a more recent unit, formed in 2019, to quicken the adoption of technology in the health and social care system.

- The National Institute for Health and Care Excellence (NICE), founded in 1999, has developed standards to ensure that new digital health technologies are clinically and cost effective. These help commissioners make informed decisions, and inform companies about how the NHS makes decisions and about the standards of evidence expected of different technologies. NICE is in the process of developing guidelines about digital and mobile interventions in terms of behaviour change, including weight management.

Digital diabetes

- NHS England has a national diabetes prevention plan focused on reducing incidence of diabetes, reducing incidence of complications and tackling health inequalities associated with diabetes.

- The National Diabetes Audit (NDA) measures the effectiveness of diabetes healthcare against NICE clinical guidelines and standards in England and Wales. Run by NHS Digital and Diabetes UK, it collects and analyses data and produces reports for stakeholders to improve the quality of services and health outcomes.[105] Its review domains

assess diabetes register coverage, levels of care received and whether treatment coverage is consistent among people with diabetes.[106]

- Clinical guidelines exist for both young people and adults, covering Type 1 and Type 2 diabetes; they recommend the use of insulin pumps and real-time glucose monitoring systems, with additional advice to educate people with diabetes on how to address their blood glucose levels.

- Digital tools available through the NHS including glucose monitoring systems (real-time and flash), insulin pumps and smartphone applications. Only smart insulin pens lack reimbursement pathways. However, access to technologies remains uneven. Real-time glucose monitoring systems, for instance, have access rates that range from 6% to 60% across different parts of the country, according to Diabetes UK. Clinical Commissioning Groups and NHS Trusts lack clear guidelines for who qualifies for reimbursed access. Differences between technologies also stem from authorisation: GPs can prescribe flash monitoring systems, but secondary care providers are needed for real-time glucose monitoring systems.

- Multiple organisations are involved in the promotion of diabetes care, healthcare worker education and best practices—including Diabetes UK, The Primary Care Diabetes Society and the Association of British Clinical Diabetologists covering tools like flash

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and real-time glucose monitoring systems. The private sector also participates in education; medical device manufacturer Abbott runs the online Freestyle Libre Academy, which offers people with diabetes and healthcare professionals training about how to use the glucose monitoring systems.

Box 2: Digitising diabetes prevention programmes

England launched a support programme in 2016 for people at high risk of Type 2 diabetes, offering face-to-face, tailored help, including on education and lifestyle, weight reduction and bespoke physical activity programmes. A technology component has since been added to introduce digital interventions like exercise-monitoring wearables, health coaching via an app, online peer support and goal-monitoring. Expansion is being piloted across eight regions through a 12 month trial involving 5,000 people.[107]

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Country profile: France

A strong culture of citizen-government digital interaction, with a national plan to support health system interoperability. France has yet to integrate digital technology into national diabetes plans or national clinical guidelines.
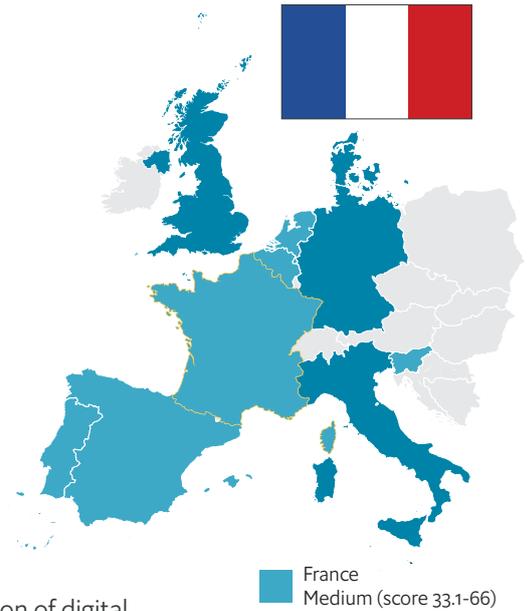
Background and disease trends

France has an adult diabetes prevalence of 7.6%, middling amongst the sample of countries in this Index. Demographically, there is a high prevalence of poorly controlled diabetes in migrants and there has been an increase in the incidence of Type 1 diabetes in children in both sexes and in all age groups.[108,109]

Although France's health system is generally recognised as providing a high quality of care, the state of its digital health infrastructure has not always matched its healthcare provision. It has seen rapid improvement to its digital health system since 2010 with a concerted policy drive. Its 2019 digital health plan builds upon this progress and is ambitious

in setting out the future direction of digital health infrastructure in France, with a focus on integration, interoperability and strong centralised governance.[110] Telemedicine has been fully reimbursed since 2018, with 2019 seeing its further roll-out to pharmacists, medical assistants and nurses. In spite of reimbursement, uptake of telemedicine had been limited until the covid-19 lockdown that led to a dramatic rise in the number of teleconsultations taking place.

Teleconsultations in France rocketed tenfold during the pandemic, supported by full reimbursement that was introduced as a temporary and exceptional measure.

France
Medium (score 33.1-66)

Figure 11: Diabetes prevalence in France
(20-79 y), %
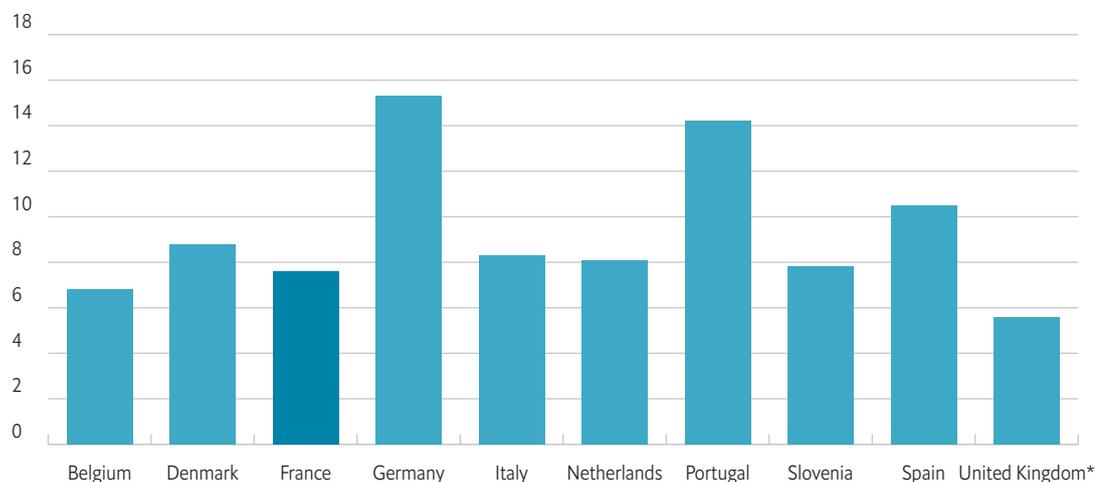
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Whether this reimbursement and the uptake it supported will continue beyond the immediate crisis remains to be seen.

Policy progress

Digital government

- France's national digital government plan is *Action Publique 2022 Concerted Development of the Territorial Digital Administration* (2018-2020). It seeks to build a common foundation for applications, digital tools and data; to ensure shared governance of digital transformation between state and local authorities; to apply data across public service provision and to facilitate the scaling up of digital administration.

- France exceeds European Union averages for the overall level of digital interactions between citizens and government, and it has launched

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Table 9: Index summary, France

Overall score (100%)	◓
Digital readiness (10%)	●
Digital diabetes readiness (50%)	○
Digital diabetes incentives and payments (40%)	◓
Digital diabetes overall readiness (100%)	◓

● High (score 66.1-100)

◓ Medium (score 33.1-66)

○ Low (0-33)

multiple digital platforms in areas including eJustice and government payments.[111] In early 2019, the government launched *Techgouv*, a roadmap to accelerate the digital transformation of public services.[112]

Digital health

- Multiple institutions are responsible for digital health in France, under the supervision of the *Agence régionale de la santé* for each region and the French Ministry of Health. These include a dedicated digital health agency (*Agence du numérique en santé, ANS*), which supports the digital transformation of healthcare through three main missions: regulating eHealth through mandatory frameworks and best practices, including security and interoperability; carrying out projects in the national interest and; supporting the national and territorial deployment of digital health tools and projects to develop uses and encourage innovation.

- The Health Data Hub links health databases and facilitates their use by research and development teams with respect to data privacy.

