Strategies to Promote Digital Health Equity: Identification of those most at risk of digital exclusion within healthcare and a qualitative exploration of their experiences

Sarah Wilson

Submitted for the degree of Doctor of Philosophy (PhD)

Faculty of Medical Sciences: Population Health Sciences Institute

April 2025

Abstract

Digital Health Technologies (DHTs) have revolutionised healthcare, but their benefits are not equally experienced among under-served populations. This PhD project aimed to identify those most at risk of digital exclusion within healthcare and explore strategies to promote inclusivity.

First, the researcher reviewed the literature to identify sociodemographic factors that may contribute to digital exclusion within healthcare, organising them into six groups to form the CLEARS framework (Culture, Limiting conditions, Education, Age, Residence, and Socioeconomic status), which recognises intersectionality across these groups (Chapter 3). This review also highlighted a knowledge gap around the needs and experiences of under-served groups, and the strategies that might support their digital inclusion. Inspired by this, the researcher conducted a systematic review of the literature to identify strategies to promote digital health equity (Chapter 4). The review highlighted the importance of user-friendly designs, supportive infrastructure (e.g., free devices and connectivity), and digital skills educational support. A qualitative study, using semi-structured interviews and focus groups, was conducted with 29 under-served individuals who represented the CLEARS groups to explore their perspectives of these strategies (Chapters 5-6). Participants raised concerns regarding the use of their social network for digital skill support (e.g., experiencing controlling behaviours) and highlighted the need to increase funding for educational support services. Co-design approaches were also suggested to ensure DHTs were designed appropriately and tailored to meet users' needs.

To understand whether these digital inclusion strategies are feasible at a local or regional level, the researcher conducted a second qualitative study with 17 stakeholders who had a professional interest in making decisions and/or delivering activities to support under-served groups at risk of digital exclusion (Chapter 7). Stakeholders emphasised the need for cross-organisational collaboration to implement free devices and connectivity, which were resource intensive. They also stressed the need for staff training to upskill healthcare professionals and develop a knowledge base of local digital inclusion support that under-served groups can be referred to.

Based on all the findings from this PhD programme of work, the researcher created eight key recommendations to advance digital inclusion within healthcare, including co-designing DHTs with user involvement, raising awareness of available support amounts under-served communities, and providing various digital inclusion support services (e.g., educational digital skills support, re-purpose devices and pre-paid SIM cards). Further research should assess the feasibility and impact of these recommendations in practice.

Table of Contents

Table of Figures

Table of Tables

Abbreviations

AAIC:	Alzheimer Association International Conference
AI:	Artificial Intelligence
A-Level	Advanced level qualifications
AMIA:	American Medical Informatics Association

APEASE:	Affordability, Practicability, Effectiveness, Acceptability, Size effects/safety, and Equity
ARUK:	Alzheimer’s Research United Kingdom
BSL:	British Sign Language
CASP:	Critical Appraisal Skills Programme
CLAS:	National Culturally and Linguistically Appropriate Services
CLEARS:	Culture, Limiting conditions, Education, Age, Residence, Socioeconomic status
COREQ:	Consolidated criteria for reporting qualitative research
COVID-19:	Coronavirus Disease
CREST:	Compact for Race Equality in South Tyneside
DHTs:	Digital Health Technologies
DigComp 2.2:	The Digital Competence Framework for Citizen
ECG:	Electrocardiogram
EDI:	Equality, Diversity & Inclusion
EDoN:	Early Detection of Neurodegenerative diseases
eGFRcr:	Glomerular Filtration Rate from serum creatinine
EMA:	European Medicines Agency
EoI:	Expression of Interest form
ETHOS:	Extreme Temperature and Health OutcomeS
FDA:	United States Food and Drug Administration
GAD-7:	Generalised Anxiety Disorder 7-item scale
GCSE:	General Certificate of Secondary Education
HEALTH:	HarnEssing Artificial intelligence to Lead Transformative Healthcare
HI NENC:	Health Innovation North East and North Cumbria
HIV:	Human Immunodeficiency Viruses
ICB:	integrated Care Board
IMD:	Index of Multiple Deprivation.
LGBTQ+:	Lesbian, Gay, Bi, Trans, Queer, questioning and ace

