UK Extended Reality Health Market Assessment & Deep Dive Report

The University of Liverpool has commissioned a national research report mapping organisations across the UK that are developing and deploying extended reality (XR) technologies for healthcare. This report provides valuable insights for stakeholders across industry, healthcare, and research.

Please consider the environment before printing this report.

Executive Summary

Commissioned by the University of Liverpool's Civic Health Innovation Labs (CHIL), this UK-wide landscape mapping study explores the role of extended reality (XR) in healthcare, with a dedicated focus on mental health. Building on the recommendations of the 2021 XR Health Alliance report "The Growing Value of XR in Healthcare" [1], this study examines the breadth of XR adoption across the NHS, universities and industry, and benchmarks the UK's competitive standing globally.

Key Findings

- **Sectoral Adoption:** XR is transitioning from early-stage research to more clinical adoption. Universities are leading, with over 60% reporting XR use, compared to roughly 30% of NHS Trusts. Private sector activity, driven mainly by micro-companies, is focused on therapeutic and training applications, but faces challenges scaling into healthcare systems.
- **Clinical Applications:** The most prevalent uses of XR are workforce education and training, followed by mental health, physiotherapy and rehabilitation. Strong evidence is emerging in depression, anxiety and cognitive rehabilitation. However, conditions such as dementia, psychotic disorders, PTSD and substance misuse remain underrepresented despite promising research.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- **Technology Trends:** Advances in standalone headsets, AI-driven personalisation, and biofeedback integration are expanding opportunities. New applications are emerging in neurodivergence, creative health and palliative care.
- **Market Drivers and Barriers:** Targeted funding, such as the £20 million Mindset XR programme, is accelerating adoption. Yet key barriers persist, including limited procurement pathways, regulatory uncertainty, fragmented evidence generation and lack of sustainable funding models.
- **Global Positioning:** The UK is internationally recognised for its strengths in combining creative industries with research and innovation. While adoption levels remain uneven, the trajectory indicates growing maturity and influence in the XR healthcare field.

Recommendations

Develop a National XR Strategy for Healthcare

- Establish a unified national XR strategy to reduce fragmentation in funding and adoption. Ensure alignment with NHS strategic priorities, including the 10-Year Plan and upcoming digital strategies.
- Update the NHS Dynamic Procurement System and/or G-Cloud Digital Market Place to include XR solutions.
- Build on existing standards and evaluation frameworks working closely with regulators and the NHS to provide a clear roadmap for industry, SMEs, and NHS adoption.

Deploy XR to Advance NHS Strategic Priorities

- Support the shift from hospital to community-based care by embedding XR into "Virtual Wards" and "Hospital to Home" models for rehabilitation, monitoring, and therapy.
- Use XR to enhance preventive health and wellbeing, from physical activity to mental health resilience, reducing long-term demand.
- Drive the shift from analogue to digital interventions, ensuring XR becomes a core part of modern, technology-enabled care pathways rather than an add-on or pilot initiative.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- Deploy XR for clinical accuracy (e.g., diagnostic simulations, professional training), improving patient adherence and outcomes while lowering per-patient costs.

Strengthen Evidence Generation and Trust

- Invest in rigorous clinical trials, health economic analyses, and real-world studies to demonstrate not only clinical efficacy but also cost-effectiveness, safety, and patient experience.
- Encourage companies to publish evidence of cost-saving and productivity benefits for NHS providers to strengthen the business case for XR adoption.
- Develop a platform to accelerate compliance, evidence generation, and commercialisation by:
    - Offering tools for instant gap analysis against regulatory and compliance standards, showing innovators what is missing and how to address it.
    - Supporting teams to create documentation and evidence tailored to relevant standards, reducing reliance on expensive consultants or academic staff.
    - Automating the design, execution, and reporting of randomised controlled trials in line with HRA guidelines, producing regulator-ready evidence more efficiently and at lower cost.

Expand XR Infrastructure and Ecosystems

- Develop XR Labs and NHS XR Centres of Excellence concept, drawing on successful academic and healthcare models to foster co-design, evaluation, and implementation across sectors.
- Support innovation in underrepresented clinical areas (beyond anxiety and depression) and in mental health resilience, chronic condition self-management, and preventive care.
- Encourage Public - Private collaboration across industry, academia, and the NHS to accelerate deployment and scaling.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Improve Funding and Scaling Pathways

- Introduce phased or iterative funding models that support long-term sustainability.
- Ensure funding and reimbursement pathways are standardised across NHS regional bodies to streamline adoption.
- Continue investment for XR solution providers to support their navigation of the complex challenges presented when scaling in the NHS.

Policy Integration, Regulation, and Scaling

- XR adoption should be supported by clear policy frameworks, regulation and governance.
- Ensure XR adoption is supported by robust governance: data protection, clinical safety, and evidence standards.
- Align deployment with Integrated Care Boards (ICBs) and local services to address population health needs and reduce inequalities.
- Embed XR within NHS operational planning (e.g., 2025/26 priorities) to reduce avoidable admissions, strengthen out-of-hospital care, and deliver productivity gains.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Foreword

It is a privilege to collaborate with the XR Health Alliance (XRHA), whose report, The Growing Value of XR in Healthcare in the United Kingdom, established an impressive foundation for progress in this sector. From the outset, XRHA have demonstrated rigour and real-world relevance, drawing together insights from different stakeholders to highlight where extended reality (XR) is already delivering impact, and where targeted action can unlock further innovative solutions in healthcare.

Building on this firm footing, we are particularly pleased to introduce the next stage of their work, a product of the University of Liverpool's Civic HealthTech Innovation Zone, part of Liverpool City Region's Life Sciences Innovation Zone Programme, which speaks to our determination to help tackle the health challenges our communities face and our remit to support the development of innovative solutions working with clinicians and industry partners: the UK XR Health Market Assessment and Deep Dive.

This work aligns with the City Region's growing reputation as a trailblazer in data-driven and tech-enabled healthcare as well as it being a hub for the digital and creative sectors, where collaboration involving academics, the public sector, industry and communities is shaping more inclusive, responsive and future-oriented solutions.

What distinguishes XRHA's contribution is their commitment to moving beyond speculation towards substance: mapping genuine adoption, identifying barriers and opportunities, and translating evidence into practical, actionable recommendations that decision-makers can confidently apply. Their passion and knowledge and expertise in the field of XR use in healthcare ensures that this is not simply an analysis of the XR market, but a blueprint for shaping and growing it.

This report reads-across to other work involving NHS colleagues and XR industry representatives to better understand local needs, capabilities and ambitions in relation to the projected deepening of challenges associated with mental health in the years ahead.

At the University of Liverpool, we are proud to partner with XRHA on this journey and look forward to working together as we realise the potential of XR in healthcare for our communities and beyond.

Dr Annemarie Naylor MBE
Director of HealthTech and Innovation Growth, University of Liverpool

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Introduction

Photo: University of Liverpool Campus, Image Courtesy of The University of Liverpool

About the University of Liverpool

Founded in 1881 as the original 'red brick', the University of Liverpool is one of the UK's leading research-intensive higher education institutions with an annual turnover of £708.3 million, including an annual research income of £163.1 million.

Ranked in the top 150 universities worldwide, we are a member of the prestigious Russell Group of the UK's leading research universities and have a global reach and influence that reflects our academic heritage as one of the country's largest civic institutions.

Further information about the Faculty of Health and Life Sciences

Further information about CHIL

Further information about M-RIC

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

About the Project

Photo: Victoria Gallery and Museum, Liverpool Courtesy of The University of Liverpool

The University of Liverpool's Civic Health Innovation Labs has commissioned a UK-wide landscape mapping study to better understand the current state of extended reality (XR) in healthcare.

This research was informed by the original recommendations of The 2021 Growing Value of XR in Healthcare in the United Kingdom report, led by the XR Health Alliance [1]. In particular, it responds to the first recommendation titled Landscape Mapping of UK XR in the Healthcare Sector, which called for a comprehensive mapping and analysis of the businesses, healthcare organisations and universities working with XR in healthcare to better understand the UK's capacity and capabilities, market size and scale, potential value and future growth.

Building on this recommendation, the present research project is being led by the XR Health Alliance in collaboration with the University of Nottingham's NIHR MindTech Research Centre.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

This report aims to identify and showcase the breadth of XR-related research, development and deployment across physical and mental health applications in the UK. It will serve as a valuable tool to help shape future grant programmes and support sector-wide growth and innovation.

Through this project, the University of Liverpool's Civic Health Innovation Labs are working with Mersey Care NHS Foundation Trust to build on and deepen the understanding of XR in the field. The CHI-Zone is part of the Liverpool City Region Life Sciences Innovation Zone Programme, part of the Government's national Investment Zone Programme, positioning the city region as a powerhouse for health and life sciences innovation.

Definitions

This report will focus mainly on the applications of VR in healthcare, with reference to the use of AR and MR in training and education.

Extended Reality (XR) is an umbrella term encapsulating AR, VR, MR and everything in between.

Virtual Reality (VR) immerses users in a fully digital environment through a headset or surrounding display. This environment can be computer-generated or filmed in 360-degree video.

Augmented Reality (AR) presents digital information, objects, or media in the real world through a mobile device or headset. These elements can appear as a flat graphical overlay or can behave as a seemingly real '3D' object.

Mixed Reality (MR) is the latter form of AR described above where physical and digital objects co-exist – in other words, the digital objects appear anchored to the real-world environment.

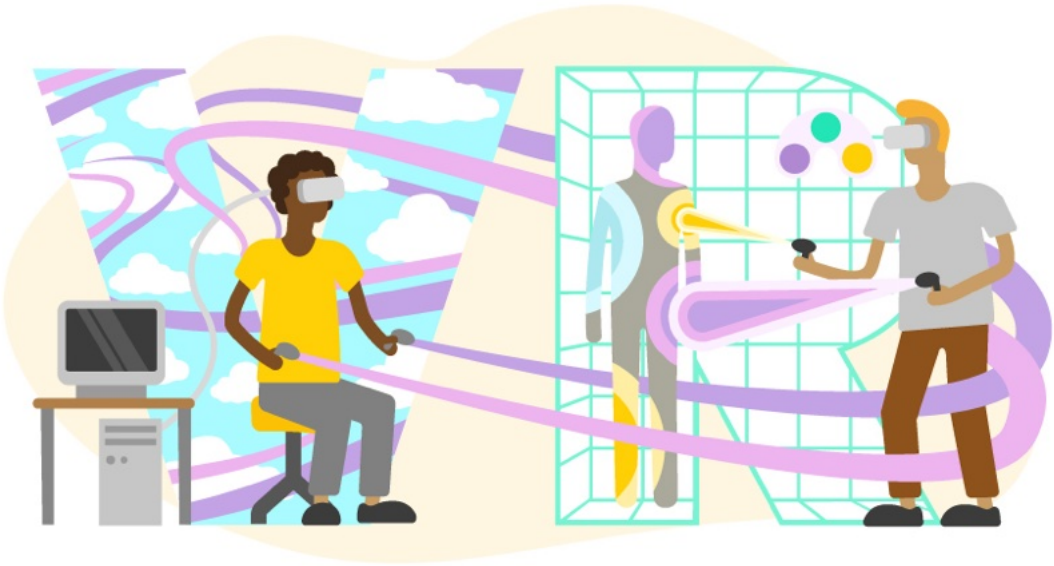
Virtual Worlds: Persistent immersive environments based on technologies including 3D and extended reality which make it possible to blend physical and digital worlds in real-time for a variety of purposes such as designing, making simulations, collaborating, learning, socialising, carrying out transactions or providing entertainment.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

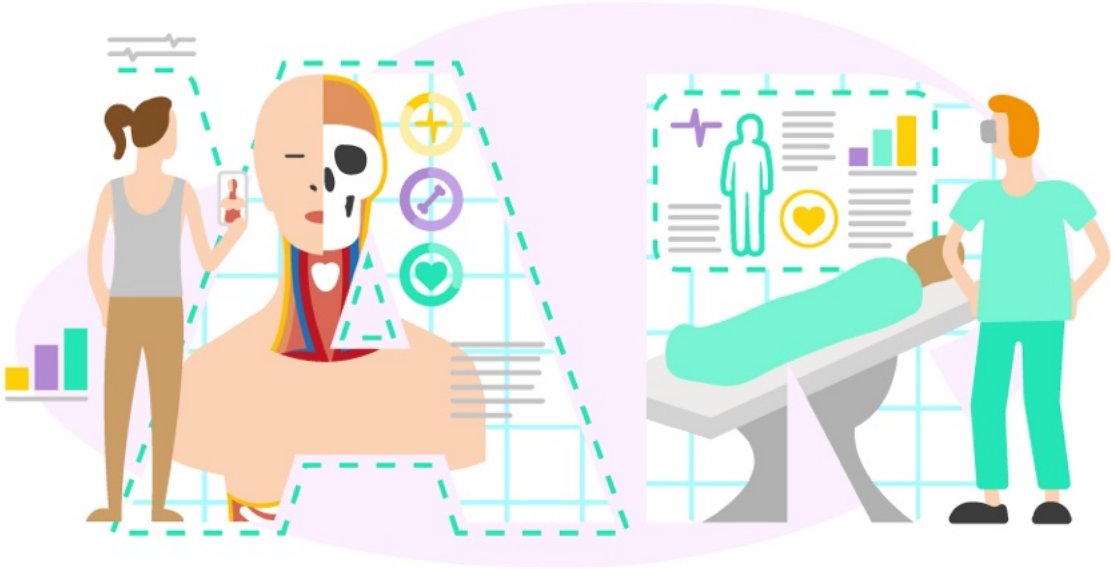
Immersive (or XR) technology solutions are being delivered in a variety of ways. Augmented reality experiences are usually accessed through a mobile phone or headset, displaying an overlay of digital objects in the user's environment. Virtual reality is used to immerse users in a completely digital environment, usually through a headset.

Immersive technologies cover a wide spectrum and can also include adjacent technologies such as **haptics** which assist in immersing the user in a virtual world through an enhanced sense of touch. Often taking the form of a pair of gloves or an articulated arm, haptic technology enables users to not only see and hear their environment but feel it through vibration and changes in temperature.

A range of Head Mounted Display (HMDs) and devices are available on the market to deliver immersive experiences.



Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



Estimates suggest that in 2020, sales of XR headsets will reach around 5.5 million units. Forecasts project massive growth in both AR and VR headset sales in the coming years, with both technologies combined expected to sell over 26 million units per year by 2023. (Statista March 21).

The picture that emerges is of rapidly increasing access to, and use of, devices and interfaces that support the delivery of XR healthcare solutions and experiences at an unprecedented scale.

The range of HMDs, devices and software available on the market is set to increase with the expected launch of Apple's AR glasses, Microsoft Mesh -which enables presence and shared experiences through MR across devices - to Facebook's neural signal wrist trackers.

Development Platforms and Software

Immersive experiences can be developed on several platforms. The most popular are Unity and Unreal, which account for the vast majority of XR applications. Some startups are also offering their own platforms, which simplify the creation and distribution of XR experiences.

WebXR technology is making access to XR experiences even easier for users. Instead of creating an application that needs to be downloaded from a store and installed locally on a user's device, it can simply be loaded from a web browser on the user's mobile phone or headset. This distribution model is becoming increasingly popular as it makes

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

XR experiences quicker and simpler to access. However, it can pose a challenge where the internet is not available, not reliable, or restricted as may be the case with some hospitals. Mozilla Hubs allows users in VR or on desktop computers to access a shared virtual world together and is a good example of WebXR technology in action.

XR - An introduction and the stats

The field of immersive technology has rapidly been developing over the last 9 years. Following the launch of the Oculus DK1, and the subsequent advancement of technologies across multiple platforms and hardware, virtual, augmented and mixed reality has been applied across a number of industries from entertainment and gaming to training, education and increasingly in healthcare.

Whilst the definition of immersive becomes increasingly broad, including the proliferation of immersive theatre and cinema, this report will focus on the adoption of technology enhanced experiences through VR, AR and MR.

The ability to enable opportunities to simulate environments, with embodied interactions that can range from playful to practical rehabilitation skills make this technology unique. The heightened sense of realisation can help experiences feel more visceral, which can be useful for recreating reality and an enhanced sense of immersion. Equally the opportunity to abstract data and make experiences that would be impossible in reality from data visualisation to fantasy scenarios can be equally powerful.

XR Applications in Healthcare

Extended Reality (XR) serves as a comprehensive term encompassing Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR), with each offering distinct yet complementary immersive experiences. In the healthcare sector, these technologies are not merely supplementary tools but are becoming fundamental drivers of innovation, efficiency and accessibility in modern medicine. Their application extends across the entire spectrum of healthcare, from foundational education to advanced surgical procedures, patient rehabilitation and mental health interventions.

Defining XR in healthcare involves understanding how these technologies integrate digital content with the physical environment to create interactive and simulated

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

experiences. Augmented Reality overlays digital information onto the real world, enhancing perception without fully obscuring the user's surroundings. Virtual Reality, conversely, immerses users entirely in a simulated environment, often for training or therapeutic purposes, by blocking out the physical world. Mixed Reality represents a more advanced blend, allowing real and virtual worlds to coexist and interact in real-time. This integration is designed to enhance clinical precision, accelerate learning for healthcare professionals, and improve patient outcomes through highly interactive experiences [2]. By leveraging cutting-edge visualisations and interactive simulations, XR provides healthcare professionals with valuable tools for diagnostics, treatment planning, and patient engagement [3].

The transformative potential of XR in healthcare is profound. It is revolutionising medical education, patient engagement and treatment methodologies by bridging the critical gap between theoretical knowledge and real-world medical scenarios [4]. This enables medical practitioners to gain practical expertise and refine their skills in safe, controlled environments, minimising risks associated with early-stage learning on actual patients [3]. The application of XR extends across various medical fields, including surgical preparation, minimally invasive surgery, pain management, rehabilitation and mental health therapies [1]. The technology's ability to replicate complex medical environments and provide enhanced therapy sessions creates new avenues for improving patient care and rehabilitation, particularly in remote or underserved regions where access to specialised care may be limited [5, 6].

Spotlight on Mental Health and XR

The UK mental health crisis has intensified significantly. Prevalence rates of MH conditions are increasing (see Figure 1) and have been since the Covid-19 pandemic with more people seeking treatment. In 2024, the current estimate is that over 20% of adults will experience a common mental health condition in the UK, leading to significant demand for services and treatment.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

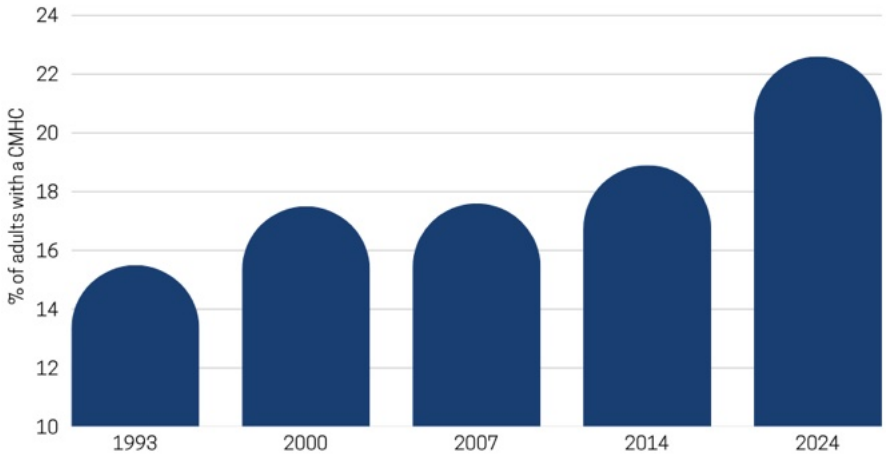


Figure 1. % of adults (16-64 years) with a Common Mental Health Condition (CMHC) is increasing year-on-year (includes depression, anxiety, OCD, phobias) [7].

The cost of poor mental health is calculated at £300 billion a year in England, with 1 in 4 adults experiencing a mental health problem each year. More than 1 in 7 UK adults (15.5%) say their mental health is currently either bad or the worst it's ever been, with women more likely than men to report experiencing common mental health problems (20.7% vs 13.2%). A 2023 survey found that 20% of children aged 8 to 16 had a probable mental disorder, up from 12% in 2017. PTSD prevalence has also increased from 4.4% in 2014 to 5.7% in 2023/4 with mental health problems also being strongly linked to patient physical health [7]. The healthcare system is struggling to meet demand, with mental health services in England receiving a record 5.2 million referrals during 2024 (up 37.9% from 2019) and latest estimates putting the mental health waiting list at 1 million people [7].

Mental health services, already under pressure and underfunded, are looking to digital technologies to improve access and provide high quality mental health support and treatment [8]. As highlighted in the previous section, XR technologies provide an area of significant potential as they offer additional functionality that is not available through other technologies such as smartphones. Most apparent is its effectiveness for virtually simulating scenarios or objects for use in exposure therapy, allowing people to safely confront and tackle their fears, but it can also enable so much more. For example, when combined with machine learning or other artificial intelligence (AI) it can use data from sensors (like EEGs) to adapt to individuals; it can be personalised and offer a platform of different interventions; it can be more engaging and enjoyable for repetitive or onerous therapeutic tasks; and it can potentially be delivered remotely and support access to more immersive therapeutics from the comfort of one's home.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

XR technologies are increasingly focused on addressing these challenges through immersive therapeutic interventions. For example, in 2025 the NHS commissioned Tend to supply XR therapy support solutions in its flagship Talking Therapies Services [9] and the first XR mental health company (XR Therapeutics) was accepted onto the NHS National Innovation Accelerator (NIA) Programme [10]. This adoption of XR technology is promising, but this report will provide comprehensive mapping of all such implementations across the UK to understand the full potential of these technologies.

Technology Advancement and Adoption

Although immersive technologies such as XR (extended reality) have existed for over three decades, the commercial release of consumer headsets like the Oculus Rift, HTC Vive, and PlayStation VR in 2016 marked a turning point in the mainstream adoption of immersive media. This surge was driven by media hype and significant private sector investment, which catalysed growth innovation across both the creative and subsequently into healthcare sectors. Pioneers in the field began to experiment with new forms of interaction, exploring novel modes of locomotion, body tracking, haptics and biofeedback integration, laying the groundwork for what would become a rapidly evolving interdisciplinary field.

In 2018, Immerse UK, in partnership with the Institute of Engineering and Technology and curated by Immerse UK Healthcare Lead Sarah Ticho, hosted the UK's first XR and healthcare conference. This milestone event showcased early applications of immersive technologies in medical training, therapeutic interventions, psychedelic research and pain management—signalling the formalisation of the sector. The series continued in 2019 and led to the launch of *The Promise of Immersive Healthcare* report in 2020 [20].

The COVID-19 pandemic further accelerated XR adoption. While many immersive healthcare innovations were already in development, the urgent need for scalable, remote and digital solutions drove faster deployment and normalised their use across healthcare settings. During this time, *The Growing Value of XR in Healthcare in the United Kingdom* report was launched, building on prior recommendations to engage government stakeholders [1]. The report contributed to one of the most significant recent developments in the UK: the £20 million UKRI Mindset XR Programme. This public investment injected renewed momentum into XR and healthcare, supporting a wave of

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

experimentation and clinical implementation. During this time NHS Trusts such as South London and Maudsley, Torbay and Devon, Sheffield Teaching Hospital , Alder Hey Children's Hospital, Hull University Teaching Hospital, and Leeds Teaching Hospital have emerged as national leaders, trialling and deploying immersive technologies for mental health, rehabilitation, pain management, and patient education, both in clinics and at home.

Globally, a number of networks, conferences and publications have been established. This includes VR4Rehab (Netherlands/Europe), the Games for Health Journal, Frontiers in Virtual Reality, and conferences such as the Virtual Medicine Conference (Cedars Sinai, Los Angeles) and Games for Change (New York). Research labs such as the Games for Emotional and Mental Health Lab (Radboud University), Yale XR Paediatrics, and Stanford University's Psychiatry in Immersive Technology Consortium (SPIT-C) continue to research and deliver products into the world, supporting cross sectoral collaboration and adoption. These growing organisations demonstrate the global enthusiasm and commitment to the XR and healthcare space, with increasing cooperation between groups.

Since 2016, substantial progress has also been made in hardware and software. The development of lightweight, standalone devices such as the Meta Quest, HTC Vive, Pico and Playstation VR, alongside advancements in real-time rendering, AI integration, haptics, and biofeedback tools, has lowered barriers to adoption and enabled increasingly sophisticated applications. At the same time, institutional infrastructure in the UK has matured. Initiatives such as the £56 million Creative Industries Clusters Programme (2018–2023) [21] and CoSTAR, a £75.6 million R&D network supporting innovation across digital performance and media [22], position the UK as a global leader in immersive content creation. Universities, creative industries, and research centres within these programmes continue to develop cutting-edge tools that often find downstream value in health contexts.

However, the pipeline from innovation to healthcare impact is not without friction. Despite consumer VR headset shipments declining, demand from the enterprise market remained more resilient, particularly in large-scale immersive Location-Based Entertainment (LBE), online entertainment usage, education, healthcare and military.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

While 65% of UK universities report using XR technologies, only 36% of NHS Trusts and Boards currently do. This disparity points to a persistent lag in adoption, rooted in regulatory hurdles, limited infrastructure, and challenges in clinical validation. In creative and research sectors, where regulation is lighter and the risk appetite higher, XR experiences can be more easily iterated. But healthcare applications require robust frameworks for evidence generation, compliance, and integration into existing systems. Support for commercialisation, certification, and service design remains critical for ensuring XR experiences reach patients in need.