- France has a national strategy to ensure health system interoperability, under the *Strategy Nationale e-Santé 2020* (2016), and the ANS works with IHE International, a health data harmonisation initiative, to define standards that facilitate sharing of health data. The Health Information Systems Interoperability Framework sets out the rules for communicating health informatics. The CI-SIS is a reference

document which offers technical and semantic rules to those carrying out projects involving the exchange and sharing of health data. In practice it is proving difficult to harmonise procedures, with digital information often not moving smoothly from hospital to hospital when different software is being used.

- The digital health department (*delegation du numérique en santé*) was launched in December 2019 to accelerate the digital transformation of health. It also publishes interoperability and security national standards for digital tools in health.

- The reimbursement pathway for medical devices is evaluated by the *Haute Autorité de Santé* (HAS), then a price negotiation with the *Comité Économique des Produits de Santé* (CEPS). In the future, digital tools are likely to have to go through an assessment to ensure they comply with security and interoperability standards.[113]

- The national healthcare card/system created in 1998 allows French residents to obtain reimbursement entitlements with health-related products and services seamlessly. The *Vitale* card is a smart card containing administrative information for medical care providers; reimbursements are made through a network connecting health establishments, doctors and pharmacists, with Health Insurance Funds.

- Digital tools are included in HTA processes for medical devices with HAS and IENAS (*L'instance Nationale de l'evaluation et de l'accreditation de la Santé*).

Digital diabetes

- Diabetes is part of the national health plan (2018-2022), including awareness-raising activities like diabetes prevention week and 'say no to diabetes', which focuses on high-risk populations.[114,115] The plan does not specifically cover digital diabetes and digital diabetes technologies are not recommended in the national clinical guidelines.

- The ETAPES programme is a pilot project to support telehealth and telemonitoring in a number of priority health areas, including diabetes. It provides specific funding for implementing telemonitoring, demonstrating a recognition of the value of telemonitoring and a desire to see its wider use within the French health system.[116] The President of the French Diabetes Association, Professor Charles Thivolet, has reported that the number of people with diabetes using telemonitoring has increased by 81% in less than a year thanks to the ETAPES programme.[117] Professor Thivolet has stated that he believes important next steps in digital diabetes are the need to ensure digital diabetes tools are interoperable and that reimbursement is sufficient to prevent it being a barrier to use. Following the impact of covid-19

on service delivery, the ETAPES eligibility criteria for telemonitoring have been expanded, making digital diabetes tools available to more people with diabetes and includes reimbursement covering telemonitoring and therapeutic support.[118]

- Digital tools are included in reimbursement pathways for medical devices once they are approved by the HAS. The HAS approved the Diabeloop closed-loop system, with discussions around reimbursement on-going, demonstrating that this is an ever-evolving area.[119]

- Making high-performance digital tools available to everyone is one of the priorities defined in the Ministry of Solidarity's and health in *Ma Santé 2022* plan.[120]

- The CNAO (*Collectif National des Associations d'Obèses*) is working in partnership on the design of the obesity component of the Care4Today platform, which aims to support people with diabetes and their caregivers throughout the care journey to stay informed, engaged and connected with their team of multidisciplinary health professionals. The platform also offers education and follow-up programmes to support people with diabetes throughout the care journey.

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Country profile: Germany

A strong performer in digital government overall, and a policy leader in its recent policy action to enable the reimbursement of apps. Germany's main weakness is its lack of a joined up digital health infrastructure, underpinned by a national Electronic Health Records system. Recent policy reform promises to accelerate digital health in the coming years.

Germany
High (score 66.1-100)

Background and policy context

Germany's diabetes prevalence is 15.3%, the highest in the group with over 10 million people forecast to have the condition by 2040 according to one projection.[121] There are large regional variations across states, by disease indicators (e.g. HbA1c, hypoglycaemic events) and treatment levels.[122]

The country's key institutions include the German Diabetes Center, the Federal Ministry of Health, the Federal Ministry of Education and Research, the German Diabetes Association, the German Center for Diabetes Research and the German Research Foundation.[123]

Efforts to introduce an EHR system began in 2005, but as of 2020 a single, national system

is not in place.[124] Slow decision-making and patchy implementation have been a source of criticism. The Appointment Service and Supply Act was enacted in 2019 to elevate Germany's overall position in digital healthcare regionally and globally. The Act enables the reimbursement of health-related apps and specifies that health funds must bring in EHRs by 1 January 2021. It has been followed up by specific legislation such as the draft Patient Data Protection Act.

The German Diabetes Society has also been influential in promoting digital diabetes through its digitisation commission, which is currently supporting the development of an electronic diabetes record (eDA).[125] The society also

Figure 12: Diabetes prevalence in Germany
(20-79 y), %
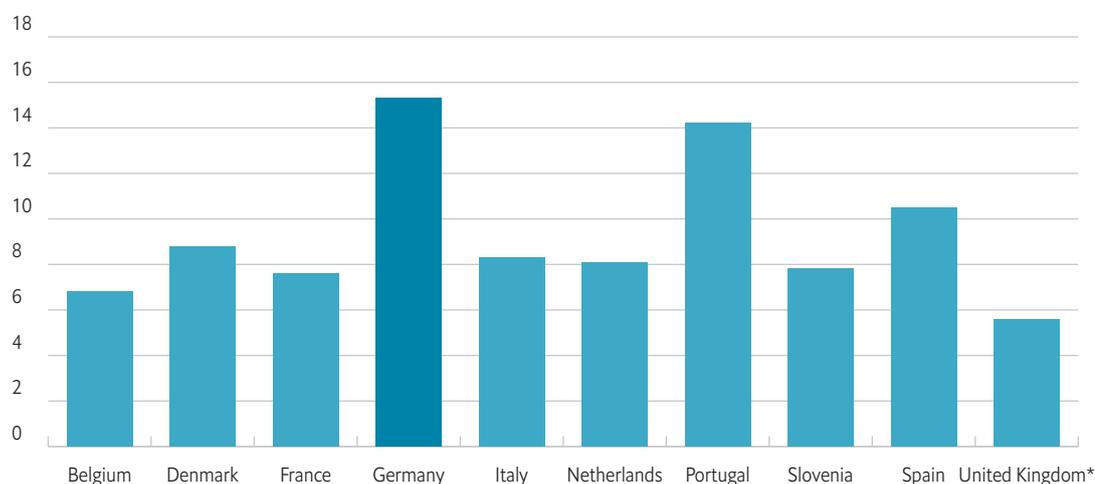
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

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runs training on digital healthcare for various healthcare professionals.

Recent digital health legislative and policy reforms have yet to impact on immediate diabetes care. For example where electronic prescriptions have not yet been implemented, people with diabetes reported having to physically go to collect their insulin and medication from pharmacies.

Policy progress

Digital infrastructure

- Germany's national eGovernment strategy (NEGS), adopted in 2010, aims to unify eGovernment activities at federal, state and local levels. It is evaluated and updated within the context of the 2017 Tallinn Declaration on eGovernment, an EU-wide political commitment on ensuring high quality, user-centric digital public services for citizens.

Table 10: Index summary, Germany

Overall score (100%)	●
Digital readiness (10%)	●
Digital diabetes readiness (50%)	●
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	●

● High (score 66.1-100)

◖ Medium (score 33.1-66)

○ Low (0-33)

Digital health

- E-health was officially introduced into German policy in 2003 and added as a pillar of Germany's Digital Agenda (2014-2017).[126,127]

- In 2010, the Federal Ministry of Health launched the "eHealth-Initiative", uniting key players (doctors, insurers together with the Fraunhofer Gesellschaft and key industry players) around the goal of identifying existing barriers to telemedicine deployment.[128] Germany includes regional bodies in the development of its eHealth governance approach.[129]

- The Department for Digitalisation and Innovation (*Abteilung für Digitalisierung und Innovation*) was established in 2018; it is located within the Federal Ministry of Health (*Bundesministerium für Gesundheit*) and is charged with oversight for digital health.

- Overall digital health infrastructure remains fragmented, with isolated solutions but no fully organised ecosystem with interoperability, according to experts.

- Germany has taken steps to enhance health data interoperability, including through a 2011/2 regulation to enable the collection and processing of data from the country's statutory health insurance funds.[130,131] In 2014 the Federal Ministry of Health published an interoperability planning study which examines interoperability within the health system and proposes measures for improvement.

Readiness for digital diabetes care

- Germany published a national diabetes plan in 2020 and its clinical guidelines mention digital diabetes tools. Given the national diabetes plan was only recently published, it will take time for people with diabetes and healthcare professionals to see an impact. As such, implementation of that plan is limited at the time of writing.