NE:	North East
NHS:	National Health Service
NICE:	National Institute for Health and Care Excellence
NIH:	National Institute of Health
NIHR:	National Institute for Health and care Research
OECD:	Organisation for Economic Co-operation and Development
OSOP:	One Sheet Of Paper
PICOS:	Population, Intervention, Comparison, Outcomes and Study design
PIS:	Participant Information Sheet
PPI:	Patient and Public Involvement
PRISMA:	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PRISMA-ScR:	Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews
PROGRESS PLUS:	Place of residence, Race/ethnicity/culture/language, Occupation, Gender/sex, Religion, Education, Socioeconomic status, Social capital. Plus refers to personal characteristics associated with discrimination, features of relationships, and time-dependent relationships.
RA:	Research Assistant
SABRE:	Spatial biomarkers of early Alzheimer's Disease
SRQR:	Standards for Reporting Qualitative Research
UK:	United Kingdom
UKRI:	United Kingdom Research and Innovation
UN:	United Nations
UNICEF:	United Nations Children's Fund
US:	United states
VCSE:	Voluntary, community and social enterprise
WHO:	World Health Organisation

Funding and conflict of interest statement

This work has been supported by the Early Detection of Neurodegenerative diseases (EDoN) research initiative, funded by Alzheimer's Research United Kingdom (ARUK) with support from Gates Ventures and the Alzheimer's Drug Discovery Foundation through its Diagnostic Accelerator Project. This project also received funding from NIHR (NIHR205190).

The author has no conflicts of interest to declare.

Acknowledgments

I would like to express my gratitude and appreciation to those who have given their time, support and guidance over the course of my PhD.

First, I would like to express my deepest appreciation to my supervisors, Prof. Sarah Slight, Dr Clare Tolley, Dr Riona McArdle and Dr Robert Slight. Since I started working with you in 2021, you have provided support throughout my MSc and PhD, and given valuable guidance, direction and patience during my journey of learning qualitative research methods, made slightly harder due to my dyslexia. All the opportunities you have provided me to learn new skills and grow as a researcher, are immensely appreciated, especially the opportunities to travel to international conferences held in San Diego, Washington DC, Amsterdam, New Orleans, Philadelphia, San Francisco and Lisbon. I have learnt so much from the opportunities to work in multiple multidisciplinary research teams and collaborate with various global experts in the field of digital health, behaviour change, health inequities, dementia and geography. Working with you has been an amazing experience; I greatly appreciate all the time taken to provide advice, feedback, and 'pep-talks' motivating me through the process of conducting this PhD project. Without your support and guidance this PhD would not have been possible.

I would like to thank Dr Adam Rathbone, Dr Steph Scott and Prof. Katie Brittan for acting as my Annual Progression Review panel, providing praise and constructive feedback of my work at various stages during this PhD project.

I would also like to thank all the gatekeepers and staff at community centres for supporting the recruitment of participants and providing a place to conduct data collection. And of course, I wish to thank all those who took time out of their day to participate in an interview or focus group, allowing me to gain a deeper understanding of how to advance digital health equity.

I must also thank my colleagues, especially Dr Nehal Hassan and those in the 'NIHR PSRC hub' for your advice, support and laughter.

I would like to thank my parents and siblings, the Jackson family and close friends for providing support, friendship and love. Finally, I'm extremely grateful to my Fiancé and gym buddy, Alex Jackson. You have always had the patience of a saint and supported me in whatever I do. Thank you for your love, humour and always having a holiday destination in mind.