Research Methodology

To investigate the developing trends and state of the market of extended reality (XR) in healthcare, we employed three different methods of data collection.

Scope and Rationale:

This project aimed to identify and showcase the breadth of XR-related research, development, and deployment in healthcare within the UK. The findings are intended to inform a future grant programme, help guide policy, and identify emerging innovation in the sector.

To achieve this, we employed three approaches:

1. Freedom of Information requests were sent to all healthcare providers and academic institutions across the United Kingdom. These requests captured both the extent of XR adoption and the types of innovations being developed, addressing all healthcare-related applications.

2. A targeted industry survey, delivered via a chatbot, was directed towards companies innovating in XR for mental healthcare. This provided an industry perspective that complemented the insights from the public-sector consultation.

3. Finally, desk research was conducted to further develop case studies, inform areas of the report, and identify current research and grey literature to provide context and extend the findings.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Ethical approval for the Freedom of Information request portion of this report was obtained from the University of Nottingham, Faculty of Medicine and Health Sciences Research Ethics Committee (FMHS 301-0924).

Freedom of Information Requests

Firstly, to assess the number of healthcare organisations and universities engaging in XR healthcare applications, Freedom of Information (FOI) requests were sent to all qualifying healthcare organisations and higher education institutions in the UK. The Freedom of Information Act 2000 provides the public with a right to access information held by public authorities in the UK, including the NHS and universities.

The questions were developed from a previous FOI which was sent to all NHS mental health services to collect data on the number of digital technologies procured and used with amendments made to align to the focus of this project. Questions addressed:

a) The nature of the XR technologies being used, researched or developed

b) Details including names and descriptions of the products

c) The categories of healthcare that were targeted

d) How products were adopted and distributed

e) Whether organisations had a dedicated XR Lab or Centre of Excellence

These questions were provided as both a Microsoft Forms and a Word document to allow organisations different options for responses and to streamline data cleaning and analysis where possible. FOI requests were sent to the 194 Trusts of England, 14 Health Boards of Scotland, 7 Health Boards of Wales, 6 Trusts of Northern Ireland and 135 higher education institutions in the United Kingdom.

Chatbot Survey

A Chatbot facilitated survey (developed in collaboration with Careful AI) was shared publicly with a number of national and international companies. This included reaching out to the 74 companies supported via UKRI Mindset XR programme, as well as direct contacts of XRHA and outreach to national and international partners. This approach aimed to capture industry perspectives that were not reflected in the data from the FOIs.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Secondary Research

Additionally, we conducted secondary research to map the current landscape of XR interventions used in mental health, identify regulatory considerations, and review relevant statistics. We used Google Scholar and Google search to identify academic literature, grey literature, and relevant publications. Search terms included combinations of “extended reality”, “XR”, “mental health”, “virtual reality”, “AR”, “regulation”, and “evaluation”. Documents were included focused on XR in healthcare, mental health applications, and available in English. Insights from the desk research informed the scope of our report and supported the landscape mapping conducted via the FOI and surveys.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

1. UK XR Healthcare market assessment

Introduction

Extended Reality (XR) technologies, encompassing virtual reality (VR), augmented reality (AR), mixed reality (MR), and related immersive systems, are increasingly being explored across the UK for applications in healthcare, education, and research [1]. While early adoption was often concentrated in specialist centres and research projects, the pace of implementation has accelerated in recent years, particularly following the COVID-19 pandemic, which prompted rapid digital innovation in service delivery and training [8]. Despite this growth, there remains limited up-to-date evidence on the extent, nature, and maturity of XR adoption across different sectors, including the NHS, universities, and private companies. Understanding where and how XR is currently being used, as well as the challenges and opportunities faced, is imperative for identifying good practice, supporting investment, and informing policy and regulation.

To address this evidence gap, Freedom of Information (FOI) requests and sector-specific surveys were conducted to capture a snapshot of XR deployment across the UK. Separate but comparable data collections targeted NHS Trusts in England, Health Boards in Scotland and Wales, and Trusts in Northern Ireland; UK universities; and private sector companies operating in the XR healthcare and mental health space. The findings presented in this report provide an analysis of responses received up until **1st September 2025.**

This section focuses on NHS adoption of XR technologies, summarising the responses from Trusts in each country and highlighting key trends in uptake, areas of application, maturity of deployment, and supporting infrastructure such as laboratories and centres of excellence. The results provide an important baseline for understanding the current position of XR within the NHS, as well as insights into emerging patterns that may inform future roll-out and cross-sector collaboration.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

NHS

On the 19th June 2025, FOI requests were sent to all NHS Trusts in England with further requests sent to the Health Boards of Scotland and Wales and Trusts of Northern Ireland on the 10th July. As of the 1st September, **147 responses had been received** from the 194 Trusts in England (75%) in addition to responses from all of the NHS Scotland and Wales Health Boards and four of the six Northern Ireland Health and Social Care Trusts.

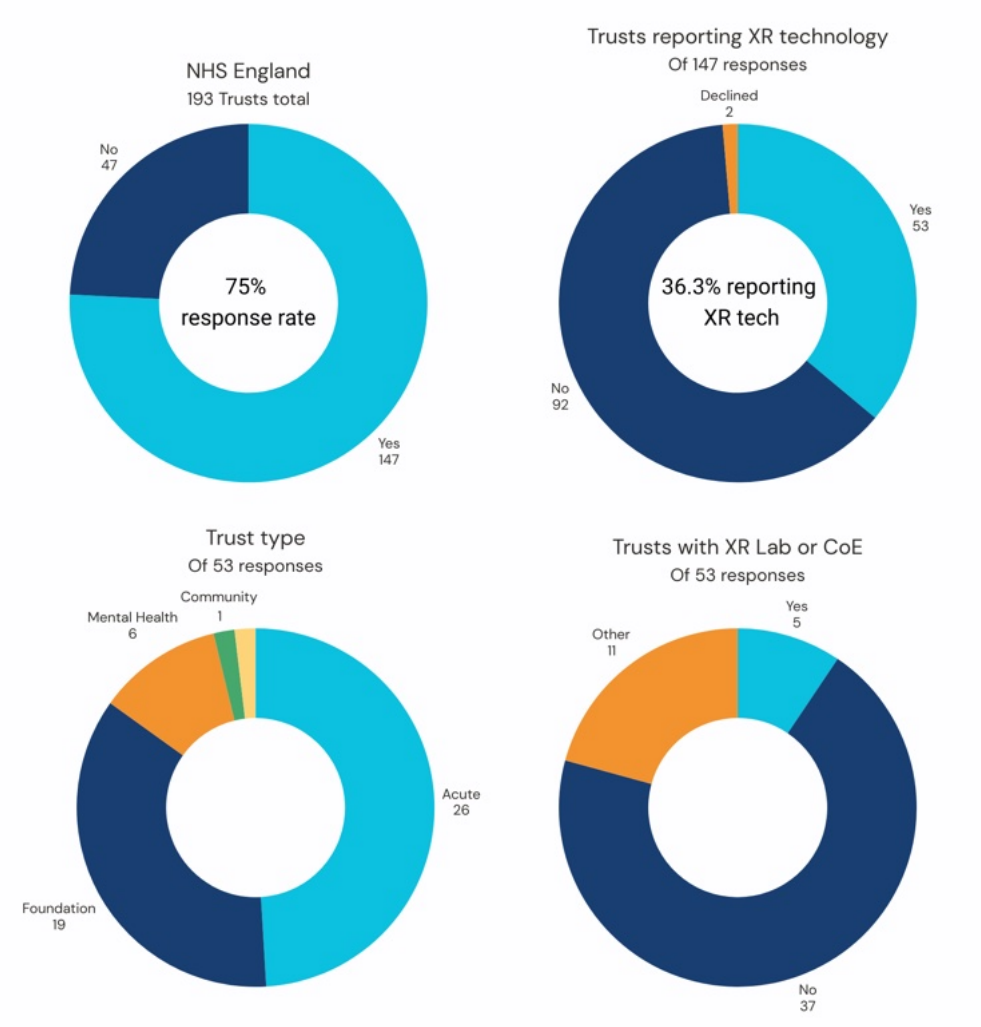
England

Of the 147 responses received from Trusts in England, **53 reported having XR technology** (36.3%) within their organisation with 92 reporting no XR technology and 2 declining to respond to the FOI requests, either due to the time limit associated with FOI requests or cybersecurity concerns.

Overview of Trusts

Of the 53 Trusts reporting XR technologies, 26 were Acute (Hospital) Trusts, 19 were Foundation Trusts, 6 were Mental Health Trusts, 1 was Community Health Trust and 1 was a Specialist/Integrated Trust. Furthermore, 5 Trusts reported having a dedicated Lab or Centre of Excellence (CoE) for XR technologies. 37 Trusts reported no Lab or CoE but 11 Trusts reported having teams, units, suites or communities within their Trust focused on XR technologies and one upcoming National Centre for Child Health Technology currently being built.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



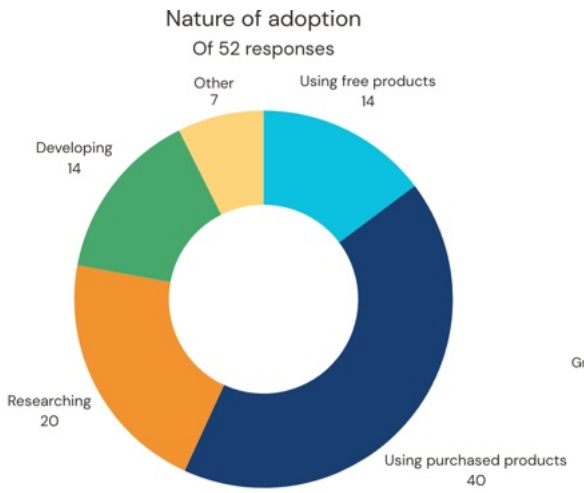
XR Adoption

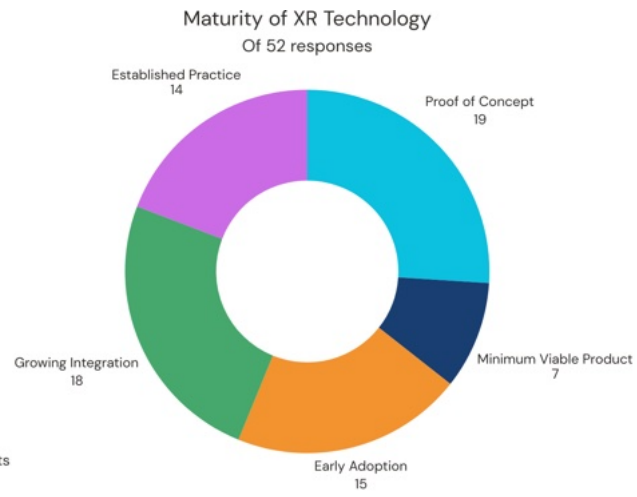
One Trust provided a partial response and therefore, the following data accounts for 52 Trust responses. Trusts varied in their adoption of XR technologies, most commonly reporting the use of purchased products, however the FOI request allowed respondents to select all appropriate categories of adoption. As a result, 14 reported using free XR products, 40 reported using purchased products, 20 reported researching technologies and 14 reported developing XR technology. A further 7 selected 'other' with one clarifying that the Trust was using an XR technology as part of a trial.

Maturity

These technologies varied in their maturity with 19 being Proof of Concept and 14 being Established Practice, with 7 being a Minimum Viable Product, 15 being in early adoption and 18 growing integration.

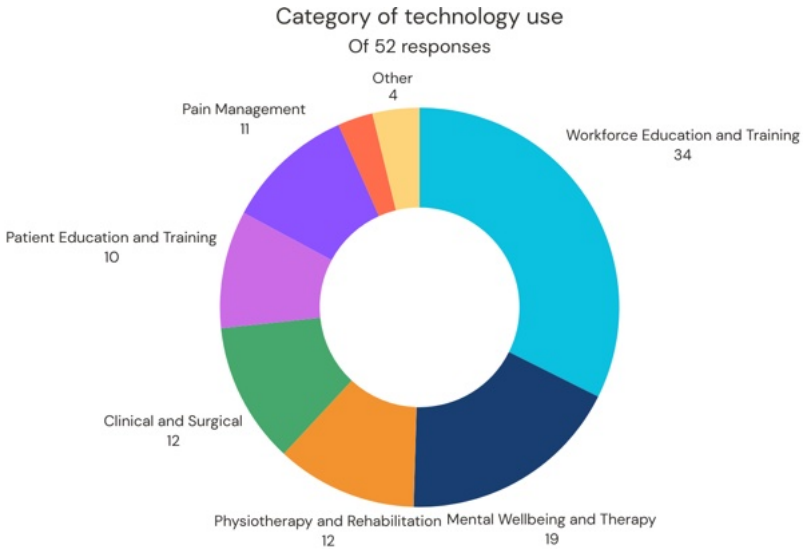
Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION





Purpose

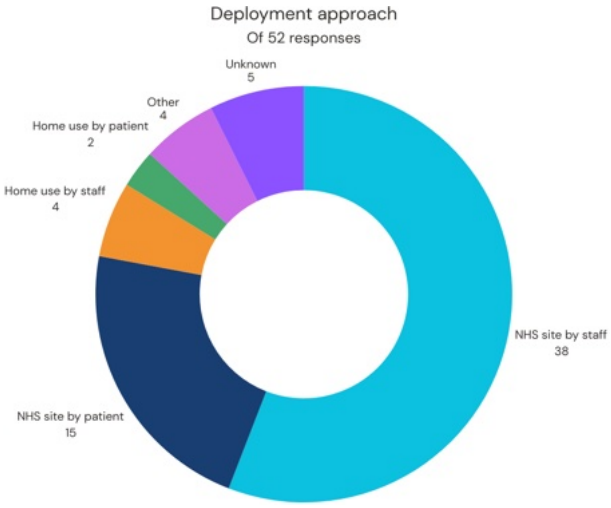
Of the technologies being reported, the most common category was technology being used for Workforce Education and Training (n=34). This is followed by Mental Wellbeing and Therapy (n=19), Physiotherapy and Rehabilitation (n=12), Clinical and Surgical (n=12), Patient Education and Training (n=10), Pain Management (n=11) and Healthy Lifestyle and Fitness (n=3). 4 selected 'Other'.



Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

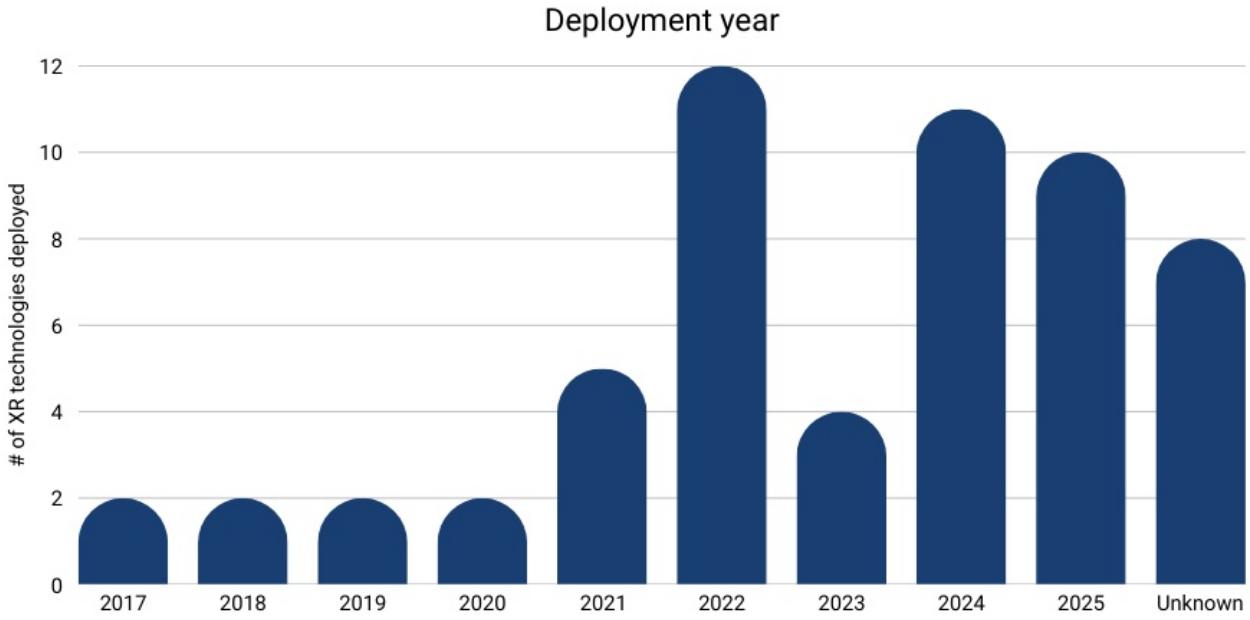
Distribution and deployment

When asked about how the technology is distributed, the most common answer was that XR technology is used at NHS sites by staff members (n=20), followed by being used at NHS sites by patients (n=3), home use by staff (n=2) and home use by patients (n=1).



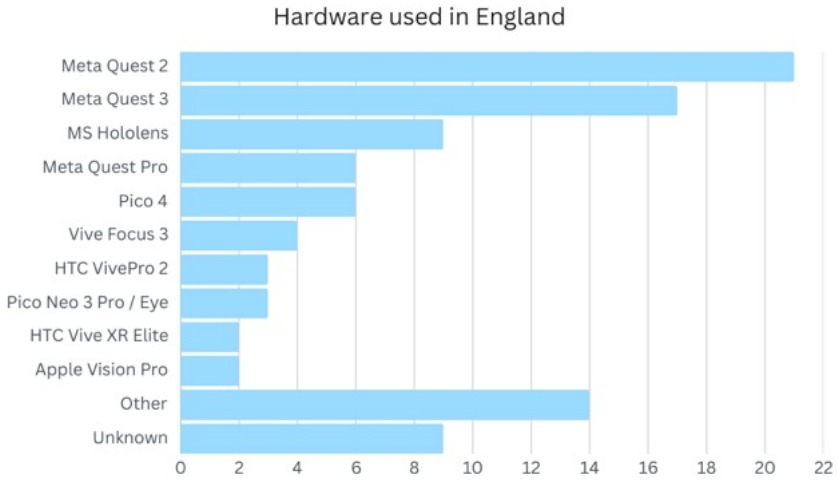
Deployment of XR in the NHS has steadily increased over the years, with 2022 being the peak deployment year (12 technologies) so far but 2025 statistics already show to be approaching this number (10), showing an encouraging trend. This upward trend of deployment in NHS England demonstrates the impact that the Covid-19 pandemic and NHS Long Term Plans may have had in encouraging the adoption of these technologies into service delivery.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

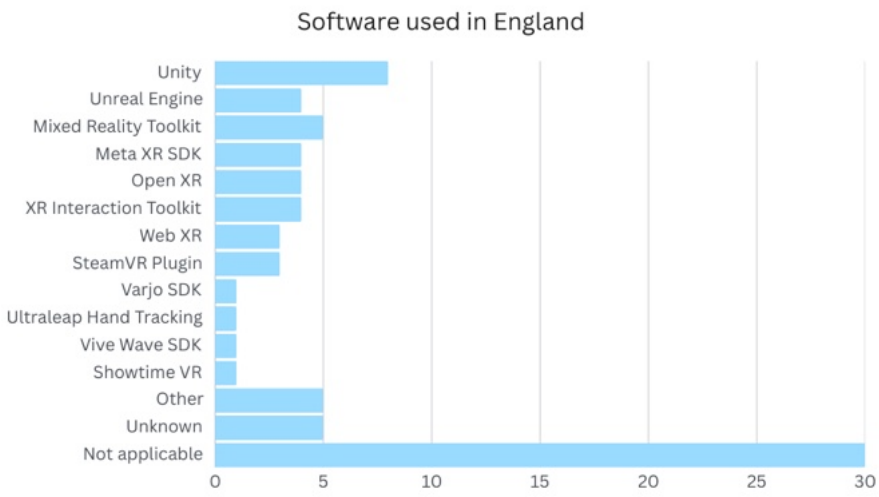


Types of XR

Meta products were the most commonly reported XR **hardware** being used by Trusts, followed by the Microsoft Hololens, Pico products and HTC. Those Trusts that selected 'other' technologies included technologies such as Cave Automatic Virtual Environments (CAVEs). 'Unknown' indicates Trusts were unable to answer or not aware of which hardware is being used. Additionally, many Trusts were unable to answer which **software** was being used to develop new XR technologies or this was 'not applicable' to those not developing XR. However, Unity was marginally the most popular.



Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



Scotland

All of the 14 Health Boards of NHS Scotland replied to the FOI requests for this project. Of these 14 Health Boards, **4 reported having XR technology** within their organisation, with the remaining 9 reporting no XR technology being used and 1 Health Board declining the request. The Health Boards reporting XR technology are as follows:

- NHS Fife
- NHS Forth Valley
- NHS Greater Glasgow & Clyde (NHSGGC)
- NHS Highland

None of these Health Boards reported having a dedicated Lab or Centre of Excellence for XR technology, but three reported using purchased XR products and the other reported to be conducting research into XR technologies for health.

When asked which **products** are being adopted by these Health Boards, some included a list of hardware and headsets such as the Meta Quest and Vision Pro headsets but the following products and their uses were also reported:

- Sim X is a VR simulation system used in medical education and training to reinforce critical thinking and clinical decision-making by simulating patient conditions.
- PeriVision for VR-based visual function testing and home/near-patient glaucoma monitoring.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- Healthy Mind for immersion to combine VR technology, medical hypnosis and advanced therapeutic principles to alleviate pain and anxiety.
- Brain Lab to bring 3D perspectives into functional neurosurgery case reviews.

Oxford Medical Simulation and other teaching pilots were also reported. Of these reported technologies and their level of **maturity**, one was Proof of Concept, two were in Early Adoption, one was Growing Integration and one was Unknown. These Health Boards were also asked which categories in which these technologies were being used:

- NHS Fife: Clinical and Surgical & Workforce Education and Training
- NHS Forth Valley: Clinical and Surgical, Patient Education and Training & Workforce Education and Training
- NHS Greater Glasgow & Clyde: Clinical and Surgical
- NHS Highland: Mental Wellbeing and Therapy, Pain Management & Workforce Education and Training.

All of these technologies were being used on NHS sites only, three with staff and one with patients. One was reportedly deployed in 2024, another in 2025 with the others either not being deployed yet or unknown. Health Boards reportedly used Apple Vision Pro and Meta Quest Pro (1), Meta Quest 3 (1), Pico Neo 3 Pro / Eye and Meta Quest 2 (1) headsets for their hardware with one reporting 'not applicable' and all Health Boards were unable to answer which software was being used.

Wales

All of the 7 Health Boards of NHS Wales replied to the FOI requests for this project. Of these 7 Health Boards, **3 reported having XR technology** within their organisation, with the remaining 4 reporting no XR technology. The Health Boards reporting XR technology are as follows:

- Aneurin Bevan University Health Board
- Cwm Taf Morgannwg University Health Board
- Powys Teaching Health Board

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

None of these Health Boards reported having a dedicated Lab or Centre of Excellence for XR technology, but two reported using purchased XR products and the other reported to be using purchased products and conducting research into XR technologies.

When asked which **products** are being adopted by these Health Boards, some included a list of hardware and headsets such as the Meta Quest 3 and Microsoft Hololens headsets but one Health Board also reported the use of the commercial product, DR.VR. This product provides four different types of content: distraction, instructional, relaxation course (8 relaxation and mindfulness meditation sessions) and games and patients can choose which content they would like to access.

Of these reported technologies and their level of **maturity**, one was Proof of Concept, one was Growing Integration and one was reported as 'other'. These NHS Bodies were also asked which categories in which these technologies were being used:

- Aneurin Bevan University Health Board: Mental Wellbeing and Therapy & Healthy Lifestyle and Fitness
- Cwm Taf Morgannwg University Health Board: Mental Wellbeing and Therapy
- Powys Teaching Health Board: Clinical and Surgical

Two of the NHS Bodies reported that the XR technology is used on NHS sites only by patients and staff with the other being used at home by staff. One was reportedly deployed in 2021, another in 2022 and the final being deployed in 2024. NHS Bodies reportedly used the Meta Quest 3 (1) and Microsoft Hololens (1) headsets for their hardware with one reporting use of only the DR.VR headset and software. The remaining two NHS Bodies said the question on which software was being used was 'not applicable', suggesting it is not being used for development at all.

Northern Ireland

Freedom of Information requests were also sent to the 6 Health and Social Care Trusts of Northern Ireland, to which 4 responses. **2 of these Trusts reported using XR technology**: Northern Health and Social Care Trust (NHSC) and Southern Health & Social Care Trust (SHSC). Neither Trust has a dedicated XR Lab or Centre for Excellence.