- Germany has a national diabetes registry.[132]

- While general practitioners' training does not explicitly cover digital diabetes tools, individual universities do set out details in their own curricula. Specialist degrees in internal medicine, endocrinology and diabetology include digital diabetes tools. Diabetes-related special training for nurses includes management of technical devices and aids. Healthcare companies also run seminars. Training and education on digital diabetes is also offered by the German Diabetes Society; it runs an organisation called *Arbeitsgemeinschaft Diabetes & Technologie* (AGDT), which promotes the use of modern technology for diabetes.

- The *Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen* (IQWiG) examines the benefits and harms of drugs, treatments, diagnostic methods and clinical guidelines, including digital tools. Digital diabetes tools are comprehensively covered by Germany's mandatory health insurance system. Under the Digital Healthcare Act (DVG) act, digital tools—including apps—can be prescribed by doctors and the cost of them is covered by statutory health insurance.[133]

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Country profile: Italy

Digital technology is included in the national diabetes strategy and clinical guidelines. Reimbursement pathways are present for most key digital diabetes tools, although regional variation in tendering processes for medical device purchasing may impact on access. A national health information system is in place, with governing frameworks.

Italy
High (score 66.1-100)
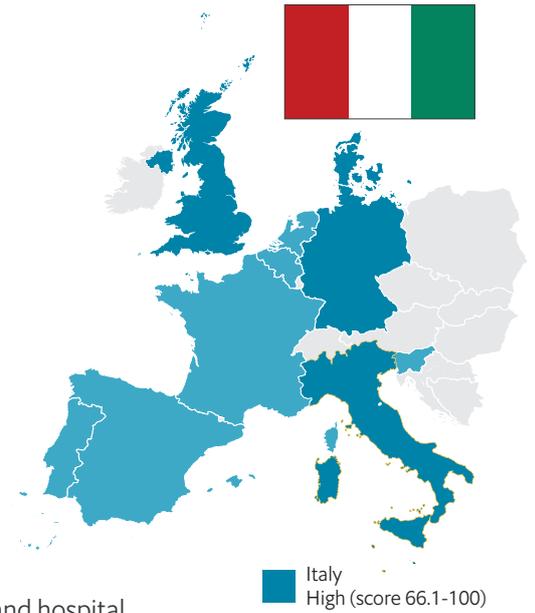
Background trends

Italy has an adult (20-79) diabetes prevalence of 8.3%, which is mid-level for the Index group. The country saw a significant jump in incidence between 1980 and 2013, with crude prevalence rising 115% in men and 45% in women, driven mostly by the ageing population. The prevalence of overweight and obesity, which are both diabetes risk factors, increased less steeply than the diabetes rate over this period. The rise is mostly affecting the elderly, low-educated males, and high-educated women.[134]

Italy's expenditure on diabetes is estimated at €10 billion per year.[135] Research shows that the country stands to benefit significantly from greater utilisation of digital tools: one study found that telemedicine, for instance,

can reduce ambulatory visits and hospital admissions related to diabetes.[136]

Italy's highly decentralised system gives regional authorities great autonomy in setting policy and decision-making. The Index is firstly based on national-level policy, with evidence of positive regional policy enabling scoring. Therefore answers indicate the existence or availability of policy within Italy, but do not reflect the variations that may exist between regions.

Italy was among the European countries worst-hit by covid-19. The crisis saw an increase in uptake of digital health, but highlighted issues around the connectedness of systems in a highly regionalised system. One analysis of

Figure 13: Diabetes prevalence in Italy
(20-79 y), %
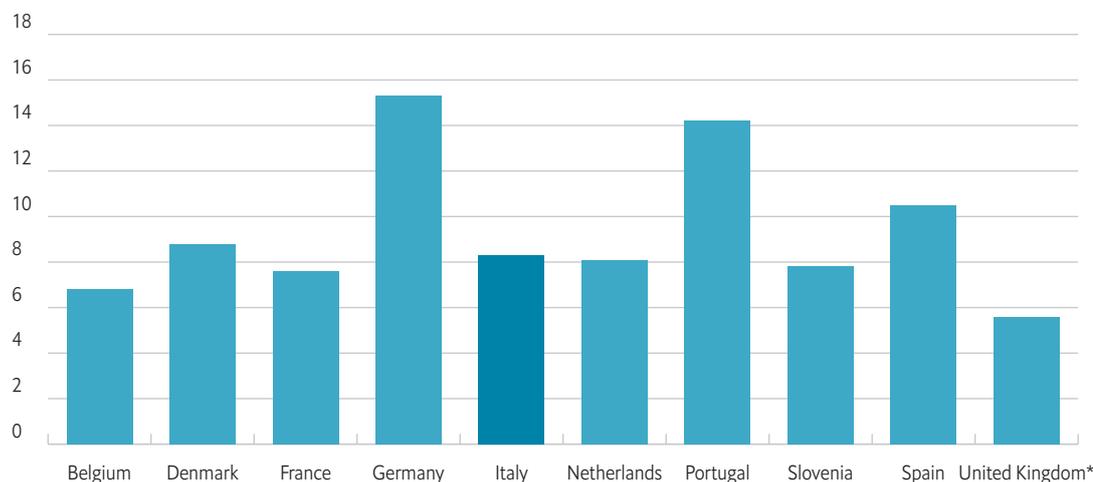
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

real-time glucose monitoring data before and during lockdown saw no significant difference in outcomes, so the impact of the pandemic and lockdown on diabetes remains to be seen.

Policy progress

Digital infrastructure

- Italy's national eGovernment policy, the Italian Digital Agenda (2014-2020), led by the Agency for Digital Italy, combines legislative measures and operational plans to enhance digital connectivity overall, while a three-year plan to increase the utilisation of IT in public administration is fostering the development of a shared model for managing and using digital technology in government. Italy has a strategic plan (*Italia 2025*) for the digitisation of the country (2020-2025), developed and led by the Ministry of Technological Innovation and Digitisation.[137]

Table 11: Index summary, Italy

Overall score (100%)	●
Digital readiness (10%)	●
Digital diabetes readiness (50%)	●
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	●

● High (score 66.1-100)

◖ Medium (score 33.1-66)

○ Low (0-33)

Digital health

- Italy has a national health information system (HIS) strategy and a national EHR system used in primary, secondary and tertiary facilities, and a legal framework covering digital health services, covering issues including jurisdiction, liability, reimbursement and remote monitoring.

- Digital health policy is delivered through pacts between regional authorities and the national government, with more strategic policy making led by the Directorate General of Health Planning and the Directorate General of Digitisation at the Ministry of Health. Italy is rare among European countries in having local/regional bodies involved in eHealth governance.[138]

Digital diabetes

- Italy's first National Diabetes Plan was issued in 2012, in response to a European Parliament resolution; it includes an objective to promote technology use, including outlining selection criteria for the use of pump therapy and more complex technologies like sensors for real-time blood glucose monitoring. It also advocates training in the correct use of tools like glycaemic self-monitoring.

- Italy's first National Chronic Disease Management Plan was issued in 2016; it includes an objective to promote digital health in chronic care, implementing telemedicine and creating a "reinforced Chronic Care Model", based on integrated platforms and supported by eHealth technologies.

- National clinical guidelines recommend the use of digital tools, including supporting the use of digital retinography in initial screenings and for the uptake of devices to detect interstitial glucose levels.

- Italy has regional diabetes registries, but is lacking a registry with nationwide coverage.

- Italy has a reimbursement pathway for all digital diabetes tools examined in this study, except for closed-loop insulin delivery systems. Most tools are free and prescribed by the diabetes services on the basis of national guidelines or regional provisions. Apps for connecting with diabetes services to share data are provided free of charge by companies.

- Italy's medical device purchasing is based on tenders, set by regional purchasing centres in alignment with the "Essential Levels of Care" (LEA) set by the National Health Service (SSN), the reimbursing agency.

- Most training in digital healthcare in Italy is offered outside of structured academic degree programmes; it exists in the initial and on-going training for GPs and endocrinologists but does not exist in the initial training of diabetes nurses. However, it is available in on-going training provided by a combination of universities, scientific institutes of the national health service and other public bodies, scientific societies and professional associations— as well as some private companies.