About the author

Sarah Wilson graduated from Newcastle University in 2020 with a Second Class (Division 1) Bachelor of Science Joint Honors degree in Biology and Psychology. She then graduated from the University of Sheffield in 2021 with a Master of Science degree in Cognitive Neuroscience and Human Neuro-Imaging (merit). Whilst completing her MSc, Sarah worked full time as a Research Assistant (RA) at Newcastle University on the Early Detection of Neurodegenerative diseases initiative (EDoN). Inspired by the research she was conducting, Sarah pursued a PhD in digital health equity. She started her PhD project exploring strategies to promote digital health equity at Newcastle University in April 2022, whilst continuing her full time RA position. In addition to her research contributions to the EDoN project, Sarah became a co-investigator on various other research projects within the timeframe of her PhD (April 2022- April 2025), including an NIHR project development grant: HarnEssing Artificial intelligence to Lead Transformative Healthcare (HEALTH), UKRI (United Kingdom Research and Innovation) funded project: Extreme Temperature and Health OutcomeS (ETHOS) and an NHIR Invention for innovation funded project: Spatial biomarkers of early Alzheimer's disease (SABRE). Since starting her PhD in 2022, Sarah has published two first authorship peer-reviewed articles in high impact journals, including npj Digital Medicine (with a third first authorship article under-review), and co-authored a peer-reviewed article (with a second co-authorship article in draft). She has also presented over 40 abstracts at various national and international conferences, including the American Medical Informatics Association (AMIA) annual conference and Alzheimer Association International Conference (AAIC). During these three years, Sarah has also co-supervised eight Summer Research Scholarship Interns and contributed to undergraduate teaching on Newcastle University's MPharm course by co-supervising 10 final year dissertation projects and three stage 3 literature review projects.

Publications relating to this PhD project

Journal articles

1. **Wilson S**, Tolley C, Mc Ardle R, Lawson L, Beswick E, Hassan N, Slight R, Slight S. Recommendations to advance digital health equity: a systematic review of qualitative studies. *NPJ digital medicine*. 2024 Jun 29;7(1):173.

Published conference proceedings

1. **Wilson S,** Tolley C, McArdle R, Hassan N, Slight R, Slight S. Strategies to advance digital health equity: a qualitative study with underserved groups. *The Lancet*. 2024 Nov 1;404:S37.
2. **Wilson S**, Tolley C, Mc Ardle R, Slight R, Hassan N, Slight S. Strategies to advancing digital health equity: perspectives from underserved groups. *European Journal of Public Health*. 2024 Nov;34(Supplement_3):ckae144-1123.
3. **Wilson S**, Tolley C, McArdle R, Slight R, Slight S. Who is most at risk of digital exclusion within healthcare?, *International Journal of Pharmacy Practice*, Volume 32, Issue Supplement_1, April 2024, Pages i3–i4, https://doi.org/10.1093/ijpp/riae013.004
4. **Wilson S**, Tolley C, Ardle RM, Beswick E, Lawson L, Slight R, Slight S, Hassan N. Strategies to develop, design, implement and support digital health equity in key underserved groups: protocol for a systematic review. *Alzheimer's & Dementia*. 2023 Dec;19:e082098.