NHSC are reportedly using purchased products and also researching and developing XR technologies. For example, they are using Oculus Quest 3 headsets to create

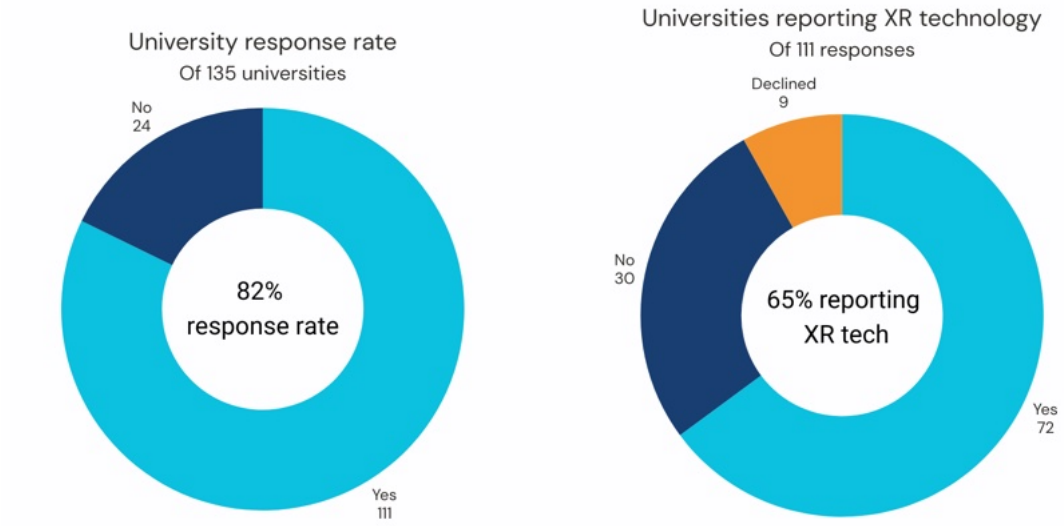
Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

personalised immersive environments for use in exposure therapy for trauma and PTSD. Currently considered as being proof of concept, it was first deployed in 2022 for Mental Wellbeing and Therapy at NHS sites by staff and patients.

Meanwhile, **SHSC** uses purchased products but withheld aspects of information for cybersecurity reasons, but uses XR technology for virtual walk-throughs for patients prior to appointment attendance as part of patient familiarisation and anxiety prevention measures and for staff training for specialist work area walk-throughs. This was deployed in 2023 and is considered to be in early adoption stages in NHS sites. SHSC declined to say which hardware and software is being used by the Trust.

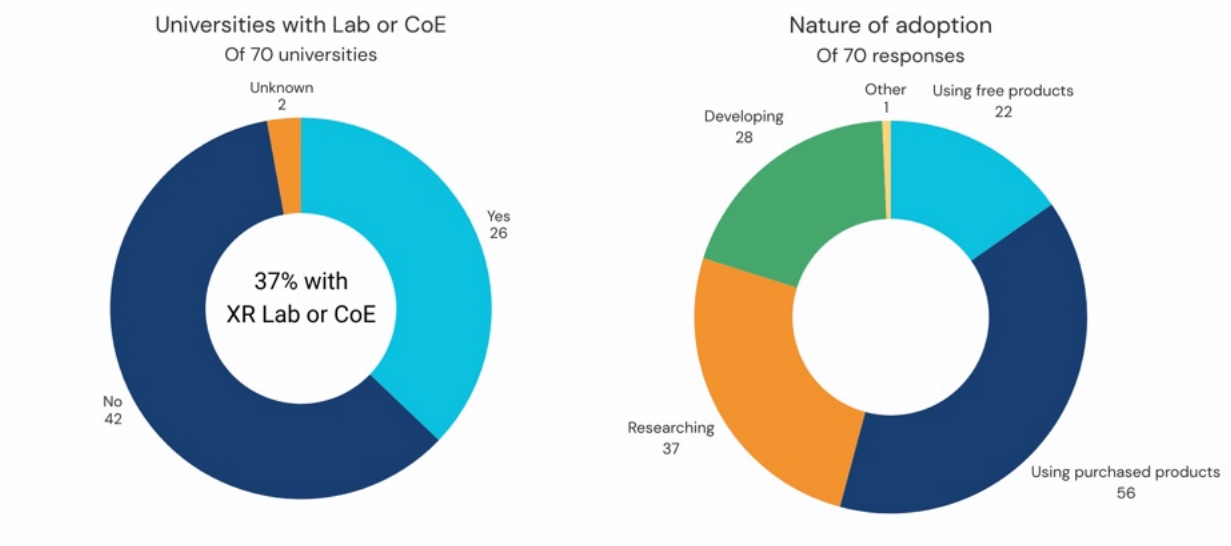
Universities

On the 19th June 2025, FOI requests were sent to all 135 registered universities in the UK. By the 1st September, 111 responses had been received (82%). Of these 111 responses, **72 universities reported using XR technology** (65%) within their organisation with 30 reporting none and 9 declining to respond to the request. However, there were two separate joint responses, meaning 70 responses will be reported hereafter.

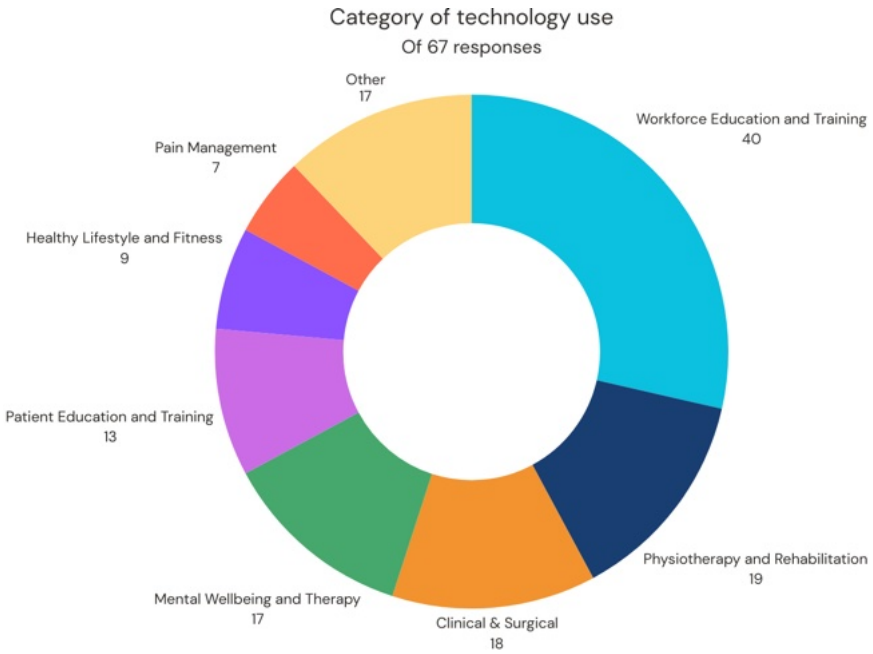


Of the 70 universities reporting that they have or use XR technology, 26 of these universities have a dedicated **Lab or CoE for XR technology**. A further 42 answered no but 10 of these reported having research groups, stimulation facilities or dedicated areas on campus for XR use or research and 2 selected ‘unknown’.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



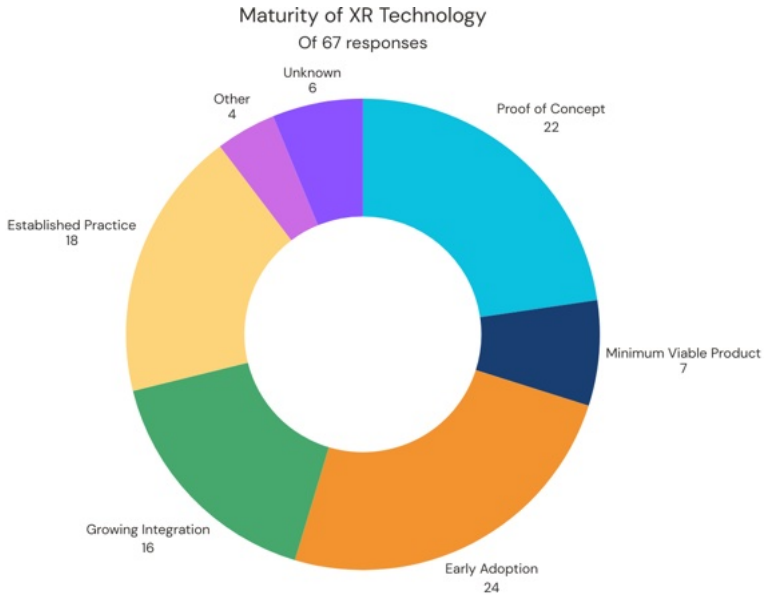
Universities had a more even split between their **nature of adoption** for XR technology, but using purchased products was still most common (38.9%) and respondents were allowed to select all appropriate options. As a result, 22 reported using free XR products, 56 reported using purchased products, 37 reported researching technologies, 28 reported developing XR technology and 1 selected 'other'.



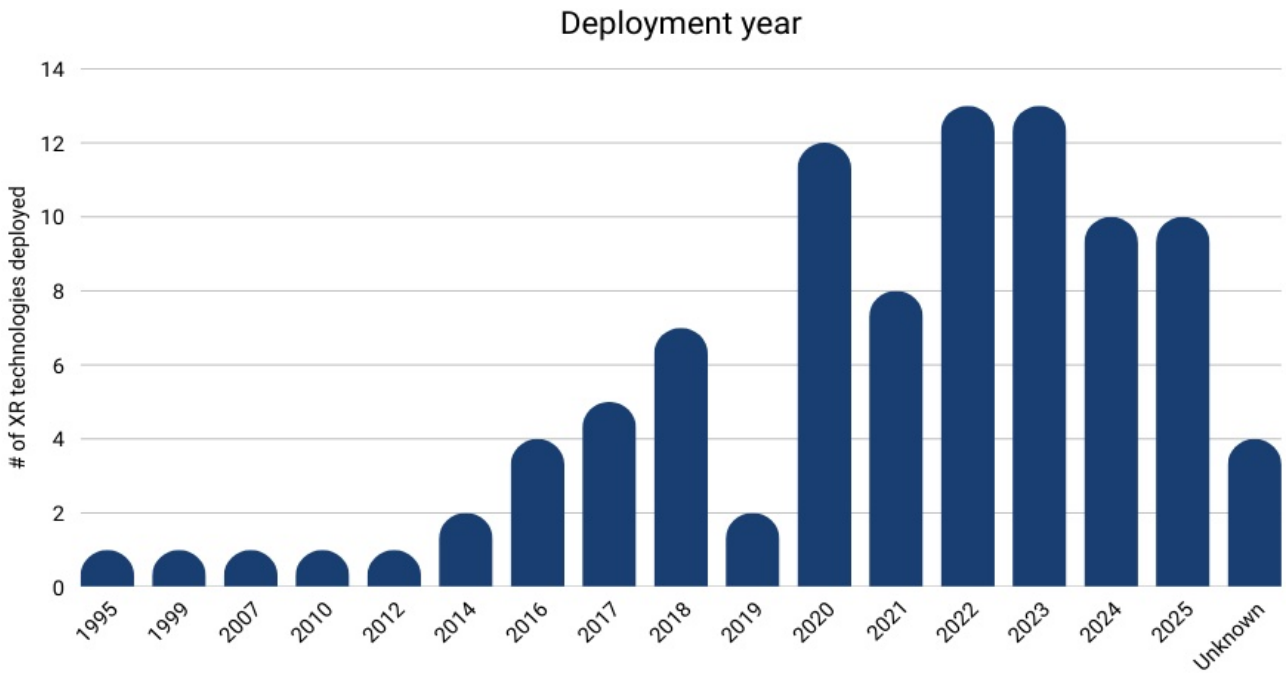
3 of the 70 respondents declined to answer further questions, therefore 67 responses will be reported hereafter. Similarly to the NHS responses, XR technology was most used, researched or developed for Workforce Education and Training (n=40). The next most common categories are Physiotherapy and Rehabilitation (n=19), Clinical and Surgical (n=18), Mental Wellbeing and Therapy (n=17), Patient Education and Training (n=13),

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Healthy Lifestyle and Fitness (n=9) then Pain Management (n=7). An additional 17 selected 'other', identifying that XR technology is used for student education and training which is one of the key differences between deployment in NHS settings versus use within university settings.



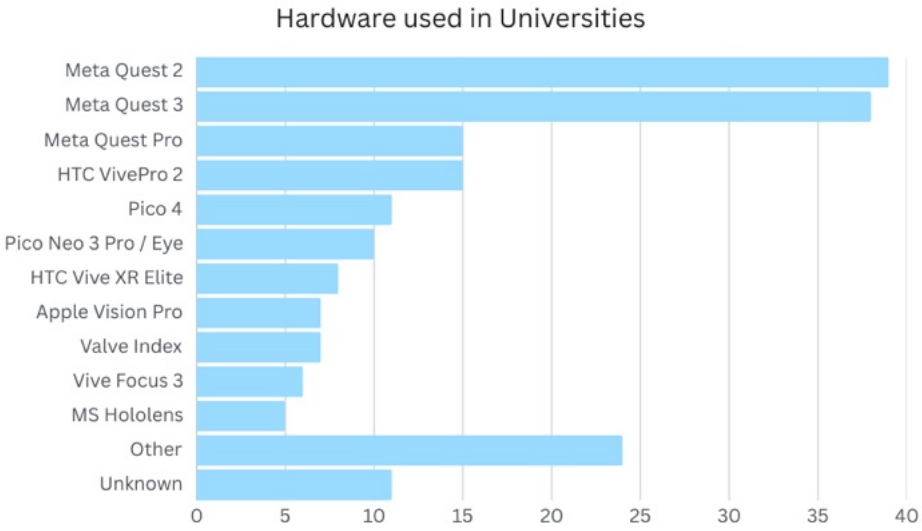
There was considerable variability in the **maturity** of the reported technology: 22 were Proof of Concept, 7 were Minimum Viable Products, 24 were in early adoption, 16 were growing in integration, 18 were established in practice in the organisations with another 6 being unknown and 4 'other'.



Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

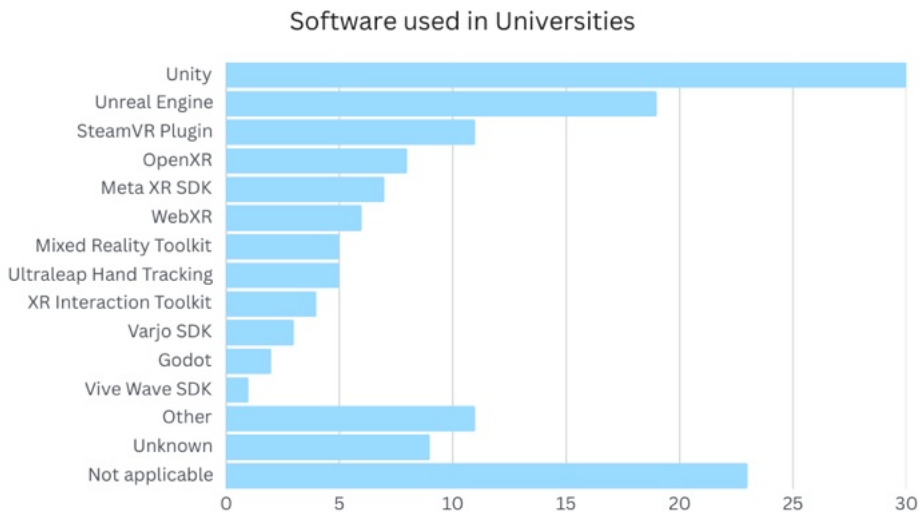
Compared to the NHS, XR technologies were being researched, developed and deployed in universities considerably earlier. Some reported technologies were being researched and deployed earlier than 2020, with XR research groups dating back to 1995 with some clarifying that research began before some technologies were formally deployed and available. Technologies were most commonly deployed during and following 2020, the year the pandemic started, with levels remaining steady thereafter. 4 reported the deployment date as 'unknown'.

Universities also reported a significantly higher number of hardware products and greater variety than the NHS but Meta products remained the most popular followed by HTC and Pico products. 11 also selected 'other' which included an onsite and streaming CAVEs.



With the greater number of respondents developing XR technology, more software is being used by universities. Unity was the most popular, followed by Unreal Engine and SteamVR Plugin.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



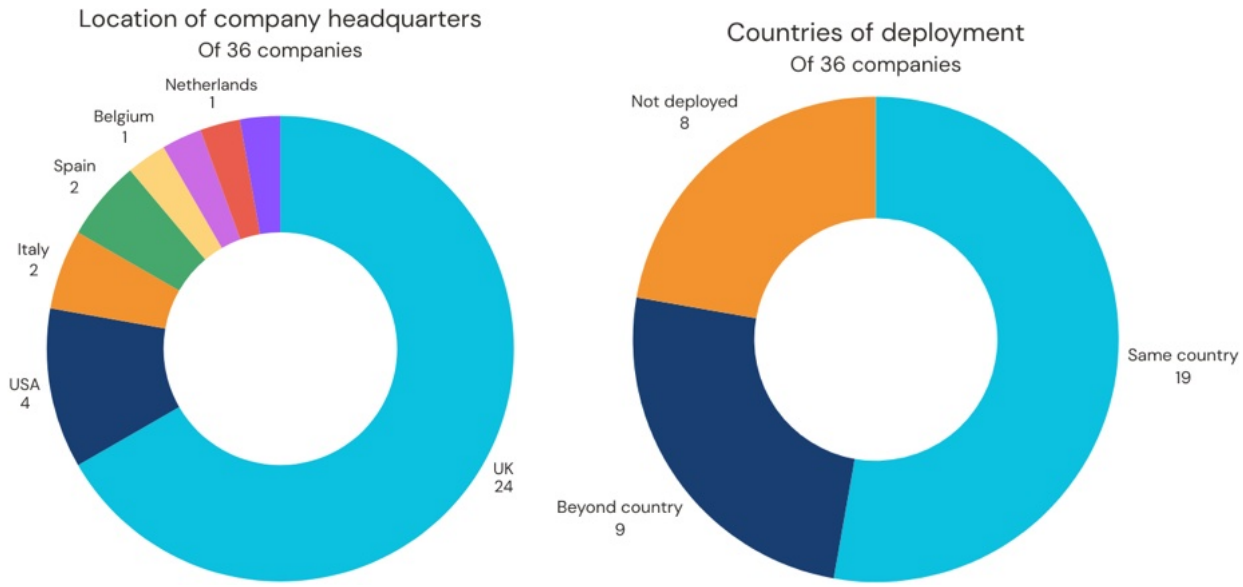
Private sector companies

Data from private companies deploying XR technologies was collected using an AI chatbot assisted survey (see Research Methodology). By the **2nd September, 36** different companies had filled out this survey (accounting for duplicate responses) providing details of their company, XR technology, which disorders and populations their technology covers and what challenges they have faced among other details.

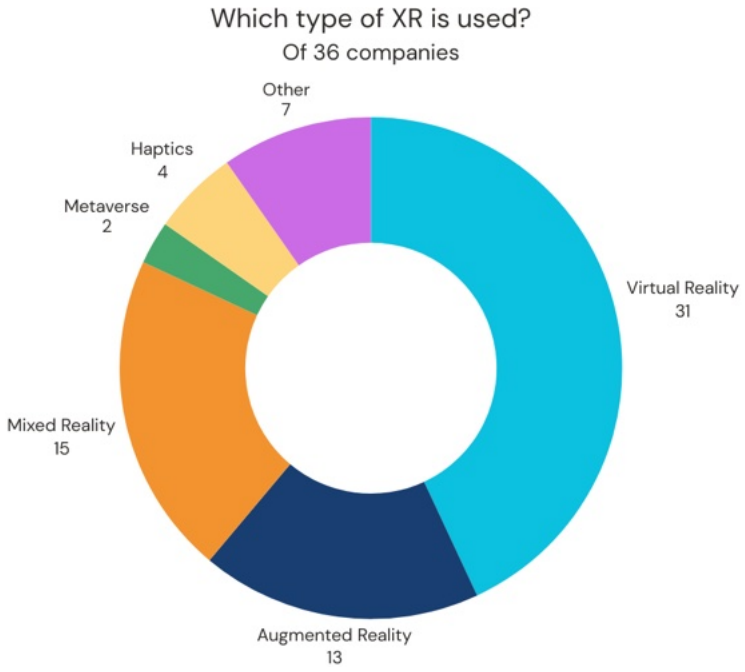
Of these 36 companies, the majority (24) had their company **headquarters located** in the United Kingdom but other headquarter locations included the USA (4), Italy (2), Spain (2), Belgium (1), the Netherlands (1), Poland (1) and Ireland (1).

Of these companies, 8 had not yet **deployed** their XR products. Meanwhile, 19 had deployed them exclusively within the same country as their headquarters, with 9 deploying outside of their headquarter's country; including the EU (e.g. Germany, Belgium, the Netherlands, France, Poland, Sweden), North America (e.g. USA, Canada) and some reporting worldwide deployment including Australia, South East Asia, New Zealand.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



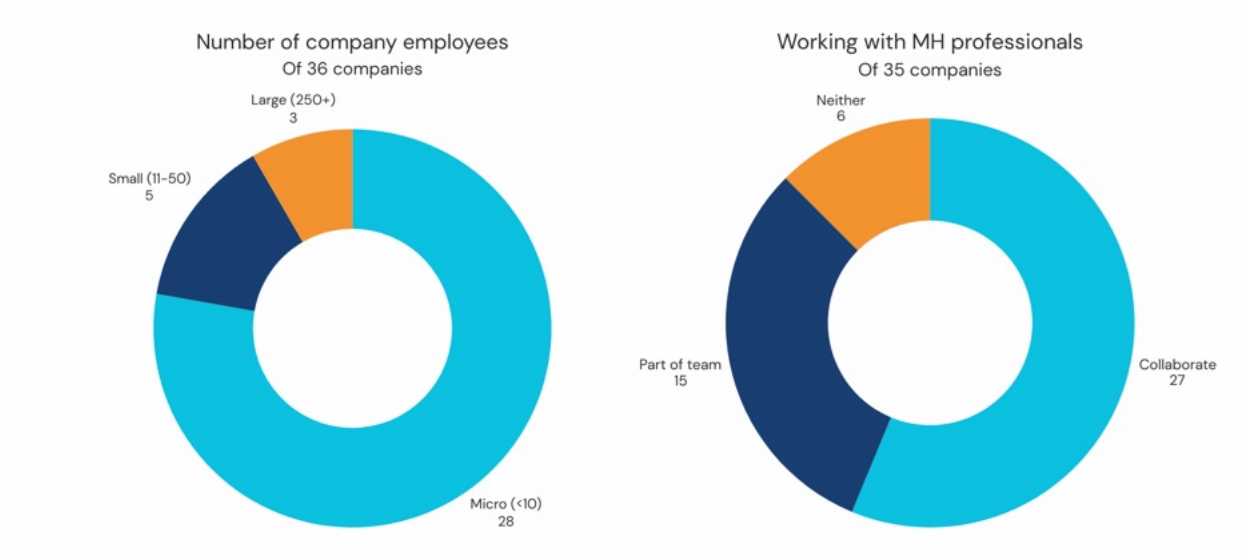
When asked **which type of XR technologies** the companies were using for their products, the majority of companies in the survey reported using virtual reality (n=31). However, companies were able to select multiple options, with 15 companies using augmented reality, 15 using mixed reality, 2 using metaverse, 4 using haptics and 7 selecting 'other'. Of these, 12 companies indicated only using one type of these technologies while the remaining 24 reported using multiple different XR technologies.



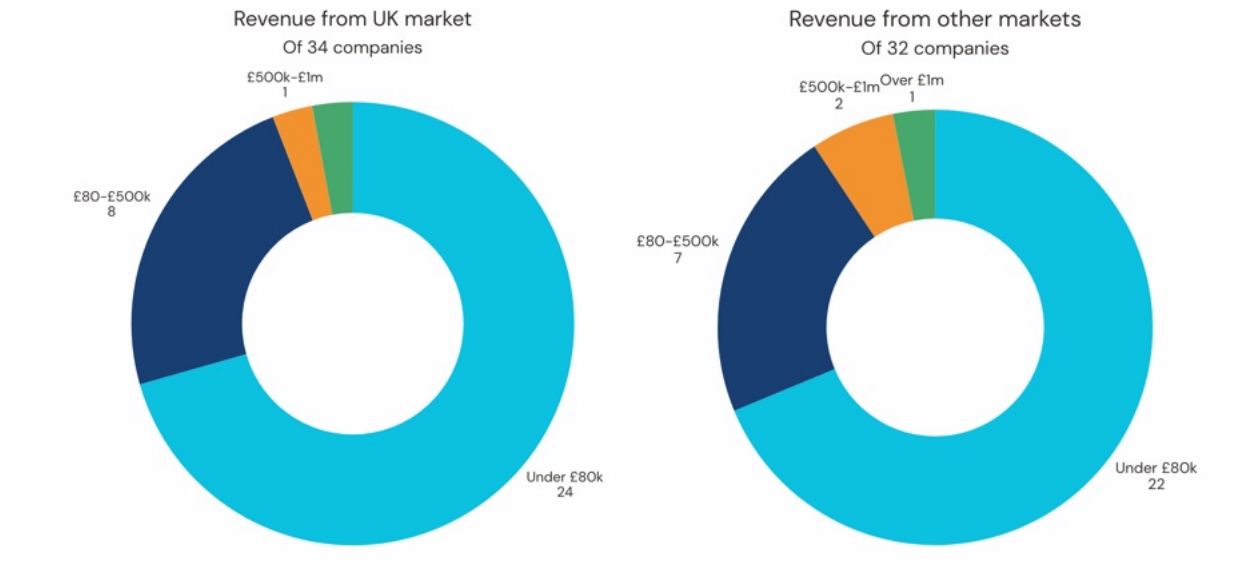
The majority of companies who responded to our survey were micro companies, with less than 10 employees (n=28) and typically collaborate with **mental health professionals** (n=27) with many also reporting to have mental health professionals

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

embedded within their team (n=15). Six companies reported that they had not worked with mental health professionals. The market appears still nascent in terms of the **size of the companies** occupying the space. Therefore, early movers into the space are likely to benefit from an open market which they can scale rapidly into.