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Country profile: the Netherlands

A national eHealth strategy with specific quantitative goals and the active participation of diabetes advocacy groups in promoting awareness of digital diabetes tools. Uneven training in digital diabetes for relevant health professionals and mixed reimbursement coverage levels, especially for newer technologies.

The Netherlands
Medium (score 33.1-66)
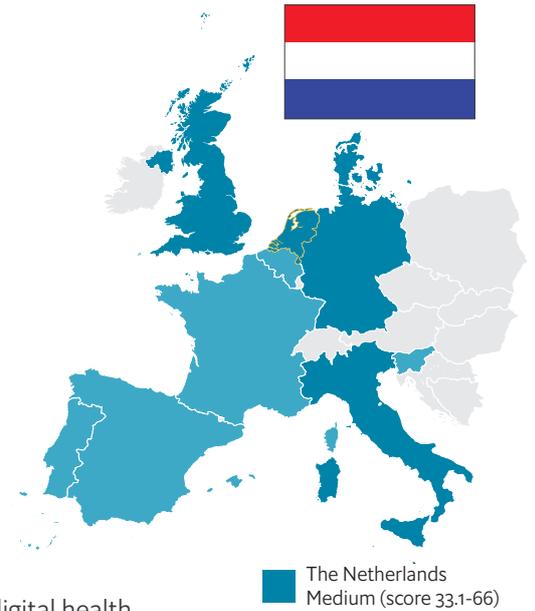
Background trends

The Netherlands has an adult diabetes prevalence rate of 8.1%.[139] While Dutch diabetes care is considered high-quality, thanks in part to a multidisciplinary approach, challenges have been identified including high levels of standardisation approach which may lead to a one-size-fits-all; and the overall cost impact of diabetes care on individuals, families and societies is high.[140]

The Dutch government began its journey to implementing a national EHR system in 2005. Its success has been attributed to a combination of national government led strategic implementation, with local and regional innovations.[141] The government has

provided specific support to digital health innovators through its *Zorg voor innoveren* programme, which provides advice to developers and financial support.[142] EHealth weeks held annually also help to raise awareness of digital health tools amongst healthcare professionals and the general public.

All Dutch citizens are required to purchase basic health insurance that reimburses the cost of treatments, but for those treatments—including digital diabetes tools—falling outside of this basic health insurance package, reimbursement decisions are made by individual insurers. Currently

Figure 14: Diabetes prevalence in the Netherlands
(20-79 y), %
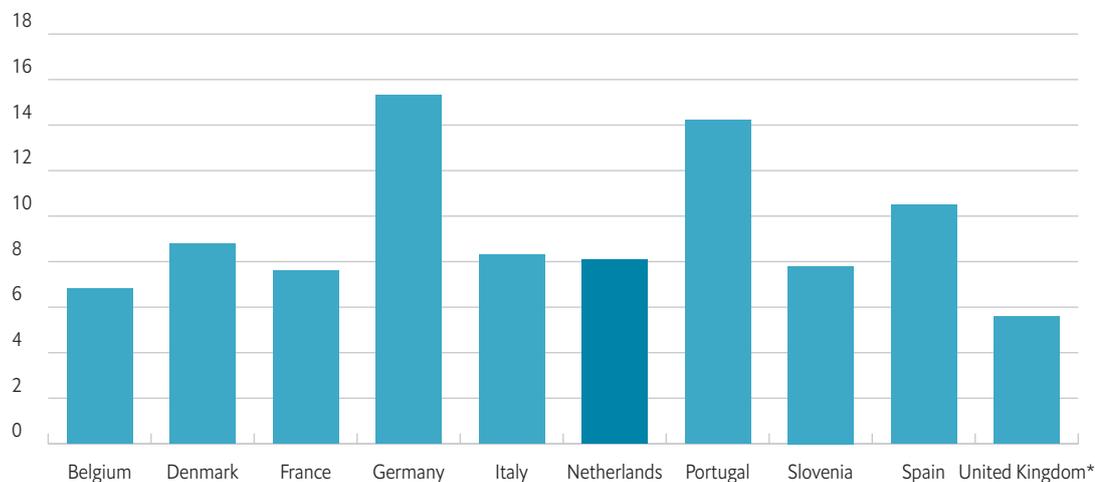
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

medical devices—including the digital diabetes tools included in this project—are classified either as medical aids or medical care, which affects whether they are included in the basic health insurance package. The *Zorginstituut*—the Dutch National Health Care Institute—has recommended that from January 2021 diabetes tools such as insulin pumps be reclassified to be included in the basic healthcare package.[143] This is as a result of research undertaken by the *Zorginstituut*, which found that a lack of reimbursement was leading to people with diabetes not being able to access key medical devices.[144] However, its decentralised system means that there is variation, especially when it comes to the purchasing of medical devices via tender and their reimbursement. This Index is based on national-level policy, with evidence of positive subnational policy enabling scoring. Therefore answers indicate the existence or availability of policy within the Netherlands, but do not

—

Table 12: Index summary, the Netherlands

Overall score (100%)	◓
Digital readiness (10%)	●
Digital diabetes readiness (50%)	○
Digital diabetes incentives and payments (40%)	◓
Digital diabetes overall readiness (100%)	◓

● High (score 66.1-100)

◓ Medium (score 33.1-66)

○ Low (0-33)

reflect the full range of variations that may exist between different insurers.

2020 had already seen a policy push in digital healthcare, as covid-19 provided greater impetus to accelerate roll-out. The Netherlands saw a new covid-19 hospital information system implemented in 95% of hospitals to enable data sharing as people moved hospitals and care settings, as well as the introduction of video consultation software.

Policy progress

Digital government

- The Netherlands has a digital government program dating to 2017 focusing on issues including digital public services, improving user-friendliness, encryption and security and raising digital literacy. The country has steadily improved its digital governance since 2015 with reforms including open public data initiatives and enhancements of the citizen eGovernment portal (*MijnOverheid)*.[145]

Digital health

- The national eHealth strategy, dated to 2014, incorporates specific goals including ensuring that 80% of chronically ill people have direct access to their health and medical data; 75% of chronically ill and older people should be able to perform certain kinds of self-examination; and people receiving medical care at home should be able to communicate with professionals at all times via teleconferencing. Additional government efforts include an annual survey monitoring usage the of eHealth services.[146]

- The country has a national health information system strategy and an EHR system in place which is used by primary, secondary and tertiary care facilities.

- The government, in collaboration with healthcare administrators, runs the Health Information Council which is aiming to build an integrated health information system through introducing standardised information exchanges and one-time registration of people's data to create a unified language. There is no detailed strategy document laying out this work, but there are target documents.

- eHealth training is available in health sciences courses and post-qualification training.

- The Healthcare and Youth Inspectorate (*Inspectie Gezondheidszorg en Jeugd*) has evaluated the benefits and harms of eHealth and digital tools since the early 2010s and the Dutch Healthcare Authority (*Nederlandse Zorgautoriteit*) indicates which e-health tools can be used by healthcare providers and covered by insurance.

Digital diabetes

- The Netherlands' most recent plan for diabetes was published in 2017, and the Ministry of Health, Welfare and Sport published a national prevention plan in 2018 focusing on unhealthy behaviours including smoking, obesity and alcoholism. It also targets diabetes through the 2diabeat programme.[147] Digital diabetes was not specifically covered in the national plans.

- None of the country's national clinical guidelines for diabetes recommend the use of digital tools specifically; the 2018 guidelines on Type 2 diabetes do mention that a small portion of people with diabetes use digital tools for education and self-management purposes, but it does not explicitly recommend them.

- Training in digital diabetes tools is uneven; endocrinologists and diabetologists receive both initial and on-going training, but GPs only receive on-going education and we identified no evidence of specific training on digital tools for diabetes nurses.

- The Netherlands has a mixed reimbursement pathway across the set of tools examined; real-time and flash glucose monitoring systems and insulin pumps have pathways in place but closed loop insulin systems, smart insulin pens and smartphone applications do not.

- The Dutch Diabetes Federation and Dutch Health Institution regularly provide information on digital diabetes tools covered by statutory health insurance and they promote the use and prescription of digital tools. The Dutch Diabetes Federation has also created quality criteria pertaining to, for example, real-time glucose monitoring systems to ensure all healthcare professionals know how to use such methods effectively. They also provide information to people with diabetes about the types of glucose monitoring systems available, and a website, supported by the Ministry of Health,

Welfare, and Sports and the Dutch Diabetes Federation, helps people with diabetes and general practitioners make informed decisions about which glucose monitor suits them best.