Conference presentations

1. **Wilson S**, Tolley C, McArdle R, Hassan N, Slight R, Slight S. (2025) “Stakeholders’ perspectives on the feasibility of implementing strategies to promote digital inclusion within healthcare.” *AMIA 2025 Annual Symposium*, Atlanta. [Poster presentation]
2. **Wilson S**, Tolley C, McArdle R, Slight R, Slight S. (2025) Key considerations to promote digital inclusivity within healthcare: stakeholders’ and under-served groups perspectives. *Alzheimer's Association International Conference,* Toronto. [Poster presentation]
3. **Wilson S**, Tolley C, McArdle R, Hassan N, Slight R, Slight S. (2024) Strategies to advance digital health equity: a qualitative study with underserved groups. *UK Public Health Science* , Cardiff. [Poster presentation]
4. **Wilson S**, Tolley C, McArdle R, Hassan N, Slight R, Slight S. (2024) Strategies to advancing digital health equity: perspectives from underserved groups. *17th European Public Health Conference*, Lisbon, Portugal. [Poster presentation]
5. **Wilson S**, Tolley C, Mc Ardle R, Slight R, Slight S. (2024) The CLEARS framework: a scoping review of groups at risk of digital exclusion with consideration for intersectionality. *Great North Pharmacy Research Collaborative conference*, Gateshead. [Poster presentation]
6. **Wilson S**, Tolley C, McArdle R, Slight RD, Slight SP. (2024) Sociodemographic groups at risk of digital exclusion: a scoping review. *British Society of Gerontology (BSG) Conference*, Newcastle. [Oral presentation]
7. **Wilson S**, Tolley C, Mc Ardle R, Slight R, Slight S. (2024) Advancing digital health equity by identify those most at risk: a scoping review. *Association of Physicians 117th Annual Meeting 2024*, Newcastle. [Poster presentation]
8. **Wilson S**, Tolley C, Mc Ardle R, Slight R, Slight S. (2024) Who is most at risk of digital exclusion within healthcare?: A scoping review. *Health Services Research & Pharmacy Practice Conference*. Cork, Ireland. [Oral presentation]

9. **Wilson S**, Mc Ardle R, Tolley C, Lawson, L, Beswick, E, Hassan, N, Slight R, Slight S. (2023) Strategies to support digital health equity amongst key underserved communities: a systematic review. *North East Postgraduate Conference*, Newcastle. [Oral presentation]
10. **Wilson S**, Mc Ardle R, Tolley C, Slight R, Slight S. (2023) Identifying Key Underserved Groups at Risk of Digital Exclusion in Healthcare. Faculty of Clinical Informatics Annual Scientific Conference, Manchester. [e-poster presentation]
11. **Wilson S**, Mc Ardle R, Tolley C, Lawson, L, Beswick, E, Hassan, N, Slight R, Slight S. (2023). Strategies to develop, design, implement and support digital health equity in key underserved groups: a systematic review. *American Medical Informatics Association (AMIA) annual symposium*. New Orleans. [Poster presentation]
12. **Wilson S**, Mc Ardle R, Tolley C, Lawson, L, Beswick, E, Hassan, N, Slight R, Slight S. (2023) Strategies to develop, design, implement and support digital health equity in key underserved groups: protocol for a systematic review. *Alzheimer's Association International Conference (AAIC),* Amsterdam. [Poster presentation]
13. **Wilson S**, Mc Ardle R, Tolley C, Lawson, L, Beswick, E, Hassan, N, Slight R, Slight S. (2023) Strategies to develop, design, implement and support digital health equity in key underserved groups: protocol for a systematic review. *Great North Pharmacy Research Collaborative Conference*, Gateshead. [Poster presentation]
14. **Wilson S.** (2023) Strategies to support digital health equity. *Soapbox Science session at Alzheimer's society early career researcher retreat*, Newcastle. [Oral presentation]
15. **Wilson S.** (2023) Strategies to support digital health equity. *3 Minute Thesis Competition,* Newcastle University finalist. [Oral presentation]

Additional work published during the PhD timeframe (2022- 2025)

Journal articles

1. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Mc Ardle R, Hassan N, Walker Z, Slight S. Acceptability of wearable technology for the early detection of dementia-causing diseases: perspectives from the CODEC II cohort. *BMC Digit Health* . 2025; **3**, 55. https://doi.org/10.1186/s44247-025-00191-3
2. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight SP. Key Considerations When Developing and Implementing Digital Technology for Early Detection of Dementia-Causing Diseases Among Health Care Professionals: Qualitative Study. *J Med Internet Res*. 2023;25:e46711. doi:10.2196/46711
3. Lawson L, Mc Ardle R, **Wilson S**, Beswick E, Karimi R, Slight SP. Digital Endpoints for Assessing Instrumental Activities of Daily Living in Mild Cognitive Impairment: Systematic Review. *J Med Internet Res*. 2023;25:e45658. doi:10.2196/45658