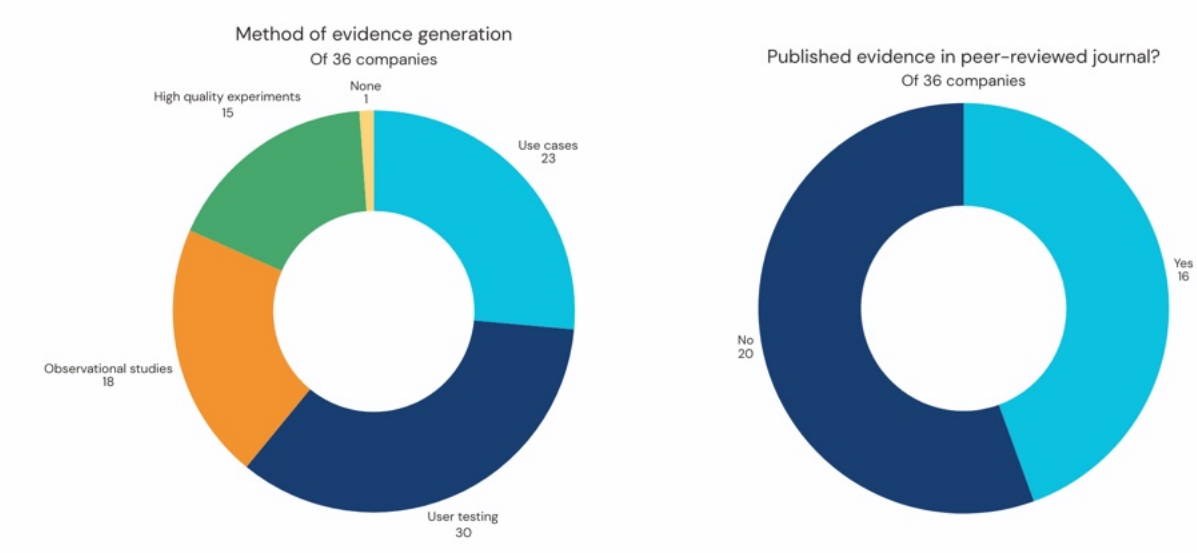


Only one company reported that their UK **revenue** was over £1 million with the majority reporting under £80k (n=24). This was similar to the revenue from other markets.

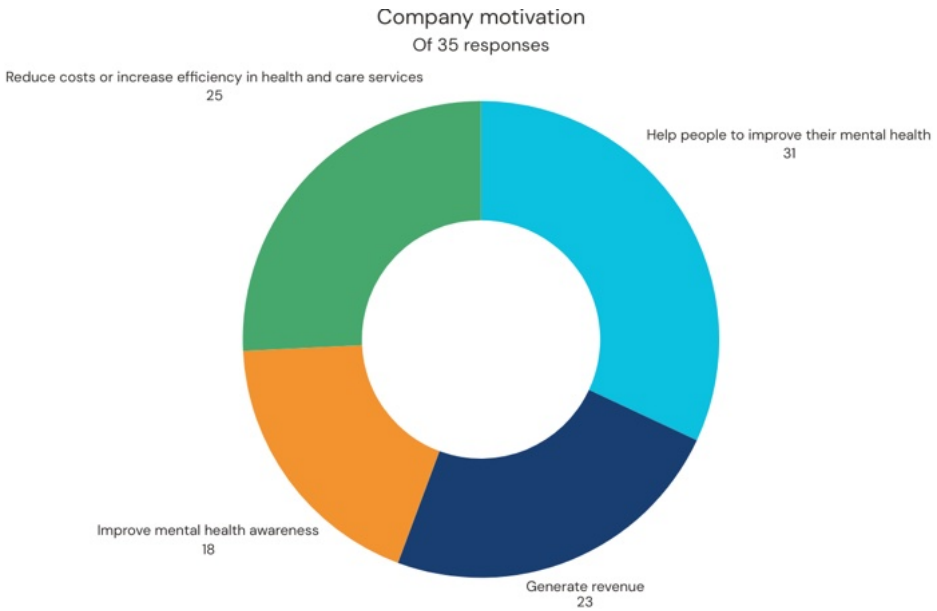


Evidence is mainly being generated through user testing (n=30) and use cases (n=23) with 15 reporting that they had conducted high quality experiments and 16 reporting that evidence had been published in a peer-reviewed journal. Only one company reported that they had not yet generated evidence.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

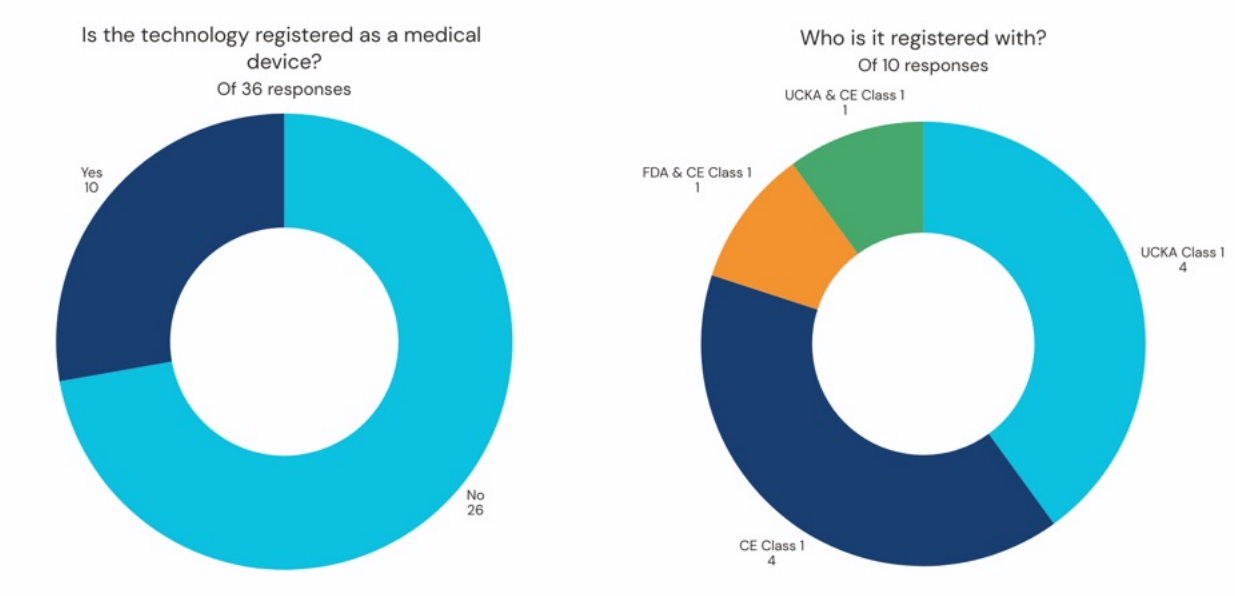


Companies were asked their **motivation** for developing XR technologies. Most companies selected multiple answers but answers were split between helping people with their mental health (31), generating revenue (23), improving mental health awareness (18) and reducing costs and improving efficiency in services (25).

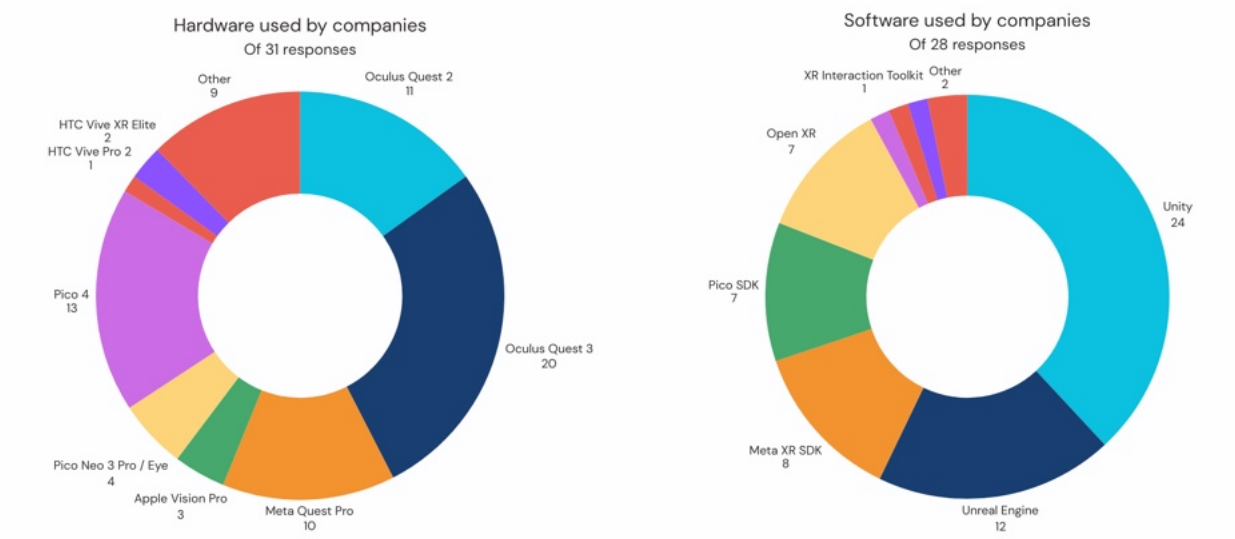


The majority of companies have not registered their products as **software as a medical device** (n=26) but of the 10 that have, four are registered in the UK, four in the EU with one being registered in both the US and EU and the final one being UK and EU registered.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION



Meta Quest products were still most popular amongst companies, similar to the NHS and universities, particularly the Meta Quest 2 and 3 headsets. However, Pico, Apple and HTC products were also used. Similarly, Unity and Unreal Engine were also the most popular software.



Populations and target markets

To understand the target markets and populations for XR companies, they were asked 1) who they market their products to, and 2) to describe who the end-user of their products are and the specific organisations who may use it.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

As shown in the graph, almost all companies market to healthcare venues, both private and public, including hospitals, NHS Trusts and Talking Therapy services. Many also market their products for educational purposes, such as to universities for medical or nursing students with other companies also marketing to the third sector and social care (including charities, care homes, voluntary healthcare), to employers (such as Employee Assistance Programs and workplace wellbeing initiatives) and some directly to consumers (general population, individuals, those with specific conditions).

End-users and organisations were described by each company and included:

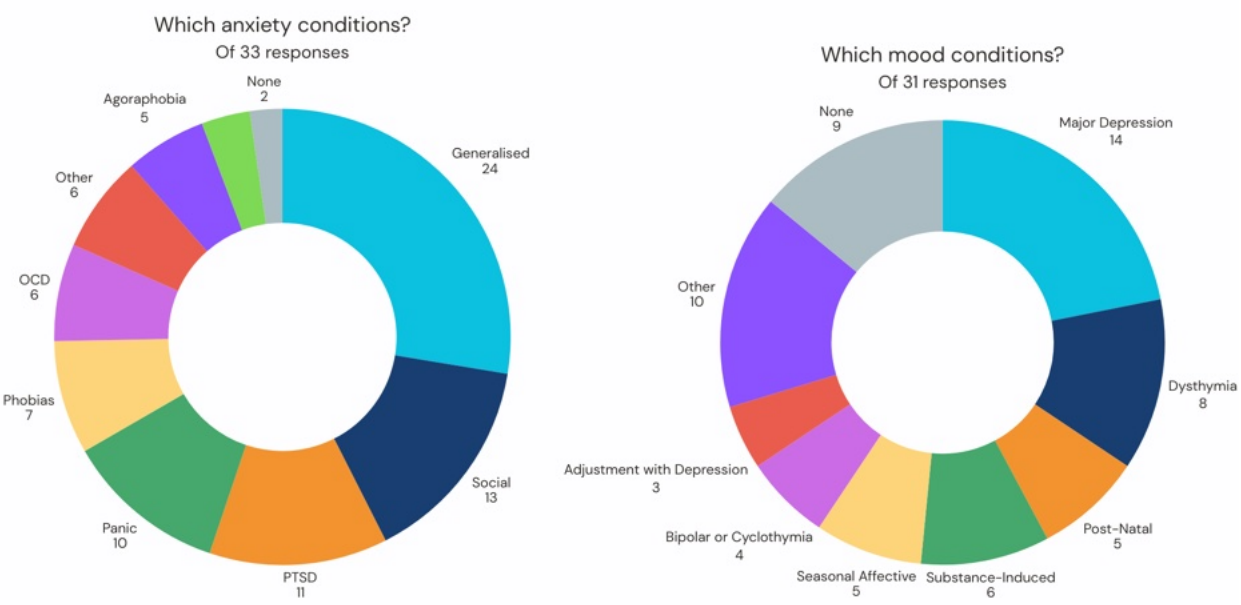
- Mental health and healthcare professionals (including those in Talking Therapies, private healthcare, NHS Trusts, occupational health)
- Researchers and universities (including those with XR labs and research students)
- Care homes and workers (including psychologists, activity coordinators, care therapists)
- Direct to individuals (also referred to as patients, service users and/ or clients)
- Other therapists including art therapists and coaches
- Educators of medical and nursing students
- General population and those with specific mental health conditions such as depression or anxiety (direct to consumer)

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- Specific population groups such as young people, marginalised groups, those with specific conditions.
- Employers for employee wellbeing services, workplace settings, HR
- Charities and voluntary sector organisations

Conditions

Anxiety (n=31) and depression (n=22) are the most common mental health conditions that companies targeted with their XR products. The most common anxiety conditions targeted are generalised and social anxiety, with some companies also covering post-traumatic stress disorder (PTSD), panic disorder, phobias, obsessive-compulsive disorders and other anxiety conditions. Similarly, whilst major depression, dysthymia and "other" were targeted the most by companies, adjustment disorder, substance induced mood disorder and bipolar were the least covered.



One company reported that they targeted all disorders but also indicated that they are developers employed by others to make products - this suggests that not all companies are already equipped with the clinical knowledge but feel confident that their skills can be applied in all areas of mental health.

Other conditions that were covered by companies include eating disorders such as anorexia or binge-eating disorder (n=5), psychotic disorders such as schizophrenia and psychosis (n=5), neurodegenerative diseases such as Alzheimer's and Motor

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Neurone Disease (n=8), cognitive-related conditions such as Vascular or Lewy Body dementia (n=3). Other conditions reported included stroke (n=6), traumatic brain injuries (n=5), epilepsy, brain tumours and multiple sclerosis (n=3). Most companies reported covering more than one condition.

Companies in this survey were also asked about the challenges they have experienced and where they see future opportunities for XR technologies. These are reported in the Challenges and Opportunities section of this report.

Market trends, growth potential, and investment opportunities.

Our Freedom of Information requests to NHS Trusts and UK universities revealed consistent patterns of how immersive technologies are being deployed across the healthcare ecosystem.

The data shows five primary application categories with varying levels of implementation and adoption between clinical and application settings:

74 Workforce and Education Training Sites

36 Mental Wellbeing and Therapy Sites

31 Physiotherapy and Rehabilitation Sites

30 Clinical and Surgical Sites

23 Patient Education and Communication Sites.

This distribution demonstrates that while workforce training dominates current applications, significant investment is also being directed into rehabilitation and therapeutic interventions. These findings suggest that UK healthcare institutes are beginning to embrace immersive across education and clinical domains, but universities are leading adoption of XR technologies, primarily for research and development (R&D) or student education, compared to NHS Trusts.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Workforce Education and Training

With 74 total implementations (NHS n=34, universities n=40), workforce education and training represents the most substantial application area for XR technologies in UK healthcare settings. Universities are leading this adoption, leveraging immersive environments to revolutionise how healthcare professionals, such as medical and nursing students, are trained. It is important to highlight here that another 17 universities reported 'other' categories of adoption. This primarily was explained to be for student education and training, showing an even greater use of XR technologies in the training of current and future healthcare professionals. This is perhaps unsurprising given one of the key functions of universities is for student education, but universities also engage heavily in research and development (R&D) and this is highlighted in how universities are more likely to be researching XR technologies than NHS sites.

The applications primarily focus on three key domains:

- Clinical simulation training in controlled, repeatable virtual environments
- Soft skills development, including communication, empathy, and patient interaction
- Process-driven tasks and procedural training for standardised care delivery

This widespread adoption reflects the significant advantages of immersive learning: reduced training costs, elimination of patient risk, standardised educational experiences, and the ability to practice rare or high-risk scenarios repeatedly until competency is achieved.

The University implementations suggest that XR technologies are being integrated into curriculum development and research initiatives before transitioning to clinical settings, potentially creating a pipeline of healthcare professionals already familiar with immersive training methods before entering NHS employment. High numbers within the NHS also suggest that XR technologies are playing a role within training in-situ, demonstrating their value in education but also opportunities for healthcare professionals to improve digital literacy.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Mental Wellbeing and Therapy

With 36 total implementations (NHS n=19, universities n=17), mental health and wellbeing highlight a significant area of growth for VR/AR applications in UK healthcare. As shown by the data collected from XR companies, the majority of these products may focus on depression and anxiety conditions but extend beyond this into other complex conditions such as Alzheimer's, dementia, eating disorders and psychotic disorders.

Anxiety Treatment

Virtual environments allow patients to confront anxiety-inducing situations in controlled settings, with therapist guidance and adjustable intensity levels. This form of exposure therapy shows particular promise for specific phobias and social anxiety disorder. The majority of treatments tend to appear within B2B and healthcare contexts, however, there is an increasing interest in B2C interventions. These include fear of heights and fear of public simulations that are being launched on online platforms for usage at home.

Cognitive Behavioural Therapy (CBT)

XR-enhanced CBT creates interactive scenarios for patients to practise cognitive restructuring and behavioural techniques in realistic situations, providing immediate feedback and reinforcement of therapeutic principles. A lack of an evidence base and the time and expense of the medical device regulation (MDR) classification pathway has resulted in a dearth of CBT for treatment offers so far (a similar picture exists in the Artificial Intelligence CBT space currently also). Therefore, until the pioneers in this space further develop a larger evidence base, therapy either direct to patients or facilitated by a healthcare professional within the NHS, will struggle to scale at pace. Investment support to develop evidence and XR specific regulatory development is critical to bridge this barrier.

Mindfulness and Relaxation

Immersive natural environments and guided meditation experiences are being deployed for stress reduction, pain management, and general wellbeing support, offering multi-sensory engagement that enhances traditional relaxation techniques. In many cases, the new MHRA guidance would suggest that these types of XR

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

technologies may not classify as a software as a medical device, suggesting a market for non-clinical wellbeing tools.

Given the balanced adoption across clinical and academic settings, this equal distribution suggests that mental wellbeing applications have successfully bridged the research-to-practice gap, with effective knowledge transfer between universities and NHS mental health services. UK researchers are particularly focused on evaluating long-term efficacy and identifying which patient populations benefit most from these immersive therapeutic approaches, with several large-scale clinical trials currently underway across the country.

Physiotherapy and Rehabilitation

With 31 total implementations (NHS n=12, universities n=19), physiotherapy and rehabilitation represents an important area for VR/AR applications in UK healthcare. Academic institutions are leading research and development, with data to suggest that promising innovations are successfully transitioning to clinical practice.

The primary focus areas include:

- Stroke rehabilitation, particularly for upper limb function recovery
- Neurorehabilitation for traumatic brain injury and neurological conditions
- Movement re-education and gait training
- Gamified therapy approaches to increase patient engagement and adherence.

These applications leverage the motivational aspects of immersive environments, addressing a critical challenge in rehabilitation: patient engagement with repetitive exercises. By transforming necessary repetitions into engaging activities with immediate feedback, VR/AR technologies are demonstrating improved compliance and potentially accelerated recovery trajectories.

UK research centres are particularly focused on developing adaptive systems that automatically adjust difficulty based on patient performance, creating personalised rehabilitation programmes that evolve with the patient's recovery journey. NHS Trusts are now evaluating these systems for potential wider implementation across rehabilitation services but not in a systematic manner. Further research funding

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

(outside of the Mindset XR Programme which concentrates solely on mental health) is necessary to develop the evidence for this and other healthcare verticals, particularly research that can demonstrate not only improved outcomes but cost-effectiveness.

Clinical and Surgical Training

With 30 total implementations (NHS n=12, universities n=18), clinical and surgical training represents a specialised but high-impact application area for immersive technologies in UK healthcare settings. This is separate to Workforce Education and Training, as it offers insight into direct clinical practice, where XR can support surgeons and clinicians in direct applications and preparing for complex procedures and surgeries.

Surgical Simulation

Advanced haptic feedback systems paired with VR provide realistic surgical training environments where trainees can practice complex procedures repeatedly without patient risk. These systems are particularly valuable for laparoscopic and robotic surgery training, where depth perception and spatial awareness are critical skills. Such systems and applications are also deployed for soft skills required for healthcare staff, as discussed in Workforce Education and Training.

Anatomical Exploration

AR applications allow trainees to visualise and interact with detailed 3D anatomical models, either overlaid on mannequins or floating in space. These applications enable understanding of spatial relationships between structures that traditional 2D learning materials cannot provide.

Rare Case Preparation

VR environments allow surgical teams to prepare for complex or unusual cases by practising on virtual models created from actual patient imaging data. This patient-specific rehearsal can identify potential complications before the actual procedure, improving surgical outcomes.

The balanced distribution between NHS and university implementations suggests strong collaboration between academic and clinical institutions in this domain, with innovations rapidly transitioning from research to practice. Royal Colleges are

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

increasingly incorporating VR assessment into specialist training programmes, signalling growing acceptance of these technologies as valid educational tools.

Patient Education and Communication

With 23 total implementations (NHS n=10, universities n=13), patient education and communication represents a small but potentially transformative application area for immersive technologies in UK healthcare. These applications directly address the challenge of health literacy and patient engagement with their own care.

Key applications include:

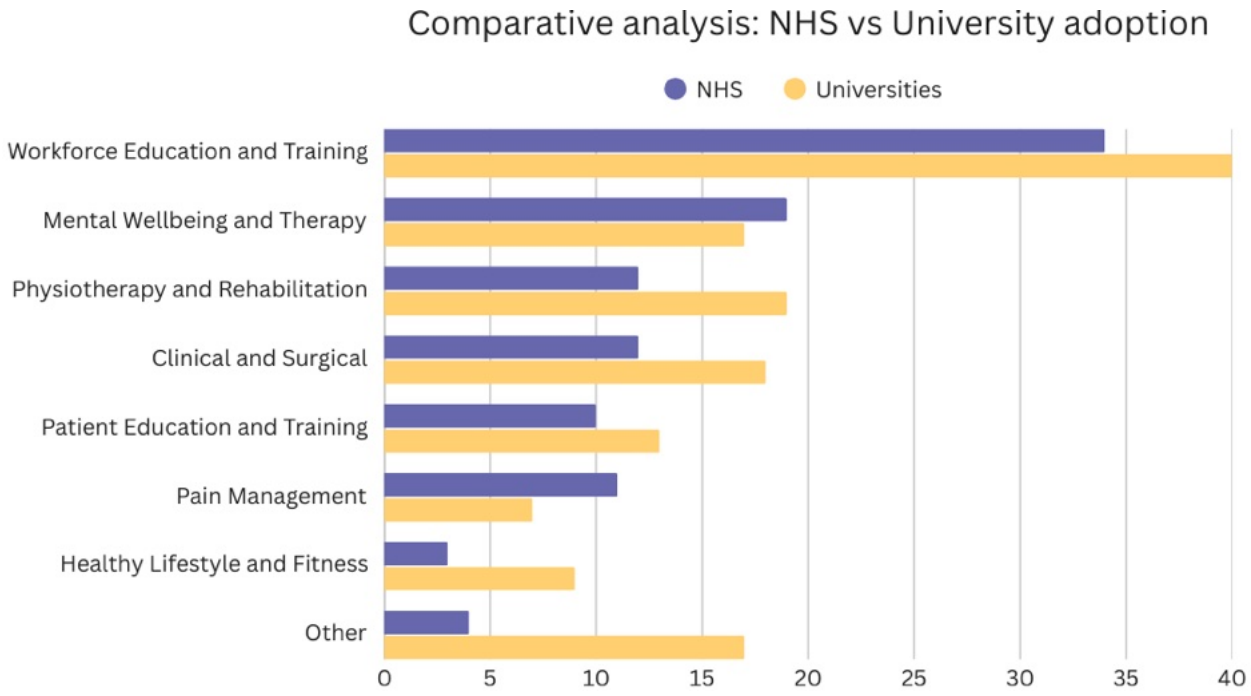
- Pre-procedure orientation and anxiety reduction
- Condition-specific educational experiences
- Treatment plan visualisation and understanding
- Hospital onboarding and navigation assistance

By creating immersive explanations of complex medical concepts, these applications help patients better understand their conditions and treatment options, potentially improving informed consent processes and treatment adherence.