Box 3: Tech-driven cost savings

Diabeter is a Dutch-certified clinic, founded in 2006, specialising in providing care for children and young adults with Type 1 diabetes.[147]

The Diabeter model shows that data and technology can simultaneously improve care and lower costs in a semi-autonomous institutional setting. Its database is more integrated than those existing in conventional Dutch hospitals, with a more collaborative approach to data development and management among staff. The clinics gather vast quantities of data, including between two and three million blood sugar points. These are integrated in a system which allows detailed patient profiling and observation, with a dashboard notifying healthcare professionals of abnormalities.[148] The dashboard approach also allows the clinics to realise cost savings by reducing unnecessary in-person consultations, to instead use Skype on occasion. Diabeter performs better than Dutch hospitals and international benchmarks in critical indicators like diabetes-related acute hospitalisations and, by putting more processes into the IT system, it enables nurses to treat more people. Since staffing is a major cost driver, this can reduce expenses.

Henk Veeze, the clinic's founder and medical director, believes the Diabeter model helps overcome one critical obstacle to the adoption of innovation and digital systems in healthcare systems: the absorption of savings into the wider healthcare system, which lowers the incentive of any individual actor to explore more efficient approaches. Semi-autonomous or autonomous specialist clinics such as Diabeter are able to adjust their costs and realise the benefits of savings more directly.

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Country profile: Portugal

Portugal was an early adopter of telehealth, dating back to the 1990s. Its digital healthcare infrastructure is good and it is a strong performer in the regulation of digital diabetes tools but has yet to integrate them into national guidelines or the country's diabetes plan to add a policy imperative to increase uptake.

Portugal
Medium (score 33.1-66)
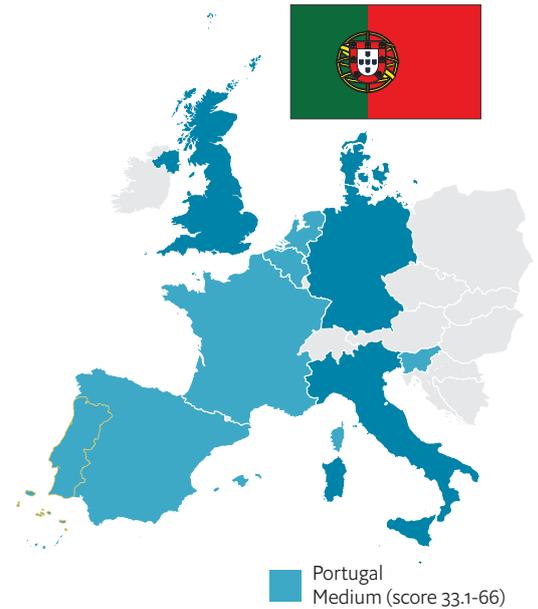
Background trends

Portugal has among the highest rates of adult diabetes in Europe, at an estimated 14.2%, and incidence increased at an estimated 4.29% per year between 1992 and 2015.[150,151]

It has, however, shown a long history in exploring the application of technology to healthcare, with telehealth initiatives dating as far back as 1990 and its first national programme for diabetes control was signed in 1998, much earlier than some other countries in the European region.[152]

Portugal has strong digital government and health infrastructure that is well supported by appropriate legislation and policy. A centralised approach has enabled interoperability and system integration across public and private healthcare providers.[153]

Portugal managed to keep covid-19 cases down despite its proximity to Spain and having the lowest number of intensive care beds in Europe. Digital transformation was already a policy priority for 2020; however, since covid-19 the focus has shifted to finding solutions for transmitting information between people and their medical teams, which is of particular relevance to people with diabetes self-monitoring.

Figure 15: Diabetes prevalence in Portugal
(20-79 y), %
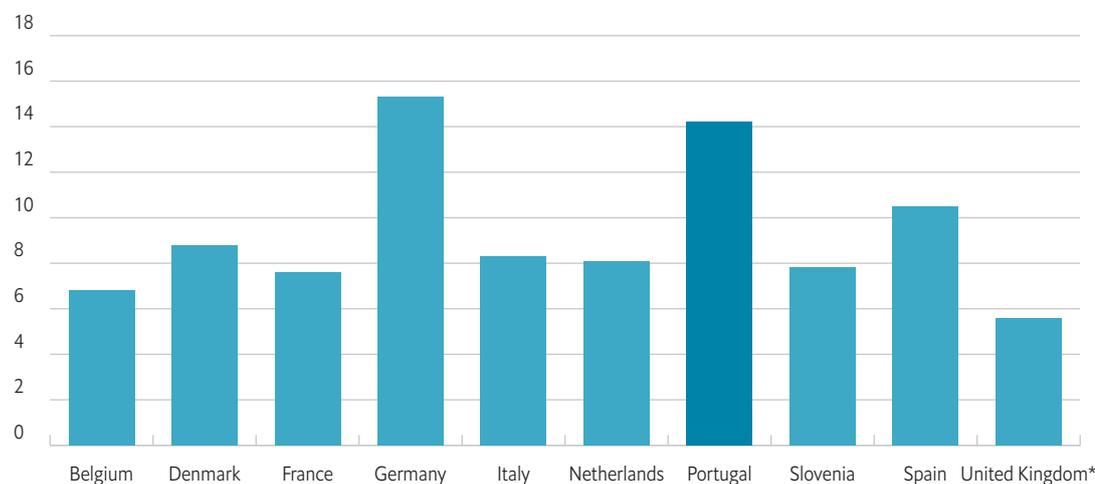
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Policy progress

Digital infrastructure

- Portugal has a national eGovernment plan; the Simplex+ Programme, launched in 2006, is a nationwide effort to co-create new online public services, optimise existing ones and reduce bureaucracy between citizens and public institutions. The country performs weakly compared to European averages in terms of overall digital connectivity levels, including digital literacy skills and use of digital technology by businesses.[154]

Digital health

- Portugal has an overarching national eHealth policy, funded by both national and regional bodies; a European Union assessment ranked the plan as

Table 11: Index summary, Portugal

Overall score (100%)	◖
Digital readiness (10%)	●
Digital diabetes readiness (50%)	◖
Digital diabetes incentives and payments (40%)	◖
Digital diabetes overall readiness (100%)	◖

● High (score 66.1-100)

◖ Medium (score 33.1-66)

○ Low (0-33)

performing well in upholding quality and safety but it scored the plan to be weaker in its emphasis of preventive healthcare which is highly relevant to diabetes.[155] Portugal also, in late 2019, launched a new National Strategic Telehealth Plan (PENTA).[156]

- A 2016 resolution created the National Centre for Telehealth (*Centro Nacional de Telesaúde*), under the umbrella of the Ministry of Health (*Ministério de Saúde*); activities include creating SNS24, the online national health service.

- Portugal has a national health information policy and legislation governing its EHR system and offers eHealth training for professionals both pre- and post-qualification. Although everyone has access to electronic health records, there is a need for better understanding about vulnerable people's level of access and engagement.

- Digital tools are included in its HTA processes, through the agency Infarmed.

- The country would benefit from a clearer policy on medium and long-term solutions to fully integrate digital health systems, to avoid them running in parallel.

Digital diabetes

- Infarmed regulates digital diabetes tools including insulin pumps and flash glucose monitoring systems. It also regulates some apps, and recently encouraged the suspension of an insulin calculation app for falling short of necessary standards.

- Portugal's National Programme for Diabetes outlined goals to be achieved in 2017–2020; in 2019, it promoted an awareness-raising campaign.[157] However, there is no mention of digital tools for diabetes prevention or treatment in the most recent (2017) report on the National Programme for Diabetes.

- National guidelines published by the Portuguese Society of Diabetology do not mention digital tools in their recommendations, although a position paper to update the National Guidelines recommended the National Health Service reimburse flash glucose monitoring systems.[158]

- Training on digital diabetes is mixed for key healthcare professionals involved in diabetes care. Training is available during specialisation for doctors and nurses and as part of their continuing professional development, but not in initial training. People with Type 2 diabetes are more commonly looked after within the primary care system and the access or ease of use of digital tools is more limited and health professionals do not have specific training. Because digital platforms are not fully integrated, they are not used in primary care centres. Different educational institutions offer different training for the use of insulin pumps, for example, which results in uneven skills across the country.