Manuscripts under peer review and in draft

1. **Wilson S**, Beswick E, Popp Z, Rahman S, Bhogal S, Whitfield T, Low S, Khan R, Tolley C, Slight S. Acceptability of technologies to support early dementia detection: Insights from the Boston University Alzheimer's Disease Centre Cohort. Submitted to Exploration of Digital Health Technologies 25th July 2025.
2. Tolley C, deNazelle A, **Wilson S**, Hassan N, Slight R, Slight S. What are the optimal strategies to communicate the risk of air pollution exposure to underserved groups? (In draft)

Published conference proceedings

1. Slight SP, Abdalla H, Hassan N, **Wilson S**, Slight R. A systematic review of cancer overdiagnosis in multimorbid patients. *European Journal of Public Health*. 2024 Nov;34(Supplement_3):ckae144-1611.
2. **Wilson S**, Dhillon G, Hassan N, McArdle R, Su L, Slight S. The effect of outdoor air pollution on Alzheimer's disease: a systematic review. *European Journal of Public Health*. 2024 Nov;34(Supplement_3):ckae144-1408.
3. **Wilson S,** Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Ardle RM, Walker Z, Slight S. Acceptance of wearable technology for the early detection of dementia-causing diseases: perspectives from the CODEC II cohort. *Alzheimer's & Dementia*. 2024 Dec;20:e094258.
4. Beswick E, **Wilson S**, Popp ZT, Rahman S, Khan RR, Tolley C, Low S, Slight S. Acceptance of using digital technologies to aid the timely detection of dementia: perspectives from Boston University Alzheimer's Disease Research Centre. *Alzheimer's & Dementia*. 2024 Dec;20:e094262.
5. Dhillon G, Hassan N, **Wilson S**, Ardle RM, Su L, Slight S. Outdoor air pollution as a risk factor for Alzheimer's disease: A systematic review. *Alzheimer's & Dementia*. 2024 Dec;20:e089538.
6. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight S. Healthcare professionals' perspectives on the key considerations for digital technology aiding the early detection of dementia-causing diseases: a qualitative approach. *International Journal of Pharmacy Practice*. 2024 Apr 1;32(Supplement_1):i33-4.
7. Hassan N, **Wilson S**, Marley K, Slight R, Slight S. Artificial intelligence informing clinical decision making on the risk of hospital readmissions in multi-morbid patients: a systematic review. *International Journal of Pharmacy Practice*. 2024 Apr 1;32(Supplement_1):i40-1.
8. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight S. Key considerations when developing and implementing digital technology for early dementia detection. *Alzheimer's & Dementia*. 2023 Dec;19:e074682.

9. **Wilson S,** Mc Ardle R, Tolley C, Slight S. Usability and acceptability of wearable technology in the early detection of dementia. *Alzheimer's & Dementia*. 2022 Dec;18:e059820.

Conference presentations

1. **Wilson S**, Hassan N, Chan D, Slight S. (2025). Perspectives of using a digital test to support early detection of Alzheimer's: A protocol for involving underserved groups. *Alzheimer's Association International Conference,* Toronto. [Poster presentation: Accepted 1st April 2025]
2. **Wilson S**, Tolley C, Morrison L, Walker D, Abayomi V, Hassan N, Slight R, Filingeri D, Vaz-Monteiro M, Esteves NK, Sheffield J, Slight S. (2025) Vulnerable populations' perspectives on interventions to reduce the health impacts of exposure to extreme temperatures: a qualitative systematic review protocol. *International Conference on Evolving Cities & Towns,* Southampton. [Accepted 21/03/2025]
3. Slight S, Abdalla H, Hassan N, **Wilson S**, Slight R. (2024) A systematic review of cancer overdiagnosis in multimorbid patients. *17th European Public Health Conference*, Lisbon, Portugal. [Poster presentation]
4. **Wilson S**, Dhillon G, Hassan N, McArdle R, Su L, Slight S. (2024) The effect of outdoor air pollution on Alzheimer's disease: a systematic review. *17th European Public Health Conference*, Lisbon, Portugal. [Poster presentation]
5. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Ardle RM, Walker Z, Slight S. (2024) The acceptance of wearable technology amongst those with cognitive impairment and their carers. *AMIA annual symposium*, San Fransisco. [poster presentation]
6. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight S. (2024) Healthcare professionals' key considerations when developing and implementing digital technology for early detection of dementia causing diseases. *AMIA annual symposium*, San Fransisco. [oral presentation]
7. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Mc Ardle R, Walker Z, Slight S. (2024) Acceptance of wearable technology for the early detection of dementia-causing diseases: perspectives from the CODEC II cohort. *AAIC conference*, Philadelphia. [Poster presentation]