Early research from UK universities suggests that VR-based patient education may be particularly effective for populations with lower health literacy or language barriers, as visual and experiential learning can transcend some communication challenges. Several NHS trusts are now piloting these approaches in pre-operative clinics and chronic disease management programmes.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Comparative Analysis: NHS vs University Adoption



Our comparative analysis reveals several important patterns in VR/AR adoption across the UK healthcare ecosystem:

- Academic Leadership: Universities consistently show higher implementation rates across all application areas, highlighting their role as innovation drivers in healthcare technology.
- Deployment: Responses from healthcare services demonstrate that XR technologies in the NHS are primarily used at NHS sites by staff and patients, as opposed to home use. This will vary based on service and use, but there is greater potential for home use by patients, as highlighted by our case study on Tend.
- Translation Gap: The difference between university and NHS adoption rates indicates opportunities to improve knowledge transfer and technology translation pathways, while acknowledging the different functions of healthcare organisations versus universities and how this plays out when it comes to implementation.
- Mental Health Parity: Mental wellbeing applications show equal adoption across both sectors, suggesting particularly effective research-to-practice translation

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

in this domain. But, this is difficult to corroborate with the limited number of sites currently offering mental health solutions/trials.

- Implementation Barriers: The lower NHS adoption rates likely reflect institutional barriers including funding constraints, technical infrastructure limitations, and staff training requirements.

- Student Education: As education institutes, universities' primary goal is the education of students and this is demonstrated through the selection of 'other' adoption methods reported here in the data. This 'other' was importantly shown to be XR being used in student education, for example for medical or nursing students, or for student research projects, highlighting a key difference between healthcare and universities use of XR.

These findings suggest that while promising research is abundant, more structured pathways for implementing proven VR/AR solutions into routine clinical practice are needed to fully realise their potential benefits within the NHS.

Market Growth and Statistics

The global XR healthcare market has experienced explosive growth, with the market valued at £3.54 billion in 2024 and projected to reach £35.16 billion by 2033, representing a remarkable compound annual growth rate (CAGR) of 29.04%. Multiple research firms report similar trajectories, with some forecasting the market will hit £16.83 billion by 2034 at a CAGR of 24.81% [11].

The pandemic has permanently shifted healthcare's relationship with digital technologies. In February 2025, XRHealth acquired RealizedCare, solidifying its position as the largest AI-driven therapeutic XR platform worldwide [12]. This reflects the maturing ecosystem where major players like CAE Healthcare, GE Healthcare, and Microsoft are leading innovation, with recent developments including Apple's Vision Pro launch in March 2024 seeking to transform healthcare sectors including clinical education, surgical planning, and behavioural health.

North America dominates the global XR healthcare market with 41% market share in 2024, driven by strong R&D investments and government support [13]. However, Asia Pacific is estimated to grow rapidly during the forecast period, contributing more than 40% of the rise in global healthcare spending [14]. The UK leads global initiatives to

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

scale government led programmes for XR Health in the form of Mindset XR [15] which aims to grow the UK's nascent immersive digital mental health sector by investing in projects which deliver immersive digital mental health therapeutics and creating a supportive ecosystem which will help companies bring these innovations to market. Whilst the majority of companies surveyed appear to be focussed on B2B, increasingly more B2C offerings are being launched. A number of wellbeing and fitness products have been successfully launched on headsets, due to hardware companies concerned about what is classified as software as a medical device there have been limitations. However, headsets such as the HTC Vive Flow focussed predominantly on wellbeing applications, launching with products including Healium, Explore Deep and Tripp.

Emerging Trends and Investment Opportunities

1. AI-Enhanced Personalisation

One of the most exciting frontiers for XR in healthcare is the integration of artificial intelligence and to personalise experiences in real time. For example, Emteq: originally a biofeedback embedded VR headset company, they have pivoted to smart glasses. Their current offerings include the OCOsense™ smart glasses developed by Emteq Labs. Optomyography technology embedded within their glasses now tracks chewing cycles and eating patterns in real time. Combining machine learning and biofeedback with haptic feedback their glasses help reduce chewing rate. Initial results demonstrated that haptic feedback may reduce chewing rate, and ultimately modifying eating behaviour to reduce obesity [23]. These systems create "closed-loop" feedback environments, where users' states influence the XR environment, enabling dynamic, adaptive care that can respond to the needs of each individual. AI personalisation is increasingly being combined with additional input and feedback, however, there is a need to consider the safety and regulation of such AI-assisted technologies.

2. Biofeedback and Mind-Body Applications

The role of biofeedback across recovery has been a known approach for many years. Researchers such as Diane Gromala demonstrated research that shows the role of biofeedback as a tool for reducing pain as early as 2015 [24]. Research increasingly demonstrates the importance of the connection between emotional and physical health, and the role of interoceptive awareness in trauma recovery. New innovations

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

that link embodiment and physiological visualisation to trauma are showing increased value in supporting anxiety regulation. For example, *Explore Deep* uses meditation in VR guided by breathing sensors to reduce anxiety and support emotional regulation [25]. *SOUL PAINT*, for example, is a multisensory experience designed to support emotional expression and trauma recovery through enabling patients to visualise the complex interplay of emotion and sensation to enhance interoceptive awareness and support stakeholder communication [18]. XR platforms are increasingly interpreting, visualising and adapting to a user's emotional or physical state by analysing signals such as heart rate, gaze, or body movement.

3. XR for At-Home Care and Remote Access

With the rise of affordable, standalone headsets, XR healthcare experiences are no longer confined to hospital or clinic settings. Increasingly, experiences are being designed for **home use**, supporting rehabilitation, mental health, and wellbeing remotely. Examples include *Concept Health Technologies*, which offers physiotherapy and pain management VR programs, was one of the only ways that COPD rehabilitation continued during the pandemic in the UK [1]. International examples include *XRHealth*, which connects patients to remote therapists through a VR platform for at home use [26]. This decentralised approach offers greater access to care, particularly for those in rural, coastal or underserved areas but also demands new models of safeguarding, digital inclusion, and remote monitoring. However, our findings from the NHS suggest deployment for home use remains limited.

4. Medical and Clinical Education

Medical education remains one of the most widely adopted use cases for XR in healthcare. Immersive simulation environments allow students and professionals to train in high-pressure scenarios without risk. This includes procedural training, emergency response, anatomy, soft skills, and empathy development. The NHS England Technology Enhanced Learning (TEL) team has been at the forefront of this movement, developing training programmes across NHS Trusts. Tools like *FundamentalXR* [27] and *Oxford Medical Simulation* [28] allow for repeated practice of surgical procedures, while also building emotional readiness. Dr. Abison Logeswaran's research has been pivotal in creating evaluation protocols that ensure these tools meet rigorous pedagogical standards [29]. Meanwhile, Bodyswaps [41] uses VR and AI for training and roleplay in interpersonal communication, teamwork, conflict management and

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

empathetic care. Education of both students and healthcare staff remains one of the most applicable areas for XR technology in the UK in the NHS and academia.

5. Neurodivergence and Sensory Environments

A growing focus in XR healthcare is inclusive and accessible design, ensuring that experiences can be used by people with diverse physical, cognitive, and sensory needs. Tailored XR interventions are now being used for stroke recovery, dementia care, and neurodivergent users. *REMO Health* offers VR cognitive training for people with dementia, while other startups are creating sensory-friendly environments for neurodivergent users [30]. By working with communities and user researchers, these tools are becoming more adaptable, customisable, and empowering for a broader range of patients but more research is needed in this area.

6. Palliative and End-of-Life Care

An emerging application of XR in health is its use in palliative and end-of-life settings. Immersive environments can support pain distraction, spiritual reflection, and legacy-making, particularly for individuals facing life-limiting illnesses. Hospices such as Prospect House have developed tools such as *Gardens of Serenity,* combining pain management and anxiety reduction techniques for their patients. These interventions are deeply personal and underscore the power of immersive storytelling to support human dignity, agency, and connection at the end of life. Organisations such as *End of Life Doula UK* are actively experimenting within this space [31] but careful consideration of ethics and users remains crucial.

7. Psychedelic Research

There is growing global interest in the intersection of psychedelic therapies and immersive technologies. Institutions such as the University of California, San Francisco's Neuroscape Lab, led by Dr. Adam Gazzaley, have been at the forefront of this movement, developing products that simulate altered states of consciousness. Gazzaley's team has also contributed to the digital therapeutics landscape through ventures such as Akili Interactive, known for its FDA-approved video game for ADHD, and Sensync, a multisensory "immersion vessel" designed to induce meditative and psychedelic-like states.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Beyond academic institutions, several companies are actively exploring the potential of simulated psychedelic experiences. Notable examples include SoundSelf, Explore Deep, and Si-PHI (Simulated Psychedelic Immersive Experience), a new mixed reality intervention developed at Yale University. Si-PHI integrates biofeedback, including EEG and other physiological markers, to create adaptive therapeutic experiences. Early findings suggest that EEG patterns observed during Si-PHI sessions mirror those seen in ketamine-assisted therapy, indicating potential for non-pharmacological approaches to psychedelic healing.

This growing field is supported by a broader cultural and research ecosystem, including communities and events like the Cyberdelic Society, Awakened Futures Summit, Breaking Convention, and Consciousness Hacking, which have long championed the convergence of technology, consciousness exploration, and mental health innovation.

8. Creative Health

The creative health industry has seen significant growth in recent years, particularly since 2019. Over this period, several key institutions have been established to champion the integration of arts and health within communities, including the National Academy for Social Prescribing, the National Centre for Creative Health (NCCH), the Culture, Health and Wellbeing Alliance (CHWA), and the Arts Council England's Creative Health team. These organisations have played a pivotal role in launching initiatives that embed creative practice within health and care systems.

In parallel, research and development in digital and immersive technologies for mental health has accelerated. A 2019 report by Nesta, in partnership with Sarah Ticho, titled *The Role of Arts and Creative Practice in VR for Mental Health*, helped catalyse new programmes at StoryFutures Academy, fostering collaborations between artists, SMEs, and researchers to explore XR and wellbeing. Audience insight guidance and a toolkit was also developed to support creative companies looking to create XR health and wellbeing solutions. Many of the projects supported through this initiative have since been further developed under the Mindset XR programme, which continues to drive innovation at the intersection of immersive technology and mental health.

More recently, in September 2025 the Creative Industries Council and Arts Council England released a new report titled CIC Health & Wellbeing Forum 2025 Report. The report sets out evidence and recommendations for strengthening initiatives that use

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

creative and cultural activities, processes or assets to improve health and wellbeing for individuals and communities. This report includes reference to the role particularly of virtual reality, using the immersive arts and health experience *Soul Paint* as a case study. It finds that the programmes presented save the NHS money and argues they should play a critical role in the government's efforts to shift the focus of healthcare systems away from a short-term reactive care model towards long-term health promotion, enabling more people to live well for longer.

Additionally, in 2025, a series of roundtables hosted at the Wellcome Trust and online titled *p_ART_icipate! – Co-Creating Futures: Ethics and Policy Pathways for Participatory Digital Arts and Wellbeing* brought together stakeholders to explore the ethical and policy dimensions of participatory creative health practices. Funded by the Arts and Humanities Research Council (AHRC) and led by a consortium including the University of Greenwich, Brunel University London, and the Central and North West London NHS Foundation Trust (CNWL), the *p_ART_icipate!* project is developing practical guidance for best practices in the design and delivery of participatory digital arts in health contexts. These resources are now being shared across cultural institutions, healthcare organisations, and artistic networks.

While still an emerging area, the integration of digital tools within social prescribing is gaining traction. Organisations such as NCCH, Arts Council England, and CHWA are increasingly focused on exploring how digital and immersive experiences can be meaningfully embedded within creative health pathways.

9. Paediatrics

In parallel with broader trends in creative health, there has been a rapid proliferation of applications focused on paediatric and youth populations—spanning prevention, intervention, and general wellbeing. Leading healthcare institutions such as Alder Hey Children's Hospital, Sheffield Children's Hospital, Glasgow Children's Hospital, and Great Ormond Street Hospital have pioneered innovative approaches, from immersive rehabilitation programmes to the establishment of the first-ever Gamer in Residence role, integrating game-based interventions into patient care.

Further advancing the field, research consortiums such as CAHREL (Creative Arts, Health and Rehabilitation for the Early Life-course), led by Leeds Beckett University in collaboration with Leeds Teaching Hospitals NHS Trust, the University of Plymouth, Edge

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Hill University, and industry partner Xploro, are pushing the boundaries of arts-based healthcare research. Their work employs participatory, arts-led methodologies to drive innovation in healthcare delivery and is currently exploring new applications of immersive technologies to support children and young people across clinical and community settings.

Challenges and Future Outlook

Despite rapid growth, challenges across development and adoption remain. Models of how the digital literacy of healthcare workforces can be developed and how front-line staff can be actively involved in the design and development of creative digital interventions are lacking. Many studies on XR in healthcare education either poorly described or completely omitted their pedagogical approaches, with less than 3% of VR simulation papers incorporating a conceptual framework [16]. Companies and innovators continue to struggle to find clear routes to market, with limited paths for procurement - particularly within the NHS.

However, the XR healthcare community continues to gain interest and traction, and whilst adoption is slowly developing, the overall trajectory remains strongly positive. The UK is renowned for creating leading global innovators, both across the healthcare innovation arena, but equally across the creative industries and XR industry. This fusion of creative storytelling and game design is leading to powerful new innovations that enhance engagement, moving beyond gamification, supporting intrinsic motivation for patients to continue to engage in their rehabilitation. Immersive projects that have expanded from creative storytelling pieces into XR innovations such as Anagram's *Goliath* and *Impulse* have won illustrious industry awards such as the Venice Biennale Grand Jury and Immersive Achievement Prize, and have recently received an Emmy nomination for *Impulse* [17]. Equally projects such as *Soul Paint* have gone onto win SXSW Special Jury Prize, Best Health and Wellness at Games for Change and other global recognitions for their potential across health and wellbeing, putting the UK XR industry on the map as a global innovator across healthcare and storytelling in XR [18].

The global AR and VR in healthcare market is projected to grow 30-35% from 2024 to 2029, driven by tech advancements, digitisation, government support, numerous start-ups, diverse applications, and increasing partnerships [19]. The XR healthcare market represents one of the most impactful use cases of early XR adoption in public services and industry, directly addressing some of the biggest global health challenges while improving access, a diversity of spaces for patients to engage, and ultimately creating scalable, cost-effective solutions for an increasingly strained healthcare system.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

2. Deep-dive into XR for Mental Health

NHS

a. South London and Maudsley NHS Foundation Trust (SLAM)

Background

One of the NHS Trusts at the forefront of research and innovation for mental healthcare is SLAM. The Digital Innovation Team continue to research and develop XR technologies for conditions such as psychosis, mood disorders, eating disorders, plus behaviour-based interventions relating to phobias, stress reduction, physical activity, and discrimination, and in 2024, SLAM were awarded £1.3 million in funding by the NIHR to further develop new VR and neurotherapeutic hubs [34].

SLAM's approach represents a strategic shift beyond individual applications towards scalable, sustainable solutions that address core NHS challenges. The Trust's major goal is to deliver mental health services more efficiently through automated and diverse digital channels, particularly XR technologies. This vision extends beyond traditional treatment models to encompass population health initiatives, where XR is integrated with IoT platforms and patient monitoring systems to provide real-time health tracking and intervention capabilities.

Deployment and Use

During the pandemic, SLAM was the first mental health trust to use AR and VR to support service users and members of staff by using these technologies to address needle phobias. By acquiring and deploying six medical VR glasses and VR applications, staff and patients were supported across NHS vaccination sites during the roll out of the Covid-19 vaccinations to the general population [35].

Working alongside King's College London and other partners, these technologies are being further developed by the Trust for various mental health conditions. Through FOI requests, the Trust currently reports on having or developing applications for eating disorders, dementia, relaxation and Dialectical Behaviour Therapy (DBT) at various stages of maturity, including proof of concept technologies and those in early adoption

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

in service. These VR therapeutics are reportedly used on Pico 4 and Pico Neo 3 Pro headsets for use on NHS sites only.

Building on their clinical success, SLAM has developed a strategic vision for commercialisation and international expansion. The Trust is developing "My Help," a prototype application store for XR mental health interventions, while establishing partnerships with healthcare systems in the UAE and exploring collaborations with Chinese mental health institutions. Their eating disorder application has gained recognition through publication in European Psychiatry and has attracted interest from the Italian clinical health agency for implementation in their services. This international outlook positions SLAM as a global leader in XR mental health innovation, leveraging their status as the second-largest academic publishing institution worldwide in mental health research after Harvard.

Photo: Courtesy of NIHR Maudsley Biomedical Research Centre article.

b. Alder Hey Children's NHS Foundation Trust

Background

Alder Hey has emerged as a national leader in paediatric XR innovation, establishing a comprehensive approach that spans patient-facing care, clinical applications, and systematic technology evaluation. The Trust's XR programme is uniquely positioned within their dedicated Innovation Hub, a purpose-built Innovation Hub facility that houses a team of 20 innovation specialists and serves as a testing ground for emerging healthcare technologies.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Through FOI requests, the Trust reports deployment across multiple clinical areas including the Innovation Hub, Cardiology, MaxFax, Orthopaedics, Emergency Department, Radiology, Pharmacy, and Therapies, with exploratory work extending into Community services and education. Their XR portfolio encompasses technologies at various maturity levels, from proof of concept through to established practice, demonstrating systematic progression from innovation to routine clinical implementation.

Deployment and Use

The Trust's XR applications are strategically organised into four primary categories: Mental Wellbeing and Therapy, Pain Management, Clinical & Surgical applications, and Patient Education and Training. Key technologies include SmileyScope for distraction therapy, XR Therapeutics for mental health interventions, and Magic Leap 2 for surgical planning applications. The Trust also utilises Meta Quest Pro with various applications including Reach Shoulder Health, ApoQlar, DR VR, and NulaVR, alongside specialised tools like the Virtual Heart developed in collaboration with the Virtual Engineering Centre.

A distinguishing feature of Alder Hey's approach is their transition from traditional 3D printing to XR-based solutions for surgical planning. The maxillofacial team has successfully implemented Magic Leap technology that allows surgeons to visualise patient scans in 3D virtual environments, collaborate with remote experts, and develop VR-based cutting guides for intra-operative use. This innovation addresses significant sustainability challenges, physical 3D printed models become part of a child's medical record and must be retained for seven years, contributing to waste and environmental impact.

Patient-facing applications focus on pain management and distraction therapy, with particular emphasis on solutions that integrate seamlessly into clinical workflows. SmileyScope has proven particularly successful due to its unique design where the front panel can be used as a tablet interface by clinicians rather than requiring them to wear the device, a crucial usability feature that has driven clinical adoption across multiple departments.

Technology and Infrastructure

Hardware deployment includes Meta Quest Pro, Apple Vision Pro, HTC Vive Pro 2, and Magic Leap 2, with technologies distributed through both NHS-funded and paid procurement models. The Trust began XR implementation in Innovation Services in

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

2018, with cardiac services signing agreements as recently as July 2025, demonstrating sustained commitment to expanding XR integration. All applications are configured with locked settings to prevent dual use, ensuring clinical-grade security and consistency.

Scaling Innovation Through Open Collaboration

In 2024, Alder Hey secured £4.1 million in funding to establish the Liverpool City Region's first Paediatric Open Innovation Centre, positioning the Trust as a national hub for collaborative healthcare technology development. This initiative represents a strategic evolution from individual technology adoption to systematic innovation facilitation, where the Trust actively partners with industry to co-create, test, and validate emerging technologies.

The Innovation Centre model addresses a critical challenge in healthcare technology development: the gap between promising innovations and clinical implementation. Clinical teams now proactively request VR integration for specific use cases, including rheumatology joint injections and specialised therapeutic interventions, demonstrating genuine clinical appetite for XR solutions. Through their established infrastructure and clinical expertise, Alder Hey provides companies with access to real-world testing environments, regulatory guidance, and direct feedback from healthcare professionals and young patients, while developing standardised evaluation frameworks that can accelerate adoption of proven XR solutions across other paediatric centres nationally.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Photo: Courtesy of NHS Alder Hey Children's Hospital

c. Torbay and South Devon NHS Foundation Trust

Background

The Digital Futures Lab, embedded within Torbay was established in 2017 as one of the NHS's pioneering digital innovation teams. Its mission is to explore and implement emerging technologies, including XR, to enhance healthcare delivery, professional education, and patient care. The Lab's approach to research and development focuses on three aspects:

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- **Design Ethos:** All XR projects are developed using a **co-design model** that involves clinicians, educators, and patients from the outset to ensure solutions are clinically relevant, usable, and impactful.
- **Collaboration** – The Lab combines their in-house development expertise with targeted external partnerships, co-creating solutions that draw on innovation both within the NHS and across wider sectors.
- **Sustainable Solutions** – Through robust testing and evaluation, they ensure digital tools are embedded effectively into clinical pathways and training, delivering lasting impact and measurable outcomes.

Deployment and Use

The Lab's early work focused on developing 360° video for education and workforce training, such as patient perspective experiences (e.g., delirium and dementia), sexual harassment awareness, and immersive care scenarios. In 2021, this expanded into the use of CGI-based XR content development, broadening the scope of interactive and customisable simulations. By late 2024, the Trust launched its first XR-integrated patient pathway (*Cureo* for pain management), marking a significant step from innovation pilots into routine clinical practice.

The Trust's XR portfolio now spans workforce education and training, pain management, physiotherapy and rehabilitation, mental wellbeing interventions, and patient-perspective simulations. This breadth reflects the organisation's ambition to embed XR across healthcare domains while addressing the unique needs of its local population. XR technologies are now deployed across NHS facilities in Torbay and South Devon, with a growing emphasis on extending access into community-based locations supported by trained facilitators. This is highlighted by their key applications in mental health and wellbeing, pain management and workforce training:

- *Cureo (by CUREOSITY)* was introduced in 2024. Cureo supports an 8-week personalised programme for chronic pain patients, combining exercise, relaxation, and distraction therapy.
- The Trust is partnering with *Cineon.ai*, as part of the UKRI Mindset project, trialling XR for staff stress management and resilience training. They are also piloting *Soul Paint* and *Tend* as therapeutic interventions targeting mental health and

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

have created localised 360° video environments (e.g., Dartmoor) used for patient wellbeing and relaxation.

- Immersive 360° experiences simulating delirium and dementia to expose their healthcare workforce in patient-perspective scenarios.

Technology and Design

- **Hardware:** Meta Quest 2, Meta Quest 3, Meta Quest Pro, Pico Neo 3 Pro/Eye, HTC Vive XR Elite, Vive Focus 3, MagicLeap 2, HoloLens 2, Varjo.
- **Software:** Unity, Unreal Engine, OpenXR, XR Interaction Toolkit, SteamVR Plugin, Meta XR SDK, Varjo SDK, WebXR, Mixed Reality Toolkit.
- **Content Types:** 360° video, CGI simulations, gamified XR applications.

Challenges and Opportunities

- **Digital literacy gap** – Many clinicians and frontline workers may lack confidence to integrate XR technologies into practice. This presents a barrier to adoption, requiring targeted digital skills training, onboarding processes, and ongoing technical support. As a result, the Trust are employing XR technology in their workforce training to empower healthcare professionals with the skills to adopt and integrate digital tools, along with using XR to train clinical skills in a safe, repeatable way.
- **Healthcare inequalities in rural and coastal communities** – Torbay and South Devon face unique demographic challenges, including an aging population, seasonal tourist demand, and limited healthcare access in rural and coastal areas. These factors amplify the need for XR solutions that are portable, scalable, and accessible outside traditional hospital settings. This has potential national significance as other NHS regions face similar inequalities.
- **Sustainability and scalability** – Balancing innovation with sustainable service delivery is a key challenge. Torbay and South Devon are aiming to build evidence-based frameworks to ensure that technologies can be scalable, sustainable and embedded into long-term care pathways. By partnering with creative industries, technology providers, and academic researchers (e.g.,

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

University of Exeter, University of Plymouth, Cineon.ai), the Trust accelerates innovation while generating transferable insights for the wider NHS.

Significance

Torbay and South Devon NHS Foundation Trust demonstrates how XR can be integrated across **education, training, therapy, and patient engagement** in a sustainable and scalable way. Its co-design ethos ensures that XR tools are relevant to clinical realities and patient needs, while its embedded lab structure enables continuous innovation.

By addressing both workforce development and patient-facing care, the Trust has positioned itself as a national leader in NHS-based XR adoption. Its experience illustrates the potential for XR not only to improve health outcomes but also to tackle systemic challenges such as digital literacy, workforce resilience, and rural health inequalities.

Photo: Courtesy of Digital Futures Lab website: https://df-lab.org/

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Academia

a. University of Chichester

Focus: Mental Health and Wellbeing - evidence generation for VR-based serious game

At the University of Chichester, a team of researchers have partnered on a project funded by the Woodger Trust to gather evidence on a VR-based serious game called Koji's Quest [36]. The game, developed by NeuroReality, is advertised as a VR game to aid in the rehabilitation of several health conditions, including brain injury, stroke and neurodevelopmental issues, by using neuroscience, gamification and algorithms to create different worlds for players.