- The National Health Service (SNS) covers digital tools such as flash glucose monitoring systems and insulin pumps through co-payments, if prescribed by a physician. However, the SNS does not cover the use of newer digital tools such as smartphone applications or closed-loop insulin systems. Although the SNS has invested in developing its own apps to facilitate user access to information, checking wait times and the like, none of their free apps deal with diabetes.[159,160]

- APDP is a nationwide institution providing healthcare and a wide range of other services to people with diabetes; it organises training courses for professionals, for people with diabetes, and their families and caregivers to promote better disease management and increased quality of life for people with diabetes.[161,162]

- Covid-19 has accelerated the use of digital tools in diabetes care: all consultations have been taking place over the telephone with people with diabetes able to send information from devices to the health professionals. Portuguese Diabetic Society of Healthcare Professionals is working on guidelines on the topic of teleconsultations to provide guidance about how to develop a mixed model of care in the future.

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Country profile: Slovenia

A rapidly ageing population along with high obesity rates, Slovenia's health system has struggled to uphold optimal care standards in diabetes. It is integrating its health information systems, offers relevant digital diabetes training and formed a diabetes registry relatively early (in 1983). Slovenia has yet to integrate digital diabetes into its national disease strategy or into clinical guidelines.

Slovenia
Medium (score 33.1-66)

Background trends

Slovenia has an adult diabetes prevalence rate of 7.8% and, with one of the fastest-ageing populations in Europe, the problem is expected to worsen in the future without remedial efforts.[163]

Slovenia also has among the highest obesity prevalence rates on the continent.[164] Challenges facing the Slovenian healthcare system include high workload among family physicians and deficient standards of care for people with diabetes.[165]

Slovenia has made good progress in integrating its fragmented digital health infrastructure and has good uptake among healthcare

professionals and the general public, with around 27% of the public using digital health services compared to the EU average of 18%.[166]

Slovenia has taken advantage of the opportunity that covid-19 presented to digital health in order to reduce infection risks for the public and health professionals alike. This has included the rolling-out of phone and video based consultations, and e-prescribing. Experts have pointed to an opportunity to update Slovenia's eHealth strategy in light of covid-19 experiences.

Figure 16: Diabetes prevalence in Slovenia
(20-79 y), %
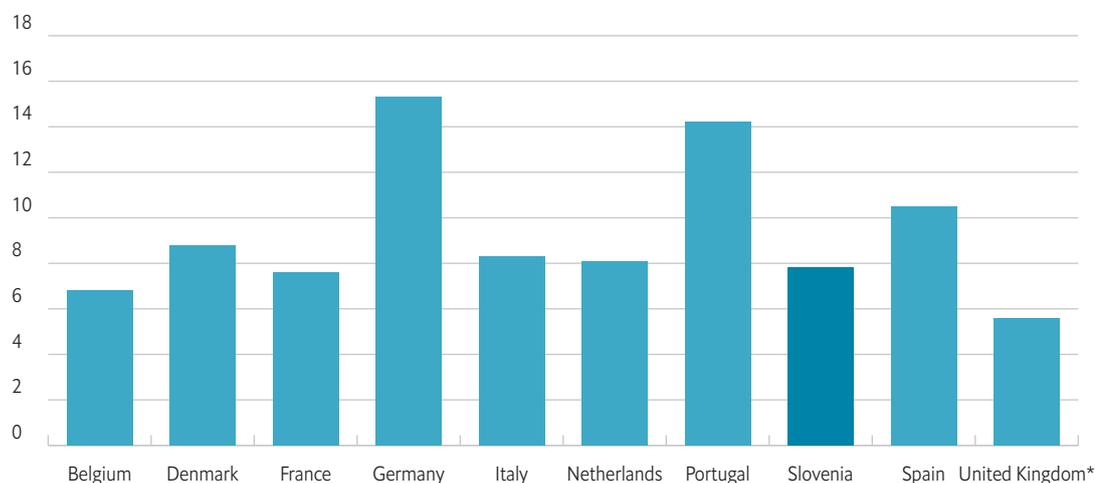
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

Policy progress

Digital government

- Slovenia's current eGovernment framework lays out plans to implement digital services in public administration, improved national broadband, cyber security and digitising government records. The quality of eGovernment improved significantly around 2015 with the launch of a government e-portal system.[167]

Digital health

- Slovenia's *eZdravje* (eHealth) project commenced in 2005 to integrate fragmented health information systems; it was successfully finalised in 2018.

- Slovenia still has fragmented internal hospital information systems which are not integrated with the national interoperability backbone.[168]

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Table 14: Index summary, Slovenia

Overall score (100%)	◓
Digital readiness (10%)	●
Digital diabetes readiness (50%)	◓
Digital diabetes incentives and payments (40%)	●
Digital diabetes overall readiness (100%)	◓

● High (score 66.1-100)

◓ Medium (score 33.1-66)

○ Low (0-33)

Readiness for digital diabetes care

- Slovenia has a National Diabetes Management Programme (2010–2020) in place, last reported on in 2017 by the National Institute of Public Health, but digital diabetes is not mentioned.

- Slovenia formed a diabetes registry relatively early (1983); it was functional until 1997 and later repurposed to be based on more contemporary technologies.[169]

- Slovenia's clinical guidelines cite tools for tracking and treating the condition and suggest user training, but do not specify whether these tools are digital, nor does it explicitly recommend their usage.

- Slovenia offers digital diabetes training to all three specialisms examined in this Index but only in the on-going professional development stage.

- The country has a reimbursement pathway for real-time and flash glucose monitoring systems, insulin pumps and smart insulin pens but not for smartphone applications or closed-loop insulin delivery.

- Regular training is offered to physicians by endocrinology associations and the Medical Chamber of Slovenia and all internal medicine specialists complete part of their training at the Department of Endocrinology, Diabetes and Metabolic Diseases at the University Medical Center in Ljubljana. Because this institution carries out clinical trials for the certification of new medical devices for diabetes,

trainee internists are exposed to the latest technologies.

- The Slovenian Diabetes Association educates people with diabetes, their relatives and the wider community about diabetes. Its consulting manual includes key digital tools and encourages usage, as well as educating people with diabetes on their rights and informing them which tools are covered within compulsory health insurance.

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Country profile: Spain

An early-mover in digital health, launching an e-identity scheme in the early 2000s and a leading European country for eHealth adoption. Spain scored well on training healthcare professionals in digital diabetes tools, but the integration of such technologies into the national diabetes plan would strengthen its digital diabetes policy.

Spain
Medium (score 33.1-66)
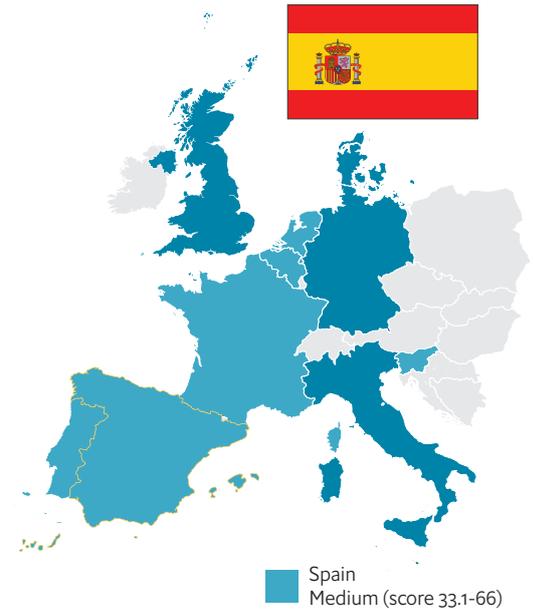
Background trends

Spain has an adult diabetes prevalence of 10.5% and direct healthcare costs have been estimated at 8% of the national health budget, which combines €5.1 billion in direct costs and €1.5 billion for diabetes-related complications with labour productivity losses representing €2.8 billion.[170]

Diabetes data is scarce and partial; one study, the first national attempt to determine prevalence and incidence of diabetes via an oral glucose tolerance test, found that nearly half of cases were previously undiagnosed, suggesting true prevalence could be much higher.[171,172] Adult obesity rates are higher than the OECD average and child rates are among the highest in the OECD.[173,174]

Spain's decentralised health system gives regional authorities autonomy in setting policy and decision-making. Digital tools are well-established in Spain, with strong national policy frameworks. However, its decentralised system means that there is variation, especially when it comes to the purchasing of medical devices via tender and their reimbursement. The Index is firstly based on national-level policy, with evidence of positive regional policy enabling scoring. Therefore answers indicate the existence or availability of policy within Spain,