8. Beswick E, **Wilson S**, Popp Z, Rahman S, Khan R, Tolley C, Low S, Mc Ardle R, & Slight S. (2024) Acceptance of using digital technologies to aid the timely detection of dementia: perspectives from Boston University Alzheimer's Disease Research Centre. *AAIC conference*, Philadelphia. [Poster presentation]
9. Dhillon G, **Wilson S,** Hassan N, Mc Ardle R, Su L, Slight S. (2024) Outdoor air pollution as a risk factor for Alzheimer's disease: A systematic review. *AAIC conference*, Philadelphia. [Poster presentation]
10. Dhillon G, **Wilson S,** Hassan N, Mc Ardle R, Su L, Slight S. (2024) The impact of outdoor air pollution on brain health: a systematic review." *Great North Pharmacy Research Collaborative conference*, Gateshead. [Poster presentation]
11. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Mc Ardle R, Walker Z, Slight S. (2024) Users' perspectives on using wearable technology for the early detection of dementia causing diseases." *Great North Pharmacy Research Collaborative conference*, Gateshead. [Poster presentation]
16. Beswick E, **Wilson S**, Popp Z, Rahman S, Khan R, Tolley C, Low S, McArdle R, Slight SP. (2024) Acceptance of using digital technologies to aid the timely detection of dementia: perspectives from an international collaboration. *British Society of Gerontology (BSG) Conference*, Newcastle. [Oral presentation]
17. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, McArdle R, Walker Z, Slight SP. (2024) Acceptance of using digital technology for the early detection of dementia. *BSG Conference*, Newcastle. [Oral presentation]
18. Dhillon G, **Wilson S,** Hassan N, McArdle R, Su L, Slight SP. (2024) Relationship between outdoor air pollution and Alzheimer's Disease: A systematic review. *BSG Conference*, Newcastle. [Poster presentation]
19. Dhillon G, **Wilson S,** Hassan N, Mc Ardle R, Su L, Slight S. (2024) Is outdoor air pollution a risk factor for Alzheimer's Disease?: A systematic review. *Association of Physicians 117th Annual Meeting,* Newcastle. [Poster presentation]