Susan Hindman and colleagues have been using Koji's Quest to test the game's effectiveness in delivering training for executive functioning skills. Executive function (EF) is a set of high order cognitive processes involved with learning and how we plan, execute and regulate everyday tasks which develop in childhood, making it important to understand how to support the development of these EF skills. The VR game, deployed using Pico Neo 3 Pro, was procured by the University in 2020 specifically for the research project with local primary school-aged children. As part of a PhD, this research team are using this XR technology to understand whether VR can be used to deliver cognitive training to children to enhance EF by firstly, understanding their qualitative experiences [37] and secondly, whether adaptive VR is an effective tool for EF training compared to controls and has shown positive results [38].

Photo of Koji's Quest: Courtesy of NeuroReality website.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Koji's Quest is marked as a CE marked Class 1 medical device and is available in five languages. NeuroReality themselves are a team of "scientists, game developers, and brain-enthusiasts" based in the Netherlands focused on VR for cognitive rehabilitation.

b. University of Leeds

Focus: Research and Development for Immersive Technologies

Background

The University of Leeds is a leading UK institution in the field of immersive technologies, hosting both the Centre for Immersive Technologies (est. 2019) and HELIX, the University's new learning innovation hub. The Centre for Immersive Technologies brings together over 80 researchers from disciplines including health, engineering, the arts, and social sciences. Its mandate spans five domains: health, transport, education, productivity, and culture and is supported by major public- and private-sector partnerships. It positions XR (extended reality) as a transformative tool for addressing societal challenges.

Complementing this, HELIX provides a physical and digital hub for students, staff, and the wider community. With facilities including immersive technology labs, multimedia production studios, and a makerspace, HELIX fosters creative experimentation and applied research, enabling new initiatives in education, wellbeing, and entrepreneurship.

Deployment and Use

The University of Leeds applies XR primarily in workforce education and training, alongside proof-of-concept projects in healthcare and student wellbeing. The adoption of some of these technologies is becoming increasingly integrated, with activity divided between large-scale research programmes and smaller experimental student-led projects.

1. Research and Development – Centre for Immersive Technologies

- Enhancing surgical practice: The Centre has been investigating the use of VR simulations to allow surgeons to rehearse procedures, experiment with techniques, and familiarise themselves with individual patient anatomies. The aim is for these methods to be used to train surgeons in new techniques, both

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

within the UK or in developing countries where there may be fewer specialist surgeons available. Utilising VR enhances surgeon's skills, improves patient outcomes while reducing hospital time and costs.

- Reducing patient anxiety in radiotherapy: The Centre have created 'virtual walk-throughs' of radiotherapy treatment departments to allow patients to preview their first appointment in order to reduce fear and anxiety.
- Global training initiatives: VR packages are being developed for surgical training in Sierra Leone and other developing countries, with the potential to scale internationally, to develop effective training packages.

2. Student and Staff Projects – HELIX

- Medical education: HELIX staff have begun integrating VR into cardiac physiology modules to support immersive learning and student engagement. For example, Awake Heart is allowing students to explore the anatomy of the heart in 3D and VR can be further used in laboratory experiments focused on anatomy and physiology.
- Neurodiversity and accessibility: A student project focused on exploring the challenges that students with ADHD encounter in learning working environments and aims to develop mixed reality tools to support these students using Meta Quest 3 headsets.
- Wellbeing: Students are also exploring the ways in which VR can support mental health and wellbeing for different populations using 1) outdoor VR environments for people with mobility impairments and 2) designing VR meditation spaces to support student mental health.

Technology and Design

- Hardware: Meta Quest 2, Meta Quest 3, Meta Quest Pro, Pico 4 & HTC Vive Pro 2
- Software: Unity & Unreal Engine.
- Platforms:
    - *Bodyswaps* – immersive soft skills training using AI-driven feedback and performance analytics for student and workforce training.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- *CenarioVR* – no-code platform enabling the creation of interactive VR learning experiences.

Significance

The University of Leeds demonstrates a dual model of XR adoption: world-class research led by the Centre for Immersive Technologies, and grassroots innovation through HELIX's student- and staff-driven projects. Together, these initiatives illustrate how immersive technologies can simultaneously address global health and workforce challenges while enriching the student learning experience. By embedding XR in surgical training, patient care, and higher education, Leeds exemplifies how universities can act as incubators of applied XR research and development, combining institutional expertise with hands-on experimentation to create impactful, scalable solutions.

Photo: Courtesy of University of Leeds, Centre for Immersive Technologies site.

c. Sheffield Hallam University

Focus: XR Integration in Student Education and Training

Background

XR technology provides significant opportunities for use within universities for the education and training of healthcare students. Sheffield Hallam University (SHU) has significant expertise in immersive technologies in hosting the Impact VR Lab since 2013,

but the university highlighted that their primary adoption model is for internal use for academic instruction, research, and skill development of our students and staff.

Deployment

SHU employs a hybrid approach to XR adoption, combining commercial platforms (e.g., Bodyswaps, Oxford Medical Simulation), freely available tools, and bespoke in-house developments. Since 2023, SHU have made significant expansions of their XR into teaching and training. These XR technologies are primarily utilised to enhance teaching and learning experiences of their students across different disciplines and being used to simulate practice for vocational skills and soft skills and to address highly specific teaching requirements that are not met by off-the-shelf solutions. Some of these technologies, such as Body Swaps, have become established practice at the university across multiple different courses, with tailored in-house developments such as SHU VR Blood and SHU Auscultation are still in earlier stages of adoption.

Unique features

The distinctive feature of SHU's XR integration lies in its pedagogical strategy, rather than in the technology itself. Their approach focuses on three defining elements:

1. Tailored Integration – Commercial XR platforms are carefully adapted to course-specific learning outcomes across a wide range of courses, particularly healthcare (e.g., Bodyswaps for soft skills).

2. In-house Development – Bespoke applications are created to fill gaps left by commercial tools, allowing SHU to address highly specific and unique teaching requirements. The Impact VR Lab's work on rehabilitation and pain management exemplifies this tailored development for clinical application.

3. Interdisciplinary Collaboration – Academics, technologists, and students work together to design immersive learning environments that bridge theoretical knowledge and practical application in a safe, repeatable environment.

Technology and Design

XR hardware and applications are managed through dedicated teaching spaces and controlled deployment to students. This combination ensures flexibility while maintaining academic control over content and deployment.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- Hardware: Meta Quest 2, Meta Quest 3, HTC Vive Pro 2.
- Software: Unity for bespoke development; browser-based platforms for wider access.

Challenges and Opportunities

SHU's approach highlights the potential opportunities available for the integration of XR into student education and training. By fostering interdisciplinary collaborations and developing bespoke solutions, XR is capable of enhancing vocation and clinical training and addressing highly specific teaching needs across disciplines, including healthcare. This, however, does highlight the challenges that other universities may face when it comes to adopting existing commercial products to address highly specific needs. SHU's approach is complemented by the Impact VR Lab's research work to develop new XR technologies for physiotherapy, pain management and mental health.

Significance

This integrated, hybrid model demonstrates how XR can be embedded across a university curriculum to create meaningful, scalable, and sustainable educational impact. SHU's approach reflects an early-adoption culture for new technologies, coupled with established use of certain commercial platforms. The Impact VR Lab and TORS department underpin this strategy, ensuring that XR remains both pedagogically relevant and technologically robust. By balancing commercial adoption with in-house innovation and emphasising pedagogy over platform, SHU has developed a scalable model for immersive learning. This case demonstrates the potential of XR to transform student education and training while fostering interdisciplinary collaboration and applied research.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Photo: Courtesy of Sheffield Hallam University article.

Industry

a. XR Therapeutics (XRT)

Background

XRT is a small software development company with revenue of between £500k and £1 million, mainly from the UK where they are based and their products are deployed. This funding is from various sources and they note that it is still a challenge to be fully budgeted within a Trust as budget holders are often required to demonstrate short-term savings rather than long-term benefits. XR Therapeutics (developers of XRT Boundless) was founded by Dr Morag Maskey (CSO) and Prof Jeremy Parr, after groundbreaking research was carried out at the University of Newcastle and Cumbria, Northumberland and Tyne and Wear NHS FT, working with clinical teams and children and young people.

Deployment and Use

The company has expertise across clinical, regulatory, technical, and marketing and works closely with mental health professionals within their team and through collaborations. Their software is designed to target anxiety, mood, eating, and

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

developmental disorders through primarily graded exposure therapy. They offer a mixed hardware and software package in order to reduce barriers to access for the NHS. The clinical origins of XR Therapy are in response to healthcare inequalities and the ambition to improve accessibility of talking therapies. XRT's intervention has been co-designed and co-developed through extensive collaboration with healthcare professionals, and patients (including neurodiverse patients) to ensure accessibility and effectiveness.

Technology and Design

The technology is mainly screen-based and can be used remotely or in-person. It recreates real-world anxiety-provoking scenarios which are viewed on a monitor and controlled by a therapist. Working together, the therapist and client are able to practice coping techniques within a safe VR environment.

Clinical evidence

Based on 9+ years of clinical-academic research between Newcastle University and CNTW NHS Trust, XRT has the potential to reduce the number of treatment sessions and treatment time by >50%, improve reliable recovery rates, and improve engagement in therapy (particularly for people who are neurodiverse) [39, 40]. XRT Boundless can be used on a desktop PC, laptop, smartphone, or tablet enabling treatment sessions to be delivered remotely. XRT can be delivered on any device used by the patient with no additional broadband speed capabilities or costs. All therapists using the XRT Boundless are provided with comprehensive, CPD UK accredited training and supported by a dedicated implementation team from onboarding to routine use in patient care. Their published research is listed here and a CHEATA report shows strong improvements by cutting session times from 6-12 to 2-4, meaning a saving of £21,000 per 100 patients [unpublished]. They note that clinical risk and the complexity of mental health mean that clinicians and end-users need to be consulted throughout design and development to ensure that it is fit for purpose and safe. It becomes tricky when each NHS Trust is asking for evidence to be generated specific to their service, meaning a reliance on pilots. It is important to recognise that XR Therapeutics is the only industry case study that has been recognised by NICE within their Early Value Assessment for XR for agoraphobia.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Regulatory status

XRT are strongly aligned with regulations and NICE recommendations, have been designed to ensure accessibility and effectiveness and to be scalable across NHS Talking Therapies and community mental health teams. It is currently in use by NHS Trusts and charities. XRT Boundless is listed on G-Cloud and the NHS Dynamic Purchasing System, easing procurement through a single tender waiver. XRT is a UKCA Class I Software as a Medical Device (SaMD) specifically developed to support healthcare professionals in conducting Cognitive Behavioural Therapy (CBT) and other talking therapies to support treatment of anxiety, phobias, depression, and other mental health disorders. Despite being one of the few companies to report a Class I software as a medical device and compliance with DTAC, GDPR, Cyber Essentials, they note that there is still a lot of uncertainty as to how their product is classified. They note that the processes and documentation is extremely resource-intensive for a small team and the high cost can be a barrier for small SMEs.

As a deployed technology at the growing integration stage, they share some barriers such as building confidence prior to implementation so that adopters can feel reassured in what they deliver. They note that whilst digital health products are prolific within the NHS, these often lead to digital fatigue as clinicians struggle with products not aligning to clinical pathways or adding to workloads.

Challenges and Opportunities

Despite some of the challenges, they also share an optimistic view of the future of XR in mental healthcare, especially considering the NHS 10 year plan which emphasises the rolling out of digital technologies at scale in the NHS, responding to long waiting lists and better care in the community to prevent escalation. XRT's products are designed to better engage with patients whom they note are often stuck on long waiting lists for talking therapies where they have a less than 50% chance of reliable improvement. Offering new tools can help supplement care, offer ways of being more personalised and accessible, agile, and able to be integrated in a way that supports rather than disrupts the patient-therapist relationship.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Photo: Courtesy of XR Therapeutics website

b. Tend – Virtual Reality Mindfulness-Based Cognitive Therapy (VR-MBCT) for Depression

Focus: Mental wellbeing and therapy – scalable digital interventions for mood disorders

Background

Tend is a London-based startup developing VR-enabled adaptations of evidence-based psychological therapies. Their flagship product, VR-MBCT (Mindfulness-Based Cognitive Therapy in Virtual Reality), delivers immersive, scalable treatment for mood disorders, particularly major depression, dysthymia, and generalised anxiety disorder. The approach combines clinical expertise - with mental health professionals integrated into the development team - with cutting-edge VR design, ensuring both therapeutic validity and patient engagement.

Deployment and Use Cases

Tend's platform has been adopted in the UK National Health Service (NHS), including by Tees, Esk and Wear Valleys NHS Foundation Trust (TEWV) in North East England, and across multiple local Mind and other mental health charities across England and Wales. The solution targets patients who would otherwise face long waits for talking

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

therapies, offering a first-line or adjunct treatment pathway for depression and related conditions.

By delivering MBCT through VR, Tend provides a scalable alternative to conventional therapy reducing pressure on overstretched clinical teams. Tend report that 1 x Tend supplied headset has the capacity to deliver a mental health intervention to 200 service users a year.

Employer/industry clients, private healthcare providers, and voluntary sector organisations have begun piloting the system, demonstrating its versatility across multiple healthcare settings.

Clinical Evidence

Tend has already completed 4 x feasibility studies (n=12, n=35, n=50, and n=75), with initial results demonstrating a large effect size in treating depression and anxiety, and significantly improved reliable recovery rates and higher completion rates in comparison to existing talking therapies. A first paper has been submitted for publication, with additional trials planned through mid-2026, including a large-scale cohort trial looking at Difficult-To-Treat Depression (DTD). Tend have developed a pipeline of clinical studies to validate both clinical outcomes and cost savings.

Technology and Design

- Platform: Oculus Quest 3
- Software: Unity, OpenXR, XR Interaction Toolkit
- Features: Immersive mindfulness modules; patient-centred interaction design; potential applications in psycho-oncology, post-operative recovery and wider mood disorder contexts

The product is built to NHS standards of data and cyber compliance (DTAC, DCB 0129/0160, Cyber Essentials, GDPR), enabling smoother procurement and integration into public healthcare.

Regulatory Status

- UKCA Class I registered device

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- Plans to move to Class II to enable global expansion (e.g. Australia, Singapore)
- Regulatory compliance covers clinical safety, cybersecurity, and data governance

Challenges and Opportunities

Tend acknowledges regulatory, financial, and technical hurdles in scaling digital therapeutics, particularly around reimbursement and adoption pathways. Nonetheless, the company is gaining traction, with 5 x NHS trusts either purchasing or preparing to procure the system. The potential cost savings are significant: At 2-5 times cheaper than existing talking therapies, Tend estimates that scalable deployment of VR-MBCT as a first-line treatment for mood disorders could save the NHS upwards of £250 million per year by reducing staff time and improving throughput.

Significance

Tend represents a strong example of how XR can deliver breakthrough mental health interventions that are clinically validated, economically sustainable, and scalable across healthcare systems. By bridging the gap between psychotherapy and immersive technology, it offers a model for how XR can move from pilot projects into routine clinical adoption.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Photo: Courtesy of Tend

c. a.health

a.health is a UK-based digital health company that incorporates virtual reality technology into mental health treatment, specifically targeting ADHD, OCD, anxiety, and depression. The company describes its offering as "groundbreaking virtual reality-based talking therapies that allow patients to engage in therapy seamlessly integrated into their lives, leading to higher patient satisfaction and improved outcomes"

VR Technology Implementation

The company presents this technology as one of three foundational principles, alongside patient-centric AI-enabled experiences and high clinical care standards led by expert consultants. The VR intervention is designed to complement their primary ADHD assessment and treatment services, which are delivered through remote consultations with GMC Registered Consultant Psychiatrists. The integration of VR technology into their clinical pathway offers an attempt to enhance traditional talking

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

therapy approaches through immersive environments, though specific details about therapeutic protocols, hardware platforms, or clinical applications are not extensively documented in their public materials.

Clinical Integration and Evidence Base

A.Health's VR offering operates within their broader digital health platform that serves patients across all age groups, from children as young as 6 years old to adults. The company has partnerships with multiple NHS organisations, being trusted by many NHS partners including various trusts across England, with their VR-enhanced services achieving a level of integration with public healthcare systems that few other XR companies have achieved.

A.health are seeking to develop and share more clinical outcome data, peer-reviewed research and detailed technical specifications for their VR interventions. This is particularly relevant given the growing evidence base for VR applications in ADHD treatment, where research has demonstrated potential benefits for attention training, exposure therapy, and cognitive rehabilitation.

Market Position and Challenges

A.Health's positioning of VR as a differentiating technology reflects broader industry trends toward immersive digital therapeutics. The company's focus on seamless integration into patients' lives reflects a home-based or telehealth delivery model for their VR interventions, which aligns with trends toward accessible mental health technologies.

Photo: Courtesy of a.health

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

3. International Best Practices and Benchmarking the UK's Standing

Global XR Healthcare Leadership Landscape

The international XR healthcare market reveals a complex ecosystem where different regions have established distinct competitive advantages and regulatory approaches. While the UK leads in government-funded XR mental health initiatives, other nations have developed sophisticated frameworks for broader healthcare technology integration that offer valuable lessons for NHS adoption.

In this chapter we initially give a comparative overview of global regions who are accelerating the growth and spread of XR health in a range of different approaches from frameworks, to networks to regulatory transparency. We then dive deeper into specific organisations, health care facilities and academic institutions by region who are notable for their leadership and pioneering work in the XR healthcare field.

European Innovation Networks and Collaborative Frameworks

Europe has emerged as a leader in collaborative XR healthcare research networks, with the Netherlands pioneering cross-border innovation models. The VR4REHAB network represents Europe's most successful collaborative XR healthcare initiative, operating as an Open Innovation Network across Netherlands, Belgium, France, Germany, and the UK to stimulate VR-based rehabilitation tool creation. This network has facilitated knowledge exchange through annual conferences focusing on patient-centered XR applications and hackathon - to - development pipelines that rapidly prototype solutions for conditions like COVID-19 rehabilitation.

The European Commission has an established Unit across Direct General Communication Networks, Content and Technology (DG CNECT), with a subchapter focussed on Interactive Technologies. The group recently commissioned a study led by PPMI titled ‘Virtual worlds - how will they affect our health and wellbeing?’ Whilst still exploratory, there is a focus on creating new processes for understanding, regulating

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

and supporting the development of XR for health and wellbeing at a European-wide level. Key pilot use cases includes:

- VRcome - VR & 360-degree video based mental health programmes for phobias, social anxiety and addiction
- Sensiks - Multisensory pods for stress reduction, corporate wellness and mental health support
- Phobius - Phobiezentrum fur Angest, Panik and Phobien - VR Exposure therapy for phobias and anxiety disorders
- Explore Deep - VR and biofeedback experience with meditation and breathing exercises for anxiety reduction
- Virtuleap Enhanced VR - VR and haptic feedback game with meditative breathing exercises and anxiety reduction
- SIMAR project - VR and drone systems for safe industrial inspections of hazardous environments
- XR Global - VR education and skills training programmes for rural communities
- Soul Paint: VR bodymapping experience for emotional expression and mental health
- Liminal VR - Immersive, AI enabled experiences for emotional regulation, pain relief and to improve health and wellbeing
- MindMaze - MindMotion Go - Immersive software and hardware solutions for neurologist rehabilitation programmes.

Key recommendations from the DG CNECT include:

1. Support healthcare professionals and providers to use and deploy virtual worlds
2. Improve awareness of virtual worlds technologies for health and wellbeing
3. Develop an evidence-based ethical framework for the safe use of virtual worlds with particular attention to consumer grade technology and with respect to use by vulnerable groups

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

4. Align occupational safety guidelines with the evolving use of virtual worlds technologies in workplaces

5. Address research gaps and improve collaboration by supporting coordinated interdisciplinary research on the health and wellbeing impacts of virtual worlds

6. Create new and improved existing commercialisation pathways for startups and SMEs development health and wellbeing virtual world use cases by addressing structural barriers.

The Netherlands has particularly excelled in translating research into commercial applications. Companies like inMotion VR have developed award-winning platforms such as Corpus VR, which is now used globally by physical and occupational therapists in hospitals and elderly care homes. Dutch institutions like Vrije Universiteit Amsterdam are leading augmented-reality neurorehabilitation research, developing systems that transition from supervised clinic care to digitally supported independent home care.

German Digital Health Application Framework

Germany has established the world's most comprehensive regulatory framework for digital therapeutics through its DiGA (Digitale Gesundheitsanwendungen) programme. Since 2019, the German Digital Healthcare Act has enabled statutory health insurance to reimburse certified apps, including those utilising virtual reality glasses, through a Fast-Track Process for Digital Health Applications. This framework (although not XR specific) has resulted in over 374,000 DiGA prescriptions, establishing a pioneering model for integrating Digital Therapeutics into healthcare systems with scalable reimbursement strategies. XR uptake via DiGA remains niche compared to CBT or chronic care apps. The DIGA platform requires manufacturers to provide sufficient evidence of positive healthcare effects through retrospective comparative studies conducted in Germany with appropriate comparison groups. This regulatory clarity has attracted international manufacturers while ensuring clinical safety, though some criticism exists regarding the quality of evidence generation within the required one-year proof period.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Asia-Pacific Healthcare Technology Integration

Singapore has demonstrated how national health technology strategies can accelerate XR adoption in clinical settings. Singapore General Hospital has successfully implemented gamified VR nurse training programs, including IV NIMBLE - a virtual reality module for intravenous cannulation training that combines virtual patient avatars, 3D-printed tactile components, and analytics dashboards. The program was backed by grants from the Institute for Adult Learning and SingHealth Duke-NUS Academic Medicine Innovation Institute.

Australia has established robust regulatory pathways for XR healthcare applications. This has been fasttracked due to a need to find new ways to deliver care and training to remote areas. XRHealth's VR headset is listed on the Australian Register of Therapeutic Goods (ARTG), with specifically designed therapeutic applications that align with NDIS funding criteria. The Australian market has seen successful partnerships between XRHealth and major insurers like BUPA, delivering VR-based physiotherapy, pain management, and cognitive exercises remotely. However, uptake remains early-stage and reimbursement is not yet as systematised as Germany's DiGA.

North American Regulatory Leadership

The United States has established the most mature regulatory environment for XR medical devices. The FDA maintains an AR/VR Medical Device List identifying devices authorised for marketing in the United States, providing transparency to healthcare providers and patients while fostering innovation through clear regulatory expectations. The US approach includes specific standards from organisations like the International Electrotechnical Commission for near-eye displays and the American Association of Physicists in Medicine for medical displays.

Major US companies like XRHealth have acquired platforms such as RealizedCare to enhance AI-driven therapeutic XR capabilities, positioning themselves as global leaders in personalised XR healthcare delivery. The US market benefits from mature health economic evaluation frameworks, with systematic reviews showing that XR interventions in healthcare demonstrate potential for significant clinical benefits and cost-savings.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Complementing regulatory efforts, the XR Safety Initiative (XRSI) has emerged as a critical standards-developing organisation addressing safety and privacy concerns in XR healthcare applications. XRSI launched the Medical XR Privacy & Safety Framework in 2021, focusing on protecting patient data and ensuring safety in immersive medical domains, collaborating with University of California San Diego researchers. The organisation's Privacy and Safety Framework sets baseline standards incorporating requirements from GDPR, NIST guidance, and other privacy regulations, providing a regulation-agnostic approach to XR safety. As a 501(c)(3) global non-profit Standards Developing Organisation headquartered in San Francisco, XRSI brings together over 200 diverse multidisciplinary advisors worldwide to address novel cybersecurity, privacy, and ethical risks in XR ecosystems and take a keen interest in healthcare specific needs of the XR safety agenda.

Evidence Generation and Clinical Validation

International approaches to XR healthcare evidence generation reveal significant variation in methodological rigor and regulatory requirements. Health economic evaluations of XR interventions show considerable heterogeneity between studies and often lack clear descriptions of XR interventions, limiting their use in procurement decisions. The need for more clinical trials and rigorous research to establish XR health intervention effectiveness has been recognised by international organisations, with efforts from the Journal of Medical Extended Reality, International Virtual Reality Healthcare Association, Stanford Psychiatry and Immersive Technology Consortium and Medical Device Innovation Consortium.

Clinical efficacy for XR-based therapies has been demonstrated across various specialties and settings internationally, with VR successfully used for pain management and physical rehabilitation in multiple countries. However, barriers persist in committing healthcare professionals to training on these new technologies due to time constraints and the need for curriculum integration. Therefore, without a uniform data standard, or a systemic approach to clinical validation, the uptake of these potentially groundbreaking technologies remain comparatively low.

China: XR in Rehabilitation and Robotics Ecosystems

China is rapidly positioning itself as a global leader in the integration of XR technologies into healthcare, supported by its strength in hardware innovation and large-scale

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

infrastructure. The acquisition of Pico headsets by ByteDance in 2021 exemplifies this trajectory. Pico devices are widely adopted in clinical contexts due to their infection-control-friendly design. At the same time, ByteDance has been expanding into healthcare delivery, acquiring private hospital chains and launching new ventures such as the 800-bed Beijing Airui Hospital, approved in early 2025. While ByteDance has yet to integrate XR directly into its hospital operations, its investments mark a convergence of digital health, hardware, and clinical ecosystems.