Figure 17: Diabetes prevalence in Spain
(20-79 y), %
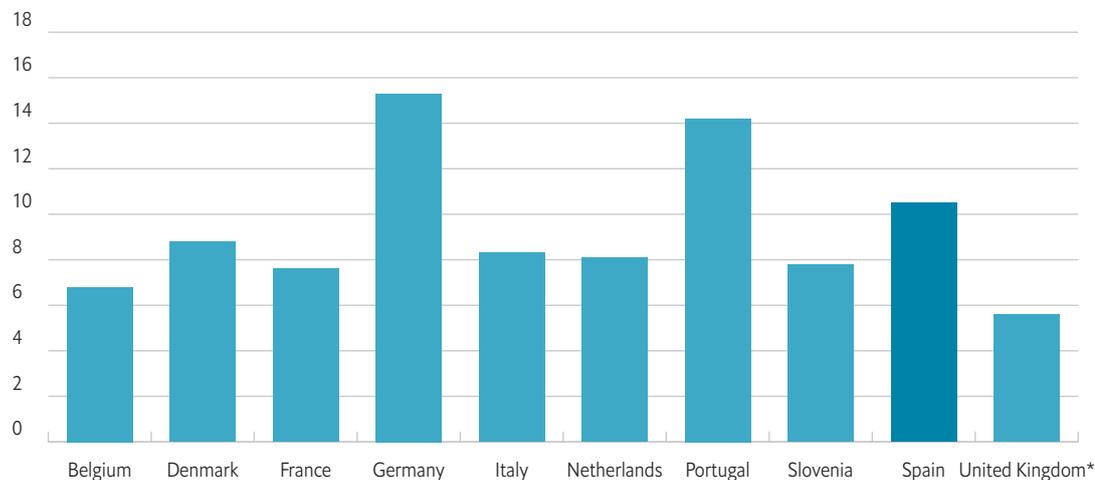
*Prevalence figures are for the United Kingdom, whereas this index focuses on England
Source: IDF diabetes atlas: ninth edition 2019. Available from: https://www.diabetesatlas.org/data/en/

but do not reflect the variations that may exist between regions.

Spain was one of the countries hardest-hit by covid-19 in Europe. It has responded to covid-19 lockdown restrictions by increasing the roll-out of digital tools already in use. Experts highlight the complications that Spain's regionalised health system creates and have suggested that a more centralised digital health strategy would support innovation, implementation and reduce variation.

Policy progress

Digital government

- Spain's national eGovernment plan is the Third National Action Plan for Open Government (2017-2019), which focuses on making the government more transparent, responsive and accountable to citizens, promoting citizen dialogue, and ensuring inter-administrative cooperation. The

Table 15: Index summary, Spain

Overall score (100%)	◓
Digital readiness (10%)	●
Digital diabetes readiness (50%)	◓
Digital diabetes incentives and payments (40%)	◓
Digital diabetes overall readiness (100%)	◓

● High (score 66.1-100)

◓ Medium (score 33.1-66)

○ Low (0-33)

country posted a steady increase in internet connectivity and digital engagement between citizens and governments since 2010.[175]

Digital health

- Spain's eHealth strategy dates back to the early 2000s, notably through an insurance ID project, implemented in 2010, which provided a unique e-identifier allowing secure exchange and management of personal data.[176]

- Spain has a national health information system in place and a national EHR system, along with legislation governing its use. The country also has a national strategy to ensure health system interoperability.

- eHealth training is incorporated into all health sciences courses and post-qualification training. Spain is one of the highest-scoring countries in Europe for eHealth adoption in primary healthcare according to a European Commission study in 2019.[177]

- Digital health is governed by the health and social services ministry (*Ministerio de Sanidad, Servicios Sociales e Igualdad*) and multiple entities have been created to promote digital transformation including a digital health commission and a national digital health centre.

- Computerised reimbursement is provided in the Spanish Digitisation Plan 2020, which also envisages electronic invoicing in collaboration between private insurances and social security.

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Digital diabetes

- Spain's first national diabetes plan, promulgated in 2007, provided general guidelines to stimulate the implementation of regional initiatives for prevention, early diagnosis and efficient treatment and research.[178] The current national diabetes plan is dated to 2012, and Spanish regions continue to have autonomy in implementing their own strategies. Although the current plan does not specifically emphasise digital diabetes, other policy documents, notably a 2018 plan, outline measures to improve information flows through digital medical records and electronic prescriptions. The country does not currently have a diabetes registry.

- Spain's clinical guidelines reference the usefulness of digital diabetes tools—specifically, smart pens for proper dosing and ensuring regimen adherence and Spanish authorities have approved the use of bolus dose calculators and digital decision-support systems.

- Spain performs very strongly on training of health professionals—GPs, endocrinologists/diabetologists and diabetes nurses are all trained in digital diabetes tools in both their initial and on-going training.

- The country has reimbursement pathways for real-time and flash glucose monitoring systems, insulin pumps, smart insulin pens, but not for closed-loop insulin delivery or smartphone applications.

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Conclusions and future directions

This Index of ten European countries shows, positively, a broad engagement with the fundamental digital health policies necessary to support digital diabetes care, including the presence of underlying eGovernment and eHealth plans, the utilisation of electronic health records, and the presence of national diabetes policy. However, to enable digital diabetes care at scale, changes may be needed to key enablers of access to digital diabetes tools: reimbursement pathways; guidance and diabetes plans; assessment and evaluation processes and training in digital diabetes tools.

Ensuring that people with diabetes can access digital diabetes tools that could improve their lives is the ultimate goal

Reimbursement decisions act as de facto guidelines and can influence which digital tools are used in practice. Established digital tools such as real-time and flash glucose monitoring systems and insulin pumps are widely reimbursed. However, newer digital tools such as closed-loop insulin delivery systems, smart phone applications and smart insulin pens are reimbursed in less than half of the included countries. The role of reimbursement decisions in enabling the use of digital diabetes tools and therefore determining what digital tools are used, underscores the need for a rigorous, but evolving approach to evaluating new technologies arriving on the market. Such policy also needs to recognise the specific value that digital tools provide beyond simply digitising once analogue tasks. Reimbursement is the only incentive to encourage the use of digital diabetes tools in half of the included

countries, therefore it is also important that reimbursement is set at a level that incentivises this change in practice and does not have a negative financial impact for healthcare providers.

Thinking beyond reimbursement could provide a new way to fund innovative technologies. The Index found no evidence of alternative ways of funding access to digital tools, beyond traditional reimbursement. Payment methods that reward and encourage innovation, such as risk-sharing models (or value-based contracts) have been adopted by payors and pharmaceutical manufacturers to fund innovative pharmaceuticals. There may be scope to adapt these approaches to digital diabetes tools, to improve access by enabling a new way of recognising their value.

National diabetes plans and guidelines should provide specific recommendations about digital diabetes tools. Clinical guidelines can harmonise best practices, quicken the diffusion of new evidence and tools into clinical settings, and reduce variations in care quality. The Index has found that only four countries explicitly include recommendations or guidance on implementing digital diabetes tools in practice. As the number of available digital tools increases, a lack of integration into guidelines may limit the uptake of effective innovations. Clinical guidance will also be critical if trends continue towards the integration of digital diabetes tools into broader health information systems. This lack of guidance may impact on access to digital tools for people with diabetes, as healthcare professionals may not be aware of them, feel confident in using them or understand the advantages of using digital diabetes tools.

Digital tools have been integrated into existing health technology assessment processes used for medical devices and general reimbursement pathways, but are these fit-for purpose? There is a need to reflect on whether HTA is the best way to evaluate digital diabetes tools, or whether different approaches could better evaluate the value of digital diabetes tools to all stakeholders. Many of the advantages of digital diabetes tools are not as easily measurable as clinically-defined outcomes, for example how do you measure the value to a person with diabetes of feeling better able to manage their own condition?

Digital diabetes training for health professionals is not yet comprehensive, which may be a lost opportunity to raise awareness and uptake. Healthcare professionals are key stakeholders in the digital diabetes landscape as trusted advisors to people with diabetes. Digital health is covered in initial health sciences training, but diabetes-specific training is lacking in specialist training for GPs, endocrinologists and diabetes nurses. There is widespread coverage of digital diabetes training in on-going, post-qualification training; however, this topic will be competing with others for healthcare professionals' continuing professional development time and budget. Training plays a key role in ensuring that relevant healthcare professionals are aware of digital diabetes tools, understand their value and feel confident in using and recommending them to their patients.