20. **Wilson S**, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Mc Ardle R, Walker Z, Slight S. (2024) Using wearable technology to support the early detection of dementia-causing diseases: perspectives from the CODEC II cohort. *Association of Physicians 117th Annual Meeting,* Newcastle. [Poster presentation]
21. Beswick E, **Wilson S**, Popp Z, Rahman S, Khan R, Tolley C, Low S, Mc Ardle R, & Slight S. (2024) Advancing the timely detection of dementia causing diseases using digital technologies: users' perspectives. *Association of Physicians 117th Annual Meeting*, Newcastle. [Poster presentation]
22. Wilson S, Tolley C, Mc Ardle R, Beswick, E, Slight S. (2024) Healthcare professionals' perspectives on the key considerations for digital technology aiding the early detection of dementia-causing diseases: a qualitative study. *Health Services Research & Pharmacy Practice Conference*, Cork, Ireland. [Poster winner]
23. Nehal Hassan N, **Wilson S**, Marley K, Slight R, Sarah SP. (2024) Artificial Intelligence predicting hospital readmissions in multi-morbid patients; A Systematic Review. *Health Services Research & Pharmacy Practice Conference*, Cork, Ireland. [Oral presentation]
24. **Wilson S**, Tolley C, Mc Ardle R, Beswick, E, Slight S. (2023) Considerations for the Design, Development and Implementation of Technologies to Aid the Early Detection of Dementia. Faculty of Clinical Informatics Annual Scientific Conference 2023, Manchester. [e-poster presentation]
25. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight S. (2023) Healthcare professionals' key considerations when developing and implementing digital technology for early detection of dementia causing diseases. *ARUK ECR Northern Network event*, Newcastle University. [Oral presentation]
26. **Wilson S**, Tolley C, Mc Ardle R, Beswick, E, Slight S. (2023) Key considerations when developing and implementing digital technology for early detection of dementia causing diseases: a qualitative study. *Royal Pharmacy Society annual conference*, London. [Poster presentation]

27. **Wilson S**, Tolley C, Mc Ardle R, Beswick E, Slight S. (2023) Healthcare professionals' key considerations when developing and implementing digital technology for early detection of dementia causing diseases. *Society for Social Medicine & Population Health 67th Annual Scientific meeting*, Newcastle University. [Rapid fire oral presentation]
28. **Wilson S**, Tolley C, Mc Ardle R, Beswick, E, Slight S. (2023) Key considerations when developing and implementing digital technology for early dementia detection. *AAIC conference*, Amsterdam. [Poster presentation]
29. **Wilson S**, Mc Ardle R, Tolley C, Beswick E, Slight S. (2023) Key considerations when developing and implementing digital technology for the early detection of dementia causing diseases: healthcare professionals' perspectives. Great North Pharmacy Research Collaborative Conference, Gateshead. [Poster presentation]
30. **Wilson S**, Mc Ardle R, Tolley C, Slight S. (2022) Feasibility of digital technology in individuals with cognitive impairments. *AMIA annual symposium*, Washington DC. [Poster presentation]
31. **Wilson S**, Mc Ardle R, Tolley C, Slight S. (2022) Usability and acceptability of wearable technology in the early detection of dementia. *AAIC conference*, San Diego. [Poster presentation]
32. **Wilson S**, Mc Ardle R, Tolley C, Slight S. (2022) Usability and acceptability of wearable technology in the early detection of dementia. Faculty of Clinical Informatics, virtual. [Oral presentation]

Chapter 1: Introduction

1.1 Introduction

This chapter provides an overview of digital exclusion, the use of digital technologies within healthcare and how this application of technology can contribute to health inequities. The researcher ends the chapter by describing current efforts from policy makers and regulatory bodies to mitigate digital exclusion.

1.2 Digital exclusion

Digital exclusion is a global issue, with estimates suggesting 2.9 billion people were digitally excluded worldwide in 2021.(1) Within the UK (United Kingdom), this would represent approximately 10 million adults.(2) It has been predicted that 5.8 million people in the UK will remain digitally excluded by the end of 2032 if nothing is done to support them.(3)

Digital exclusion has been described as the marginalisation of an individual or group, deprived of full access and capacity to use digital technologies, hindering their participation within society.(4) Digital exclusion is often caused by barriers accessing compatible devices and connectivity, an individual's ability to use digital technologies, and their motivation to use digital technology.(4,5,6,7) Inadequate access to digital technologies can occur if an individual does not have the financial resources available to purchase compatible devices or reliable broadband packages,(7) and/or if a residential area does not have the network infrastructure to support reliable internet access at home.(6) Limited ability to use digital technologies can be due to low digital literacy skills, hindering their ability to understand how to use digital technologies and/or adapt to new technologies.(5,6) A lack of motivation to use digital technologies is often due to poor understanding of the benefits digital technologies can provide, a fear or mistrust in digital technologies, or a lack of self-confidence to use digital technologies leading to digital anxiety.(5)