Beyond corporate initiatives, XR is already reshaping medical practice across China. Hospitals in Beijing, Hunan, Gansu, Zhejiang, and Fujian are deploying VR for surgical training, patient rehabilitation, psychological therapies, and intraoperative support. Companies like Fourier Intelligence are accelerating adoption with platforms such as the MetaMotus Galileo, which blends VR with biomechanical analysis for rehabilitation, and robotics like the GR-2 that extend XR-enabled clinical applications. Coupled with research from institutions like the China Rehabilitation Research Center, these developments highlight how China is weaving XR into a comprehensive healthcare innovation strategy, bridging robotics, rehabilitation, academic research, and patient care at scale.

South Korea's Digital Health Leadership in XR

South Korea has positioned itself as an early adopter of XR in healthcare through coordinated national strategies that combine technology investment with hospital partnerships. The government's *Digital New Deal* explicitly prioritises immersive training and medical simulation, enabling accelerated development of XR-based curricula across universities and teaching hospitals. Major institutions such as Samsung Medical Center have deployed VR-based rehabilitation programmes for stroke patients and pain management, while Seoul National University Hospital has piloted immersive psychiatric therapies for anxiety and PTSD.

In addition to clinical care, XR is widely used in surgical and nursing education across Korea. Startups such as LudenVR provide VR endoscopy training tools now used in Korean medical schools, while Looxid Labs integrates VR headsets with biometric sensors to support cognitive assessments. The Korean government has backed these developments through targeted R&D funding, creating a supportive innovation pipeline that connects academic research, hospital pilots, and commercial XR applications. This comprehensive approach has enabled South Korea to emerge as a regional leader in immersive medical technology, with growing export potential across Asia-Pacific markets.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Middle East: XR Health Innovation through Virtual Hospitals and Pain Management

In the Middle East, XR technologies are emerging within national health innovation agendas, particularly in the UAE and Saudi Arabia. Under the aegis of Vision 2030, the Saudi Ministry of Health launched the Seha Virtual Hospital, a vast virtual care network linking over 224 hospitals and providing more than 44 specialized services. The platform has gained recognition as the world's largest virtual hospital, earning both a Zimam Award in November 2023 and a Guinness World Record in October 2024. Complementing remote care, XR telehealth tools such as Caregility's mixed-reality ICU solution have been deployed across 17 Saudi hospitals, delivering around 5,000 virtual intensive-care sessions via the Seha system. In the UAE, Dubai Health is pursuing immersive pain and anxiety relief methods—piloting VR programs in its Thalassemia Centre to reduce procedural discomfort using headset-based distraction techniques, with validation through heart rate and eye-movement metrics. Additional implementations in Abu Dhabi, such as at NMC Royal Hospital, leverage VR for pain management and interactive physical rehabilitation therapies. These XR deployments reflect a region-wide strategy to integrate immersive tech into patient care, training, and telehealth infrastructure.

UK's Competitive Position and Strategic Opportunities

The UK's position in the global XR healthcare landscape reveals both significant strengths and areas for development. The £20 million Mindset XR programme represents the world's largest government investment specifically in XR mental health, positioning the UK as a global policy leader. However, the 30% NHS adoption rate of XR across NHS Trusts suggests implementation challenges compared to more integrated approaches seen in Netherlands rehabilitation centers or Singapore's systematic hospital deployment.

The UK's strength in creative industries provides a unique advantage in developing engaging, therapeutically effective XR applications. Projects like Anagram's award-winning immersive experiences and Soul Paint's international recognition demonstrate the UK's capacity to combine artistic storytelling with healthcare innovation. This creative-healthcare fusion represents a differentiating factor that other nations are seeking to replicate.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Drawing on international best practices, the UK can build on its creative strengths and government investment in XR mental health by addressing structural barriers to wider healthcare adoption. The following opportunities highlight where the UK could act decisively:

1. **Adopt Regulatory Clarity (Germany)**
   – Introduce a streamlined, UK-specific fast-track pathway for digital therapeutics, modelled on Germany's DiGA, to reduce uncertainty for XR developers and provide clear reimbursement routes for NHS procurement.

2. **Establish Cross-Border Innovation Networks (Netherlands / EU)**
   – Build EU-style open innovation networks for XR healthcare, reconnecting with international consortia post-Brexit and fostering joint hackathons, trials, and knowledge exchange across borders.

3. **Integrate Systematic Training Approaches (Singapore / South Korea)**
   – Embed XR into medical, nursing, and allied health curricula nationally, ensuring clinicians are trained at scale. South Korea's Digital New Deal and Singapore's hospital-based programmes offer replicable models.

4. **Enable Large-Scale Clinical Deployment (China / UAE / Saudi Arabia)**
   – Support the Department of Health and NHS national, regional and Trust level bodies in rolling out XR beyond pilots, learning from China's rehabilitation robotics and Saudi Arabia's Seha Virtual Hospital in scaling immersive healthcare across multiple hospitals.

5. **Leverage Creative-Health Fusion (UK Competitive Edge)**
   – Expand on the UK's unique strength in blending immersive storytelling with therapeutic outcomes, positioning UK XR exports as culturally engaging and patient-centric solutions with international appeal.

6. **Champion Global Health Equity (LMICs)**
   – Partner with WHO, FCDO, and global NGOs to pilot affordable XR in pain management and training in LMICs. This not only strengthens UK leadership in global health diplomacy but also tests scalable, cost-effective XR models adaptable for the NHS.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Region by Region

North America

United States of America

1. Cedars-Sinai - Cedars-Sinai Medical Center operates a world-leading Virtual Medicine Program under the direction of Dr. Brennan Spiegel that hosts the long-running annual Virtual Medicine (vMed) Conference, now in its seventh year, which convenes nearly 400 international XR specialists and features 60 speakers discussing Medical Extended Reality (MXR) applications, with over 19,000 published studies now supporting VR in healthcare demonstrating its "uncanny ability to calm pain, steady nerves, and boost mental health." The hospital has conducted extensive clinical research involving over 300 patients across multiple studies, demonstrating that VR therapy achieves a 24% reduction in pain scores for hospitalized patients, with applications spanning from childbirth pain management and pediatric inflammatory bowel disease infusions to anxiety reduction in cancer patients, establishing VR as an effective non-pharmaceutical complement to traditional medicine. Cedars-Sinai maintains a close partnership with the National Institutes of Health through a nearly $4 million NIH HEAL Initiative grant supporting the Back Pain Consortium (BACPAC) VR trial, which is studying 360 patients with chronic lower back pain using three different VR approaches—distraction VR, cognitive behavioral therapy VR, and sham VR—following participants for up to 90 days to monitor pain outcomes and medication requirements. The program's multidisciplinary approach has established Medical Extended Reality as a new field of mind-body medicine, with applications ranging from helping deliver babies and treating PTSD in soldiers to supporting cancer care, positioning virtual therapeutics as scalable technologies that transform healthcare delivery beyond traditional gaming applications.

2. IVHRA - The International Virtual Reality and Healthcare Association, or IVRHA, is a member-driven organisation, composed of entities throughout the healthcare ecosystem, including technology companies, teaching hospitals and universities, as well as healthcare providers and insurance companies. IVRHA's mission is to facilitate and support the growth of the virtual reality and healthcare industry as this new computing platform impacts healthcare practitioners and patients alike. Led by Bob Fine in partnership with leading XR healthcare expert, Walter Greenleaf (Stanford University).

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Hoag Memorial Hospital - Hoag Memorial Hospital Presbyterian has established itself as a nationally recognized leader in Experiential Reality (XR) technology under the leadership of Dr. Robert Louis, Chief of Neurosurgery, opening the dedicated Hoag Center for Advanced Visualization and Immersive Therapeutics in 2021 with specialized facilities including a Therapy Treatment Room for treating conditions from phobias to PTSD and an Experiential Theater for virtual surgical fly-throughs and patient education. The hospital has pioneered surgical applications since 2015, with surgeons using 3D modeling and VR tools to "rehearse" complex procedures, reducing surgical time and risk while taking patients on virtual "flights" through their own planned surgeries, demonstrating measurable impact with patient attrition rates falling from 35% to 4% due to improved understanding and satisfaction. Hoag's maternal health innovation includes NurtureVR, a groundbreaking 32-week perinatal program developed with BehaVR that provides personalized prenatal education, pain management, and postpartum support through VR headsets, allowing mothers to upload their own 3D ultrasound images and customize experiences including skin tones and breastfeeding positions, with functional MRI evidence showing VR's ability to reduce both emotional and physical pain sensations. Beyond patient care, Hoag has pioneered staff wellness applications, becoming among the first healthcare facilities nationally to deploy CenteredVR mindfulness and stress management programs to frontline workers, particularly COVID-19 unit nurses, demonstrating the hospital's multidisciplinary approach that has enabled other global health facilities to realise XR's potential across all hospital settings.

3. Boston Children's Hospital - Boston Children's Hospital operates a comprehensive Immersive Design Systems (IDS) program that serves as a full-scale human-centered design lab specializing in XR applications across training, systems engineering, and rapid prototyping to advance patient care. Their XR initiatives span multiple domains including VR learning experiences for surgical training (such as cleft lip repair, pediatric ECMO cannulation, and infant tracheostomy care), patient-facing therapeutic applications for procedural pain distraction and meditation, and family preparation tools for medical appointments and home care procedures. The hospital has pioneered VR-based staff onboarding and competency training, utilizing platforms like Oxford Medical Simulation for nursing education and creating customized 360° virtual operating room environments that help trainees familiarize themselves with clinical spaces and equipment before entering real-world scenarios. Additionally, BCH developed HealthVoyager, a groundbreaking VR platform in partnership with Klick

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Health that allows pediatric patients to take immersive 3D tours through their own bodies using their individual medical findings, helping bridge the communication gap between doctors and young patients while improving understanding and engagement with their treatment.

4. Stanford & Lucile Packard Children's Hospital - Stanford's Lucile Packard Children's Hospital operates the pioneering CHARIOT (Childhood Anxiety Reduction through Innovation and Technology) program, co-founded by pediatric anesthesiologists Dr. Sam Rodriguez and Dr. Thomas Caruso, making it one of the first hospitals worldwide to implement distraction-based VR therapy across every patient unit for children as young as 6 years old undergoing procedures ranging from IV placements to cancer treatments. The program has scaled to become one of the nation's largest pediatric VR initiatives with over 150 use cases per month, demonstrating significant clinical impact with 99.5% of patients showing improved cooperation after VR interventions, while adverse events remain rare at under 4% and primarily involve mild anxiety or dizziness. CHARIOT has developed custom VR experiences like "Space Pups" and introduced augmented reality applications showing IV placement procedures, alongside innovative tools like "Sevo the Dragon" that gamifies anesthesia mask breathing, transforming necessary medical procedures into engaging interactive experiences. ArborXR For 3D cardiac planning, Stanford has clinically deployed EchoPixel's True3D technology in dedicated cardiothoracic surgery suites, which creates life-size interactive holograms from CT and MRI scans that surgeons can manipulate in open 3D space without special eyewear, significantly enhancing understanding of complex congenital heart anatomy and surgical planning—technology that played a crucial role in high-profile cases including the 17-hour separation surgery of conjoined twins.

5. Nationwide Children's Hospital (Columbus, US) - Nationwide Children's Hospital's Center for Pediatric Trauma Research, led by Dr. Henry Xiang, has developed the innovative VR Pain Alleviation Therapeutic (VR-PAT) featuring the "Virtual River Cruise" game with cooling snow effects, demonstrating in randomized clinical trials that active VR significantly reduces overall pain scores in pediatric burn patients during dressing changes compared to standard care. The lightweight, smartphone-based VR system has expanded beyond burn care to emergency departments, plastic surgery clinics, and orthopedic clinics for procedures like needlesticks and pin-pulling, with providers reporting that procedures are faster and easier to accomplish due to reduced patient anxiety, though the team found the VR games work best with younger children as teenagers often need more sophisticated gamification to maintain engagement.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Research insights at Nationwide reveal that VR's effectiveness operates through neurological mechanisms beyond simple distraction, with studies showing potential for enhanced pain management when patients actively interact with VR environments during painful procedures.

Canada

1. Montreal Children's Hospital/Shriners Hospital for Children-Canada - Montreal's Shriners Hospital for Children-Canada has pioneered pediatric VR pain management through a comprehensive four-year research program led by nurse scientist Argerie Tsimicalis, demonstrating that 84% of patients using VR headsets from Quebec-based Paperplane Therapeutics reported positive medical experiences during procedures including IV insertions, blood collection, Botox injections, cast removals, and suture removal. The hospital has fully integrated VR into daily clinical operations with four constantly in-demand headsets, expecting to serve over 15,000 patients in the next five years, while training nurses across multiple departments including plaster rooms, day centers, pre-op clinics and care units to become "VR Champions" who can independently deploy the technology with patients.

2. The Hospital for Sick Children (SickKids), Toronto - The Hospital has established itself as a leader in pediatric VR healthcare applications under the direction of Dr. Clyde Matava, a staff anesthesiologist and director of eLearning and technology at the University of Toronto's Department of Anesthesia, who has created "the first VR lab of its kind that's actually based in a hospital" with two well-equipped rooms for developing custom VR content in-house using HoloLens, Oculus, and Vive technologies. SickKids has demonstrated significant clinical impact through multiple studies, including research with 100 children and 100 parents showing that VR surgical preparation was universally preferred over traditional PowerPoints and videos, with parents suggesting that VR is the technology they want to help prepare their children for surgery, leading to widespread adoption and research implementation across the hospital. The hospital's comprehensive VR program encompasses medical education with full-scale training rooms for advanced procedures and suturing practice, augmented reality applications using HoloLens for surgical tool enhancement with mapped ultrasound overlays and augmented coaching, and patient-facing applications including the custom-developed ChildLife VR mobile app for Google Cardboard that familiarizes children with operating rooms, recovery rooms, and X-ray suites to reduce pre-procedure anxiety. SickKids has partnered with Samsung to create the Samsung Space, an interactive

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

digital healing room on the hospital's top floor featuring VR technology, 360 cameras, digital tables and tablets designed as a therapeutic play and recreation area where patients, siblings, and family members can experience virtual trips to outer space and augmented reality mobile games, while the hospital also provides VR goggles as distraction tools during uncomfortable procedures in the Emergency Department.

Europe

1. The XR Health Alliance (XRHA) - XRHA is dedicated to the responsible development, investment and adoption of immersive technologies in healthcare, bridging the gap between industry, research and healthcare to unlock cross-sector innovation and collaboration. The alliance shares best practice and connects inclusive and diverse communities of patients, creators, researchers and healthcare professionals across digital health SMEs, charities, statutory bodies, pharmaceuticals, corporates and private medical insurers. In 2020 XRHA produced "The Growing Value of XR in Healthcare in the UK" report—the first study of its kind—in partnership with NHS England, Health Education England, UK Research & Innovation (UKRI) et al, revealing that while a world-class XR healthcare market is emerging in the UK, more evidence is needed to measure patient benefits and healthcare system value to leverage wider funding and sustainable sector growth. The XRHA report played a central role in establishing the UK's £20 million Mindset-XR programme. The programme offers a supportive ecosystem for immersive digital mental health therapeutics, facilitating investment in SMEs, knowledge sharing across communities of practice and drives industry-wide conditions for change through comprehensive roundtables and learning programmes.

2. XR4Rehab

XR4REHAB is a Collaboration & Innovation Network that evolved from the original VR4REHAB Interreg Northwest Europe project launched in 2017, bringing together seven European partners to develop VR-based rehabilitation tools through co-creation when VR was still in its early days in the healthcare sector, with no tools specifically designed to enable non-experts and their therapists to safely extend rehabilitation outside the clinic. The network organizes annual conferences (now in its 5th edition), supports research through staff exchanges, webinars, and training materials while facilitating knowledge exchange among researchers, clinicians, innovation managers, and developers worldwide, with initiatives including the "Catch a Rising Star" programme that provides 10 months of non-financial mentoring and networking support to help

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

individuals or small companies in rehabilitation technology advance to the next level. In 2020, XR4REHAB launched a groundbreaking Long COVID support programme through an Interreg grant extension, organising a hackathon in 2021, where 18 teams and 10 individuals from 9 countries competed to develop VR and AR solutions for Long COVID rehabilitation, with the 9 finalist ideas advancing to development jams and the top 3 concepts receiving €50,000 funding each to create prototypes that were tested with 40 long-COVID patients and 15 therapists. The COVRehab study demonstrated that VR is a feasible and effective tool for multidomain long-COVID rehabilitation, leading to the development of scalable, home-based, patient-centered solutions that virtually connect patients and therapists through VR exercise suites integrated with intelligent telehealth tools, addressing the challenge of creating affordable solutions to serve maximum numbers of patients with VR rehabilitation.

3. VR Health Champions - This project is a €7.8 million EIT Health initiative involving healthcare units, research centers, and universities from Italy, Latvia, Hungary, Poland, Portugal, Spain, Belgium and Germany, supported by industry leaders like Medtronic to accelerate XR adoption in healthcare across Europe. Co-funded by the Interregional Innovation Investments (I3) instrument under the European Regional Development Fund, this three-year project aims to break down market, clinical and regulatory barriers in less developed European regions and fast-track the advancement of VR/AR applications. Eighteen partners from eight EU Member States, embedded in nine regional ecosystems, will join forces to provide targeted support to five flagship SMEs, driving innovation in medical diagnostics, therapies, and surgeries, while also expanding the European healthcare XR ecosystem through knowledge transfer and funding opportunities.

4. The Mind VR Consortium in Italy is a collaboration between several universities and hospitals across Milan, Rome and Lecco. Commencing in 2020, the program was developed by Federica Pallavicini , Fabrizia Mantovani , and Chiara Caragnano , three psychologists with expertise in the use of virtual reality and video games for psychological well-being. They design, develop and test user-centred VR programs that offer psychoeducational content for healthcare workers to manage stress and anxiety. Since March 2021, MIND-VR has been being tested as part of a psychological support program for doctors and nurses at the IRCS Fondazione Neurologica Carlo Besta hospitals in Milan and the Gazzaniga Alzheimer's Center of Excellence – Ferb Onlus . Research is also underway at Niguarda Hospital in Milan to test virtual

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

psychoeducational content for managing stress and anxiety among caregivers of patients with dementia.

5. The Mindset XR Programme - The programme represents the UK's flagship government investment in immersive digital mental health technologies, launched in 2022 influenced by the recommendations from The XR Health Alliance's 2020 report "The Growing Value of XR in Healthcare in the UK." With £20 million in funding from UK Research and Innovation (UKRI), the three-year programme specifically targets the development and commercialisation of XR solutions for mental health applications.

The programme operates through a competitive funding model that supports small and medium enterprises (SMEs) developing XR mental health interventions, with two rounds of funding awarded to date. Round 1 supported companies including AppliedVR, Psious, Oxford VR, and Immersive Rehab, while Round 2 expanded to include TendVR, A.Health, and other emerging companies. Each funded company receives financial support alongside access to a comprehensive ecosystem designed to accelerate product development and market entry.

Beyond direct funding, Mindset XR provides a supportive infrastructure including clinical validation pathways, regulatory guidance, and access to NHS testing environments. The programme facilitates partnerships between technology companies and NHS Trusts, enabling real-world testing and evidence generation. Companies participate in structured learning programmes, roundtables, and communities of practice that address common challenges including clinical evidence requirements, regulatory compliance, and NHS procurement processes.

The programme's strategic focus on mental health reflects both clinical need and market opportunity. With mental health services in England receiving a record 5.2 million referrals during 2024 and waiting lists reaching approximately 1 million people, XR technologies offer potential solutions for improving access and treatment efficacy. Mindset XR companies are developing interventions for conditions including anxiety, depression, PTSD, eating disorders, and ADHD, with applications ranging from exposure therapy and cognitive behavioural interventions to mindfulness and stress management.

Early outcomes from the programme indicate growing clinical adoption, with several funded companies now deploying solutions within NHS Trusts. The programme has also contributed to establishing the UK as a global leader in XR mental health innovation,

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

attracting international attention and potential export opportunities. However, as the programme enters its final year in 2025, questions remain about sustainable funding mechanisms and long-term support for the ecosystem it has created.

Asia-Pacific (APAC)

Samsung Medical Center & Seoul National University Bundang Hospital (Korea) – In South Korea, leading hospitals are working with industry partners to embed XR into anaesthesia and peri-operative workflows. Samsung Medical Center has introduced immersive VR distraction platforms developed by domestic startups such as LudenVR, whose gamified training and patient-education modules are now used across several Korean medical schools and hospitals. These solutions are designed to reduce anxiety before anaesthetic induction by immersing patients in calming or interactive virtual environments rather than clinical surroundings. Similarly, Looxid Labs, a Seoul-based neurotechnology company, has collaborated on integrating biometric sensors with VR headsets to measure stress responses and tailor immersive experiences to individual patients in real time. At Seoul National University Bundang Hospital, XR has been taken further through the development of a digital-twin operating room, supported by collaborations with technology companies supplying 360° video capture, high-resolution imaging, and metaverse integration platforms. This system enables surgeons and anaesthesiologists to simulate the peri-operative process in VR, improving patient preparation while also serving as a next-generation teaching and remote-observation tool. The hospital has also tested VR products designed for peri-operative anxiety reduction in children, with startups providing custom modules that walk patients through the surgical journey in a playful and interactive manner. These initiatives highlight South Korea's broader XR healthcare ecosystem, where hospital-industry collaboration—exemplified by Samsung Medical Center, Seoul National University Bundang Hospital, LudenVR, and Looxid Labs—is creating commercially viable XR products that directly enhance surgical safety, patient experience, and clinical training.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

4. Comprehensive Market Analysis

Top applications and products reported

1. Oxford Medical Simulation (OMS) [28] was the most widely reported XR technology for health by the NHS and universities. It was reportedly used by 6 NHS Trusts and 15 universities for workforce education, predominantly for physical health conditions. For the NHS, OMS offers solutions for clinical training using immersion and performance analytics to expose staff to new scenarios, procedures and protocols while identifying skill gaps and competencies. Within universities, it is used similarly but for student nurses and doctors to learn and apply foundation skills and show readiness for practice. This technology relies on VR technology to develop these clinical and soft skills for the workforce.

2. Body Swaps [41] was the second most commonly reported XR technology, reported by 2 NHS Trusts and 12 universities. Also used for workforce training, Body Swaps uses VR and AI for skill development. Specifically, the technology builds on interpersonal communication, teamwork, conflict management and empathetic care to prepare students or healthcare workers using different scenarios and AI roleplay. This has reportedly increased confidence in being able to stay calm in hostile scenarios and in supporting patients' self esteem and identity.

Some of the other most reported products and applications include:

- Smiley Scope - used by two NHS sites and one university, Smiley Scope is a medical-grade VR headset designed to reduce pain and anxiety in children during medical procedures like needle insertions, dressing changes, and MRI preparation.
- DR.VR by Rescape - used by five NHS sites, it is used for distraction, relaxation and pain management for stress reduction and during painful treatments, such as for burns patients.
- XR Therapeutics - used by four NHS for treating anxiety conditions and specific phobias using a large flat-screen in a therapy room. One site was also using it to

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

enhance anxiety and psychosis research therapy applications. Read more in our case study.

- Anatomage - used by four universities, this product is a virtual dissection table for advanced real-human-based 3D anatomy designed to be a superior medical learning tool to transform medical education and training.

- Gener8 - used by four universities, Gener8 is an immersive interactive room designed to transport learners into fully interactive clinical scenarios. Using 360-degree projection and spatial audio, learners can simulate a wide range of healthcare and external environments, from emergency departments to shopping centres, and supports scenario customisation enabling educators to tailor experiences to specific learning outcomes and clinical competencies.

XR Applications in Mental Health Provision

Overall, XR has a lot of potential in the following areas, as identified in the survey and FOI:

1. Enabling preventative care and self-management
2. Scaling access to support during early stages of mental health concern, although not accessible to some with disabilities
3. Supporting blended models of care beyond clinical settings

XR is able to simulate environments, enable practice and repeated exposure, and support learning through embodied interactions. This could help reduce waiting lists if it is used to support self-management, increase engagement with therapies, support staff training, and offer more personalised and adaptive experiences when integrated with AI and sensors. AI may be seen as a competitor but it is likely that the next iteration will be reliant on more embodied experiences, as seen with established AI models like Replika.

“We simply do not have sufficient people and money to accommodate the large demand for mental healthcare. We should let XR play its role, most likely in hybrid or blended therapy formats.”
- Remco Hoogendijk, XR4Rehab

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

There are still some significant gaps and research/evidence is needed in these areas. Although there is significant evidence in its use for exposure therapy, our survey of companies shows that this is not an area of growth within the UK. There are more XR tools available for anxiety and depression which remain the most common mental health conditions demonstrating that there is a link between market need and product development in this sector. However, other conditions such as dementia, psychotic disorders, neurodevelopmental conditions, and substance use disorders remain underrepresented.

In general, VR is the most used XR technology with little focusing on AR or MR despite their potential. Whilst other areas like haptics and AI are emerging, these are not yet in widespread adoption. Similarly, whilst XR is mainly used for training and education there are few technologies being used for diagnosis, monitoring or prevention – these are key pressures within the NHS. Opportunities are still being missed for its integration in social prescribing, early screening or digital triage.