What else is needed?

Diabetes is a major challenge for the European region, with an estimated 59 million people affected. Diabetes is a promising domain for the application of digital technology which can improve communication between healthcare specialists and people with diabetes, support self-management and monitoring, and ease communications between different specialisms involved in treatment. **Stakeholders can, by working together, leverage the power of currently existing and future digital technologies by ensuring the right regulatory frameworks, incentives and support mechanisms, and education levels.** In so doing they can greatly support people with diabetes, healthcare providers and health systems in responding to diabetes.

Insights from experts have highlighted the role of financial structures and policy in the form of clinical guidelines and diabetes plans in guiding clinical practice, which in turn impacts on access to these tools for people with diabetes. This emphasises the importance of ensuring that a solid policy foundation is in place to facilitate access to digital diabetes tools. **Future work could evaluate the gap between policy and implementation in further detail to explore the impact on access to digital diabetes tools.**

Covid-19 has brought a welcome engagement with digital technology but this has been uneven and new tools and platforms need to integrate the views and needs of users. Experts warn that use of digital health technology during Covid-19 has not been equal, with some users and healthcare professionals more engaged than others. Platforms have also been rolled out quickly. **Going forward, any new technologies that become routine need to integrate the views of people with diabetes in terms of user-friendliness, access, benefit and data privacy/ protection.**

Appendices

Appendix 1: Methodology

Index Framework

The final set of indicators aim to measure and benchmark the ten included countries.

- **Readiness for digital healthcare** (10% of total score)

  – Is there a national eGovernment policy?

  – Is there a national eHealth policy or strategy?

  – Is there a national health information system (HIS) policy or strategy?

  – Is there a specific institution or body with oversight of digital health?

  – What are the funding sources for eHealth?

  – Are key legal frameworks covering jurisdiction, liability, reimbursement, safety, quality, data privacy, data sharing, data access and editing present?

  – Is there a national EHR system?

  – Is there legislation governing the use of the national EHR system?

  – Which types of health facilities are using EHRs?

  – Is there national infrastructure for remote patient monitoring?

  – Is there a national strategy to ensure system interoperability within the health system?

  – Is there legislation governing the sharing of data between private companies (e.g. device manufacturers) and government?

  – Is there a policy or strategy governing the use of big data by private companies?

  – Is there eHealth training for health professional pre- and post-qualification?

  – Are digital tools included in health technology assessment (HTA) for medical devices?

  – Are digital tools included in reimbursement pathways for medical devices?

- **Readiness for digital diabetes care** (50% of total score)

  – 2.1 Is there an operational policy/strategy/action plan for diabetes?

  – 2.2 Does the national diabetes plan include digital diabetes?

  – 2.3 Is there a national diabetes registry?

- 2.4 Are digital diabetes tools recommended in national clinical guidelines for diabetes?

- 2.5 Are relevant healthcare professionals trained on digital diabetes tools?

- **Digital diabetes care incentives and payments** (40% of total score)

  - 3.1 Is there a reimbursement pathway for key types of digital diabetes tools: real-time glucose monitors, flash glucose monitors, insulin pumps, closed-loop insulin delivery system, smart phone applications (apps), smart insulin pen?

  - 3.2 Are alternative funding models in place to provide access to digital diabetes tools? e.g. risk-sharing models, bundle payments, direct payments etc.

  - 3.3 Are there incentives in place to encourage the use of key types of digital diabetes tools: real-time glucose monitors, flash glucose monitors, insulin pumps, closed-loop insulin delivery system, smart phone applications (apps), smart insulin pen?

  - 3.4 Are there incentives in place to encourage patients to use key types of digital diabetes tools: real-time glucose monitors, flash glucose monitors, insulin pumps, closed-loop insulin delivery system, smart phone applications (apps), smart insulin pen?

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Appendix 2: Embase.com search strategy

	Search terms	Results
1	diabetes mellitus'/exp OR diabet*:ti,ab	1107489
2	telehealth'/exp OR 'digital health technology'/de OR 'digital health intervention'/de OR 'mobile health application'/de	41645
3	tele*:ti,ab OR remote:ti,ab OR digital:ti,ab OR mobile:ti,ab	520233
4	#2 OR #3	531481
5	#1 AND #4	16267
6	#1 AND #4 AND [2009-2019]/py	12989
7	#1 AND #4 AND [english]/lim AND [2015-2019]/py	6819
8	tele*:ti OR remote:ti OR digital:ti OR mobile:ti	137403
9	#2 OR #8	158920
10	#1 AND #9	5567
11	#1 AND #9 AND [english]/lim AND [2015-2019]/py	2602
12	#11 AND 'human'/de	2508
13	diabetes mellitus'/exp OR diabet*:ti	975282
14	#2 OR #8	158920
15	#13 AND #14	5038
16	#15 AND 'human'/de	4705
17	#15 AND 'human'/de AND [english]/lim AND [2015-2019]/py	2289
18	#17 AND 'Review'/it	230

Appendix 3: Key components of digital health

Digital health component	Description
Electronic health records	Clinical records of patient information, which can be accessible by patients and all involved in their care. Can be integrated with decision support tools and e-prescribing systems.
Wearable devices and apps	Devices that record clinically relevant data such as heart rate, blood glucose level.
Decision support tools	Decision support tools integrate patient data into existing treatment pathways and algorithms to support healthcare professionals' and patients' decision making.
E-prescribing	Enables the electronic prescribing of medication or other healthcare intervention.
Registries	Collect large quantities of patient data, which can be analysed as part of research studies and operational studies.
Telehealth/telemonitoring/ telecoaching	The digital exchange of information between a patient and health care professional. Telemonitoring remotely transmits clinical data, telemedicine involves remote consultations via phone, video, email etc., and telecoaching encourages behaviour change.

Source: adapted from 'Delivering the benefits of digital healthcare'[11]

Appendix 4: Key digital diabetes tools currently available

This project uses a broad definition of "digital diabetes tools" to refer to a range of tools that can be used to digitally manage diabetes, including diabetes-specific medical devices and smartphone apps that are not diabetes-specific as a class but have significant uses in the digital management of diabetes. The table below details diabetes-specific medical devices that are digital tools.

Digital tool	Description	Integration with other devices
Closed-loop insulin delivery system	Integrates a real-time glucose monitor and insulin pump so an algorithm calculates insulin dose based on real-time data.	**Sends data to display device**
Flash glucose monitoring systems	Operates much like a real-time glucose monitor, but data is only transmitted when the scanner (can be a mobile phone) is passed over the sensor.	**Sends data to display device**
Insulin pumps	A small device connected to a cannula to deliver a baseline insulin dose day and night. Users can top up their insulin as needed.	**Sends data to display device**
Real-time glucose monitoring systems	A small device fitted under the skin, which measures glucose levels in real-time. Connects to a display device, providing readings and trends over time and alerts users to highs or lows.	**Sends data to display device**
Smart insulin pen	A reusable injector that captures injection data (such as the amount and time) and sends it to a secure mobile app. Users can view their data and set reminders via the app.	**Smart phone**

Appendix 5: Types of digital health tools for managing diabetes

This project uses a broad definition of "digital diabetes tools" to refer to a range of tools that can be used to digitally manage diabetes, including diabetes-specific medical devices and smartphone apps that are not diabetes-specific as a class but have significant uses in the digital management of diabetes. The table below details digital health tools that are used to manage diabetes.

Digital tool	Description	Integration with other devices
Message service text messaging	Periodic reminders via text message to take medication, measure bloods or administer insulin.	**Basic mobile phone**
Smart-phone applications (apps)	Diabetes apps can provide: education, lifestyle information, log food, advice on how to stay within desired ranges, motivational insights, collect and analyse blood glucose data, etc.	**Glucose monitoring devices/ smart phone**
Remote clinician access	Virtual consultations via telephone or video, patient devices—such as real-time glucose monitoring systems—can be connected to transmit data direct to the healthcare professional.	**Glucose monitoring devices/ smart phone**
AI-based algorithms	Patient applications can include personalised nutrition, prevention and management advice based on user-provided data. Healthcare professional applications include diabetic retinopathy screening and data-informed decision-making support.	**Glucose monitoring devices/ smart phone**
Online portal	Websites containing information and advice about all aspects of diabetes available to patients. Can be connected to remote clinician access services.	**Glucose monitoring devices/ smartphone**

Acknowledgements

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