As of July 2025, a third of the NHS Trusts in England that responded to FOI requests reported having or using XR technologies, suggesting modest uptake. However, the adoption of XR technologies for healthcare in the NHS appears to have moved forward significantly in the last five years, suggesting more confidence in these technologies and the capacity of staff to implement them. By contrast, 62% of UK universities reported XR use and significantly earlier and more broadly within research. The private sector is starting to show strong engagement with immersive technologies and across most mental health conditions.

Challenges and Opportunities

Within the following sections, we provide an analysis of challenges and opportunities that have been highlighted by industry respondents to the survey.

The Technical Challenge

In the surveys, several highlighted how important the content, e.g., virtual environments, are and the need to ensure they are developing them to meet demand and at the required quality. The content needs to be engaging and evidence-based, providing the benefits required. Many felt that this led to a reliance on developers but where expertise

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

was not always easy to access. Those who noted that they had few or even no technical challenges often identified their team as the reason for this.

"Creating enough 3D content in the metaverse" "making an engaging game for multiple platforms including VR" "and making sure it contains beneficial exercises."

A significant challenge was the dependency and reliance on large technology companies or hardware providers which meant a lack of control when changes are made. This can further exacerbate other technical challenges such as integration and interoperability.

"Also headset manufacturers are constantly updating headsets/operating systems which means that things that once worked no longer work."

Importantly, accessibility was highlighted by many. Several recognised the need to make both the software and hardware accessible, particularly for people with disabilities or cognitive impairments. They emphasised the need for co-design and to ensure that accessibility did not impact on affordability. Users were also considered a technical challenge, both because of their attitudes and digital literacy as well as the reliance on them to actually deliver the product, which meant ensuring they had sufficient training. Hardware can also still be difficult to use.

"Our challenge technically is to create a product that is as accessible as possible with a limited budget – we are consulting on accessibility requirements from the very beginning."

Integration and implementation was a significant challenge, with the need to ensure there was integration technically with things like EHRs but also integration in different healthcare systems and infrastructures with aspects such as wifi and infection control needing to be considered. Additionally, requirements for interoperability place a significant burden on developers, especially when personalising their product. Deployment and scaling up can be limited by these challenges. Additionally, running the product across multiple sites and building the infrastructure needed can be very challenging when not wanting to sacrifice quality or security, particularly when

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

considering international markets. Some felt this was linked to their position as content-providers and their dependency on platforms.

"Most XR systems do not interact very easily with the larger hospital patient records, we need to fix the way we can prescribe and follow up digital interventions."

	Technical Challenges
Content	• Need to create sufficient, high-quality, clinically credible, engaging XR content • Scarcity of skilled VR developers • Balancing realism with hardware limitations.
Platform Dependency	• Reliance on Meta, Apple, headset OS • Frequent updates disrupt functionality • Lack of control increases costs.
Accessibility	• Ensuring usability for people with disabilities or cognitive impairments • Balancing inclusivity with affordability • Infection control limits hardware.
Users	• Low digital literacy among staff/patients • Clinician "digital fatigue" • Hardware difficult to use • Reliance on user confidence.
Integration & Interoperability	• Poor interoperability with EHRs and healthcare IT • Hospital constraints (WiFi, networks, infection control) • Compliance with FHIR and security standards adds burden.
Scaling Up	• Logistical difficulty deploying hardware across Trusts • Maintaining quality/security at scale • Developers are reluctant to act as hardware distributors.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

The Regulatory Challenge

Developers highlighted several regulatory hurdles they encounter when developing XR for mental health, including medical device classification or UKCA/CE marking, quality management systems, NHS procurement, and data protection. One key barrier for many was the uncertainty of what classified as a medical device, many felt that XR *"falls in the cracks between health and wellness"* meaning "*companies need more clarity on where they sit"* and that this could mean that *"many don't even realise"* that they need to consider medical device regulations. Most felt that another barrier to compliance is the investment needed, both in terms of cost and time. This is particularly true for smaller organisations or start-ups, who struggle to ensure that they have capacity to complete the necessary documentation and processes.

"We and many other XR startups aren't prepared for the length and cost of this process"

Regulation is an area of significant complexity for industry to navigate. It requires an understanding of not just a single requirement but requirements of different stakeholders across the healthcare system and beyond, for example understanding NHS clinical standards as well as GDPR legislation. Evidence of effectiveness, cost savings, and interoperability/ implementation is required for approval but to gather this evidence approval is often needed, creating a gap – *"we want to gather evidence with the patient group to validate the product, however we need regulatory approval to do this"*. Some discuss procurement models and how they have been designed in ways that do not account for emerging technologies. They also highlight issues whereby partners are concerned about regulations, meaning they are more wary about providing support for funding. Additionally, the area of mental health means more consideration of GDPR as not only is *"mental health data... classed as special category personal data"* but that *"XR apps track biometric or emotional data, raising concerns over informed consent, data minimisation, and data storage".*

"Minimal adoption, lack of adequate funding for general populations and as such market rollout as a result of production and validation blockers, lack of budget from end markets to actually adopt the technologies being funded for R&D, lack of new digital systems and procurement within healthcare for market adoption and rollout"

Support is required to traverse the complex spaces and understand regulations but even when this is provided, developers highlight that it is not always sufficient: *"we have spoken to a number of experts on how to navigate this but so far have not been given a clear route through this*

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

*process (*regulation*)".* Support can also cost, particularly when needing intermediaries to help navigate the complexities.

Many feel that innovation has been stifled, particularly due to the investment needed and the complexities highlighted. They feel uncertain which *"suffocates rapid iteration and experimentation by enforcing strict rules too early in the process"* and this *"prevents anything but massive orgs from competing".* Most responses focused on the cost of regulating, particularly in relation to medical device regulations, recognising not just the financial requirements but also the time and complexity that required additional support. They especially highlighted this for early-stage products or for start-ups who wouldn't have the resources needed. Many referred to the issue of qualification and classification, uncertain whether their product would be considered Software as a Medical Device.

One of the benefits of XR for healthcare is also a challenge to our understanding of its use; the adaptiveness of interventions allows for creative uses of applications that have not necessarily been designed for a healthcare purpose. Anecdotally, we often hear of how people are adapting existing applications for mental health-related purposes such as using Wander, which allows people to virtually visit different locations in the world, with people who are hospitalised to provide some respite. These types of secondary uses, while impactful, may fall outside the scope of this report's focus which prioritises tools that have a primary healthcare purpose.

This raises an important distinction relevant to regulatory frameworks, particularly how the intended purpose of a technology is defined. Within the context of medical devices and software as a medical device, the intended purpose should be clearly defined by the manufacturer with details not only about the product's functionality but also the clinical problem or unmet need it addresses. Appendix 1 provides the MHRA's Digital Medical Health Technologies (DMHT) Device Characterisation Form, which supports developers in defining their product's intended purpose [42]. This includes information on:

- functionality
- clinical problem or unmet need
- any medical purposes or claims
- whether it targets clinical symptoms or conditions

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

- who the population are and whether they are patients
- who the intended user is
- where in the healthcare pathway the product is intended to be used
- any contra-indications or potential harms

It is also important to note that a product's intended use, how it is actually deployed in practice, can sometimes align with a medical purpose even if the original intended purpose was not explicitly medical. This creates a regulatory grey area, where applications designed for more general wellbeing can be repurposed for therapeutic contexts without consideration of regulatory compliance.

	Regulatory Challenges
Classification	• Uncertainty over whether XR products are medical devices or wellness tools. • Inconsistent requirements and confusion.
Investment	• High financial and time costs for UKCA/CE marking, QMS, and evidence generation. • Startups often lack resources.
Start-ups/Early Stage	• Startups disproportionately impacted, lacking capacity for lengthy and costly processes.
Complexities Across the Health System	• Fragmented and opaque requirements across MHRA, NHS procurement, GDPR. • Evidence needed for adoption often requires prior approval. • Universities/Trusts reluctant to sponsor due to risk.
Support	• Expert advice is often unclear; intermediaries required, adding cost burden.
GDPR & Data Protection	• XR in mental health collects sensitive biometric/emotional data. • Concerns over informed consent, storage, minimisation.
Innovation & Flexibility	• Overly rigid/early application of rules stifles iteration and prevents SMEs from competing.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

The Financial Challenge

The biggest financial challenge shared by developers was funding. Many felt that funders still failed to recognise the value of XR in healthcare and, even when they did, typically awarded universities rather than industry. One commented that this may be due to the language they use in grant writing and the need to consider support from bid writers. They felt that funding was often geared towards early-stage innovations rather than scaling or continued development, not recognising the high costs associated with development and deployment which requires specialist expertise. Additionally, very few highlighted the need for funding to generate evidence.

"Grants are all or nothing which discourage phased and rapid iteration."

Those that did highlight the need for evidence focused on clinical trials and health economics, emphasising that without this kind of evidence there is little incentive for investors or procurers to adopt their products. Private investment was attractive to some but they questioned how confident investors are in XR for healthcare without sufficient evidence or use cases.

"Nobody wants to buy your product till you've done clinical trials. And nobody wants to do clinical trials unless you have money."

Another challenge is the fit that funding has to ensure business sustainability, with long application processes and delays to securing funds, for example being paid in arrears, this can make relying on funding difficult.

"Most public funding is reimbursed in arrears, so startups must front costs."

Some with experience of NHS contracts highlighted how laborious these could be and that even within place, they were often short-term and uncertain. Others discussed potential reimbursement models, with some having experience in other health systems such as the US, highlighting some early successes. However, the software aspect was highlighted as a barrier where *"Standard models for software – i.e. monthly/annual licence fees – do not appear to have been accepted in healthcare."*. Overall, many felt there was a disconnect between what was needed to support XR and the existing

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

funding streams, which do not account for the iterative, creative development cycles needed and which can guarantee a higher quality product.

	Financial Challenges
Team	• Specialist skills (developers, 3D artists, clinicians, data experts) are expensive • Sustaining teams is difficult without early funding.
Funding for Development	• Funding often targets early-stage innovation but not scaling • Grants are "all or nothing," discouraging iteration.
Funding for Evidence	• Limited funding for efficacy data, clinical trials, and health economics • Difficult to access investment without evidence and vice versa
Time	• Funding is slow, competitive, and often paid in arrears • Cash flow challenges for SMEs.
Grants	• XR undervalued or misunderstood by assessors • Universities are more successful, possibly because SMEs lack bid-writing capacity.
Alternatives to Grants	• Private/VC investment difficult at early stage • Investors demand evidence SMEs can't generate without investment.
Contracts	• NHS/academic contracts often short-term, preventing sustainability • Long route to procurement.
Reimbursement	• No established reimbursement models for XR • Licensing/subscription models not accepted in healthcare.
Appropriate Funding Models	• Grants misaligned with XR's iterative cycle • Require ROI/rollout data too early.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Organisational

There is somewhat of a postcode lottery for XR companies seeking support from e.g., Health Innovation Networks where certain regions have more expertise than others. This highlights the lack of a central XR strategy and the fragmentation that exists within the NHS. This means that it can be a slow process to procurement, with contracts and other requirements needing to be met individually for each Trust.

"NHS procurement favours established providers."

There is, however, a clear interest in XR within the UK and it compares favourably to other markets. XR is already widely accepted for training and simulation so this could also be a potential pathway for intervention-based deployment. Companies have seen a shift towards digital tools since COVID, including within the NHS, and feel that this could lead to the wider adoption of XR.

The Clinical Challenge

Developers share that they face high costs to generate clinical evidence, for example through clinical trials, which is needed to secure investment. Many draw on clinical expertise but share that it can also be expensive, with clinical experts difficult to access and often with limited availability.

"To build effective mental health tools, you need input from qualified clinicians … These professionals typically have limited time and high day rates."

Many felt that there was a reluctance amongst clinicians to engage with new technologies, perhaps due to less experience. This also impacted on implementation, with less access to patients and services for real world testing. Integration and implementation into clinical environments faced several barriers – infrastructure, interoperability with care systems, existing workflows. They also highlighted the demand for Trusts for local evidence before adoption despite the need to transition away from pilots. Even when access is provided, developers felt there was a clarity about what evidence was needed for adoption, particularly when making the case for the products. For example, some felt it was difficult to demonstrate value because their products offered solutions in areas where there were no other interventions to compare against or were preventative.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

"Our product does not neatly replace an existing process or treatment … it is not clear how this can be captured for evidence/efficacy."

This was further complicated by the lack of existing evidence, limiting what is known about longitudinal use, comorbidities or variability in users and its impact, and risks and harms.

"We need funding… to generate evidence and complete our health economics work. But we need evidence and health economics in order to secure paid opportunities."

	Clinical Challenges
Costs	• High costs of clinical trials • Funding complex • High cost for expertise (clinicians/researchers)
Clinical Partners	• Few clinicians with XR expertise • Limited time and availability • High cost • Reluctance to adopt XR • Implementation also involves non-clinical staff
Implementation	• Infrastructure gaps (e.g. poor Wi-Fi) • Difficulty integrating with EHRs and workflows • Limited access to patients and services • Trusts demand localised evidence, leading to repeated pilots
Evidence	• Complex to demonstrate efficacy in mental health (comorbidities, variability) • Longitudinal outcomes hard to capture • Unclear what evidence is needed • Risks around safety and harms (e.g. retraumatisation, cybersickness) • Trust-specific requirements fragment adoption

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Offering Solutions for Evidence Generation, Regulation and MDR Compliance

- **Context:** Currently companies reportedly spend 1-2 years going through Medical Device Registration (MDR) processes with MHRA/UKCA and circa £1million per year waiting for a class IIa medical device license to be able to be used in the NHS covering costs of compliance, the data team and a team of developers and clinicians to further develop the product without being able to sell it. This cost and timescale is known as the 'valley of death' after initial product efficacy is demonstrated in small scale trials. This is the stage where many innovations do not make it to market, companies fail and what was innovation, becomes outdated by the time it receives the necessary licence to sell within the NHS
- **Proposed Innovation:** Governments outside Europe and the US (who are not governed by MHRA and the FDA) are looking to new models of AI enabled, rapid regulatory and MDR compliance tools that can take regulatory timescales down from years to weeks and millions to thousands of pounds/dollars.

We propose a new approach: develop a platform that radically accelerates compliance, evidence generation, and commercialisation. Offer tools and processes that provide instant gap analysis against any regulatory or compliance standard, showing innovators exactly what's missing and how to address it. Help teams create the required documentation and evidence, tailored to the relevant standards, reducing the need for expensive consultants or academic staff. Automate the design, execution, and reporting of randomised controlled trials, following HRA guidelines and producing regulator-ready evidence at a fraction of the time and cost.

From this approach we will see benefits including the cutting of time-to-market by 12-24 months, companies saving up to £2 million per product for Class IIa MDR and above. Enabling Liverpool to become a global leader in rapid, responsible health tech innovation and attract investment, create jobs, and deliver real impact for patients and the local economy.

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

Acknowledgements

Report Commissioners - The University of Liverpool's Civic Health Innovation Labs (CHIL)

Annemarie Naylor MBE | Chawisa Deesomboon

Authors / Editors - XR Health Alliance

Sarah Ticho | Ross O'Brien

Research Authors - University of Nottingham
Aislinn Gomez Bergin - RAi Transitional Assistant Professor at the University of Nottingham and NIHR MindTech HealthTech Research Centre Emerging Technologies Lead

Lucy Hitcham - PhD Researcher with the EPSRC Horizon Centre for Doctoral Training at the University of Nottingham

NIHR MindTech HealthTech Research Centre
MindTech is a national centre based at the University of Nottingham focusing on the development, adoption and evaluation of new technologies for mental healthcare and dementia. https://www.mindtech.org.uk

Responsible AI UK
RAi UK brings together researchers from across the four nations of the UK to understand how we should shape the development of AI to benefit people, communities and society. https://rai.ac.uk

The EPSRC Horizon Centre for Doctoral Training (CDT) is based at the University of Nottingham and is supported by a multi-million pound investment from UKRI, the University of Nottingham and over 40 industry partners. The CDT focuses on *digital identity, personal data and data creativity* within the global digital economy.

Digital Design and Development

Jeremy & Martin Pitt - Social Heads, Stephen Hellens - User Experience Consultant

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

References

1. Dalton J, Craven M, Bergin A, Ticho S, O'Brien R, Phelan I, Carrion-Plaza A, Price R, Logeswaren A, Kilkelly F, Ghatnekar P. The growing value of XR in healthcare in the United Kingdom [Internet]. XR Health UK; [cited 2025 Jul 23]. Available from: https://www.xrhealthuk.org/the-growing-value-of-xr-in-healthcare

2. openPR.com. Healthcare extended reality market by application analysis, regional outlook, competitive strategies and forecast 2033 [Internet]. [cited 2025 Jul 23]. Available from: https://www.openpr.com/news/4112003/healthcare-extended-reality-market-by-application-analysis

3. IMARC Group. Global healthcare extended reality market to reach USD 67.7 billion by 2033 [Internet]. [cited 2025 Jul 23]. Available from: https://www.imarcgroup.com/global-healthcare-extended-reality-market

4. Pons P, Navas-Medrano S, Soler-Dominguez JL. Extended reality for mental health: Current trends and future challenges. Front Comput Sci. 2022 Nov 18;4:1034307.

5. Dimension Market Research. Extended reality (XR) market to hit USD 2,826.0 bn by 2033 [Internet]. [cited 2025 Jul 23]. Available from: https://dimensionmarketresearch.com/report/extended-reality-market/

6. Gómez Bergin AD, Craven MP. Virtual, augmented, mixed, and extended reality interventions in healthcare: a systematic review of health economic evaluations and cost-effectiveness. BMC Digit Health. 2023 Dec 15;1(1):53.

7. Morris S, Hill S, Brugha T, McManus S, editors. Adult psychiatric morbidity survey: survey of mental health and wellbeing, England, 2023/4. NHS England; 2024.

8. Torous J, Myrick KJ, Rauseo-Ricupero N, Firth J. Digital mental health and COVID-19: using technology today to accelerate the curve on access and quality tomorrow. JMIR Ment Health. 2020 Mar;7(3):e18848.

9. Health Innovation Network. Mindset XR: introducing round 2 companies for the programme [Internet]. [cited 2025 Jul 23]. Available from: https://

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

healthinnovationnetwork.com/mental-health/mindset-xr-introducing-round-2-companies-for-the-programme/

10. NHS Innovation Accelerator. XR therapeutics [Internet]. [cited 2025 Jul 23]. Available from: https://nhsaccelerator.com/innovations/xr-therapeutics/

11. Straits Research. AR/VR/MR in healthcare market size, top share and forecast to 2033 [Internet]. [cited 2025 Jul 23]. Available from: https://straitsresearch.com/report/ar-vr-mr-in-healthcare-market

12. Auganix. XRHealth acquires RealizedCare to expand its AI-driven therapeutic XR platform [Internet]. [cited 2025 Jul 23]. Available from: https://www.auganix.org/xr-news-xrhealth-acquires-realizedcare-to-expand-its-ai-driven-therapeutic-xr-platform/

13. Precedence Research. Augmented and virtual reality in healthcare market size to hit USD 18.38 billion by 2034 [Internet]. [cited 2025 Jul 23]. Available from: https://www.precedenceresearch.com/augmented-and-virtual-reality-in-healthcare-market

14. Express Healthcare. Asia-Pacific healthcare market set to hit $5 trillion by 2030, driving global growth: BCG report [Internet]. [cited 2025 Jul 23]. Available from: https://www.expresshealthcare.in/news/asia-pacific-healthcare-market-set-to-hit-5-trillion-by-2030-driving-global-growth-bcg-report/447773/

15. UK Research and Innovation. Mindset: extended reality (XR) for digital mental health programme [Internet]. [cited 2025 Jul 23]. Available from: https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/mindset-extended-reality-xr-for-digital-mental-health-programme/

16. Kivuti-Bitok LW, Cheptum JJ, Mutwiri M, Wanja S, Ngune I. Virtual reality and serious gaming in re-engineering clinical teaching: A review of literature of the experiences and perspectives of clinical trainers. Afr J Health Nurs Midwifery. 2022;6:53–86. doi:10.52589/ajhnm-mfh6yys8.

17. Anagram. News [Internet]. [cited 2025 Jul 23]. Available from: https://weareanagram.co.uk/news

18. Soulpaint [Internet]. [cited 2025 Jul 23]. Available from: https://www.soulpaint.co

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

19. Towards Healthcare. Mixed reality in healthcare market expands by 48.74% CAGR till 2034 [Internet]. [cited 2025 Jul 23]. Available from: https://www.towardshealthcare.com/insights/mixed-reality-in-healthcare-market-sizing

20. Institution of Engineering and Technology. The promise of immersive healthcare [Internet]. [cited 2025 Jul 23]. Available from: https://www.theiet.org/media/9487/the-promise-of-immersive-healthcare.pdf

21. UK Research and Innovation. Creative industries clusters programme [Internet]. [cited 2025 Jul 23]. Available from: https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/creative-industries-clusters-programme/

22. UK Research and Innovation. Convergent screen technologies and performance in real-time (CoSTAR) [Internet]. [cited 2025 Jul 23]. Available from: https://www.ukri.org/councils/ahrc/remit-programmes-and-priorities/convergent-screen-technologies-and-performance-in-realtime-costar/

23. Emteq Labs [Internet]. [cited 2025 Jul 23]. Available from: https://www.emteqlabs.com/

24. Gromala D, Tong X, Choo A, Karamnejad M, Shaw CD. The virtual meditative walk: virtual reality therapy for chronic pain management. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems; 2015 Apr 18; Seoul, Korea. p. 521–4.

25. DEEP VR. About DEEP [Internet]. [cited 2025 Jul 23]. Available from: https://www.exploredeep.com/#about-deep

26. XR Health EU [Internet]. [cited 2025 Jul 23]. Available from: https://www.xr.health/eu/

27. Fundamental XR [Internet]. [cited 2025 Jul 23]. Available from: https://www.fundamentalxr.com

28. Oxford Medical Simulation [Internet]. [cited 2025 Jul 23]. Available from: https://oxfordmedicalsimulation.com

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

29. Logeswaran A, Munsch C, Chong YJ, Ralph N, McCrossnan J. The role of extended reality technology in healthcare education: Towards a learner-centred approach. Future Healthc J. 2021 Mar 1;8(1):e79–84.

30. Remo Health [Internet]. [cited 2025 Jul 23]. Available from: https://remo.health

31. End of Life Doula UK [Internet]. [cited 2025 Jul 23]. Available from: https://eol-doula.uk

32. Proximie [Internet]. [cited 2025 Jul 23]. Available from: https://www.proximie.com

33. South London and Maudsley NHS Foundation Trust [Internet]. [cited 2025 Jul 23]. Available from: https://slam.nhs.uk/

34. Hughes O. SLAM awarded £1.3m for new VR and neurotherapeutics hubs [Internet]. Digital Health. 2024 Nov 18 [cited 2025 Jul 23]. Available from: https://www.digitalhealth.net/2024/11/slam-awarded-1-3m-for-new-vr-and-neurotherapeutics-hubs/

35. South London and Maudsley NHS Foundation Trust. South London and Maudsley uses virtual reality for needle phobia and anxiety [Internet]. 2022 Apr 20 [cited 2025 Jul 23]. Available from: https://slam.nhs.uk/pressreleases/south-london-and-maudsley-uses-virtual-reality-to-support-people-with-needle-phobia-and-anxiety-2465

36. Neuro-Reality. Products [Internet]. [cited 2025 Jul 23]. Available from: https://neuro-reality.com/products/

37. Hindman S, King R, Pereira A. Virtual reality based executive function training in schools: The experience of primary school-aged children, teachers and training teaching assistants. Comput Hum Behav Rep. 2024;16:100500. doi:10.1016/j.chbr.2024.100500.

38. Hindman S, King R, Pereira A. Virtual reality based executive function training in schools: The impact of adaptivity on executive function and motivation. Comput Educ. 2025;234:105344. doi:10.1016/j.compedu.2025.105344.

39. Maskey M, Rodgers J, Grahame V, Glod M, Honey E, Kinnear J, Labus M, Milne J, Minos D, McConachie H, Parr JR. A randomised controlled feasibility trial of immersive virtual reality treatment with cognitive behaviour therapy for specific

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION

phobias in young people with autism spectrum disorder. J Autism Dev Disord. 2019 May 15;49(5):1912–27.

40. Maskey M, Lowry J, Rodgers J, McConachie H, Parr JR. Reducing specific phobia/fear in young people with autism spectrum disorders (ASDs) through a virtual reality environment intervention. PLoS One. 2014 Jul 2;9(7):e100374.

41. Bodyswaps [Internet]. [cited 2025 Jul 23]. Available from: https://bodyswaps.co

42. Medicines and Healthcare products Regulatory Agency. Guidance on digital mental health technologies: Device characterisation, regulatory qualification and classification [Internet]. [cited 2025 Jul 23]. Available from: https://assets.publishing.service.gov.uk/media/6866572fadfe29730ea3a9d5/MHRA_guidance_on_DMHT_-_Device_characterisation_regulatory_qualification_and_classification.pdf

Funded by UK Government
LIVERPOOL CITY REGION COMBINED AUTHORITY
METRO MAYOR LIVERPOOL CITY REGION