Experiencing digital exclusion can impact a broad range of everyday activities as more services within society are moving online. For example, the shift to online banking and reduced number of high street banks can result in the exclusion of financial advice and support for those who do not have access, skills or desire to use online financial services.(6) Furthermore, national government's agenda to increase the use of digital technologies in healthcare systems to increase productivity of healthcare services,(8,9) without consideration for those experiencing digital exclusion, can affect health outcomes as digital exclusion becomes a barrier to accessing healthcare.(9)

1.3 Digital exclusion within healthcare

1.3.1 Digital health technologies

International public health agencies, including the World Health Organisation (WHO), support the use of Digital Health Technologies (DHTs) to advance global population health.(10) DHTs are defined as the use of technologies intended to benefit the wider health and social care system and provide healthcare users with services relating to the prevention, detection, diagnosis and management of diseases and other health conditions.(11,12,13,14) Examples of DHTs currently used within healthcare range from electronic medical records that contain information about a patient's medical history, medications and past treatments, and wearable devices such as portable electrocardiogram (ECG) devices to remotely monitor a patient's cardiac health.(11,15) DHTs provide a secure method of storing and communicating information within healthcare,(16) and holds the potential to reduce healthcare costs by improving the efficiency of healthcare delivery systems.(17,18) DHTs used by patients, such as health related smartphone applications and wearable devices, may also empower individuals to better manage their own conditions by keeping track of their symptoms.(12,13,14) For example, enabling self-monitoring of blood glucose records using app-cloud cooperation systems have been shown to improve the self-monitoring of glucose levels and reduce hospitalisation.(19) Due to these advantages of DHTs and the vast range of healthcare areas that DHTs can support, the use of these technologies have gained global momentum.(18)

The coronavirus disease (COVID-19) pandemic further accelerated the implementation of existing and novel DHTs into healthcare.(20,21) Fast-track policy approvals were implemented and governments enhanced their priorities for DHTs to support communities overcome barriers accessing healthcare due to lockdowns, home quarantines, and reduced availability of medical services.(20,21) The rapid increase in the use of DHTs has been further aided by advancements in the capabilities of technologies and researchers exploring new purposes and opportunities to use DHTs. For example, some researchers have been exploring the use of 3D printing to deliver dosage forms tailored to individual patients, including customisable dosages, drug combinations, shapes, and drug release profiles.(22,23) Others have been exploring the use of DHTs (e.g., electronic pill boxes) to detect longitudinal deterioration of symptoms, such as subtle impairments in instrumental activities of daily living (e.g., taking medication) which have been associated with the progression of mild cognitive impairment.(24) If successful, this will help support earlier diagnosis and intervention. However, there are growing concerns that not all populations are able to benefit from DHTs, resulting in health inequities, with under-served groups (i.e., those typically left out of research or experience inadequate access to healthcare) at particular risk.(25)

1.3.2 Health inequities exacerbated by digital exclusion

Health inequities are unfair, avoidable differences in health status and health outcomes of different population groups.(26,27) This differs from the term ‘health inequality’, which refers to the uneven distribution of health or health resources.(26,27) National health services, such as the NHS (National Health Service) in the UK, and health insurance schemes including Medicare in Australia,(28) promote equal access to healthcare (i.e., health equality) once individuals are in the system, regardless of sociodemographic status (shared characteristics of a population related to social and demographic aspects, e.g., ethnicity, gender).(29) However an individual’s ability to benefit from these services is subject to an individual’s autonomous decision making,(29) and social determinants of health, defined as non-medical factors that influence an individual’s health outcomes, such as income, education, social discrimination and employment.(30) For example, those on a low income are more likely to experience a range of health conditions including serious mental illness, obesity and diabetes,(31,32) as they are unable to afford basic necessities of life, such as adequate housing, food and/or access to medical care.(32,33) Not acknowledging and considering the needs of those who require additional support to access healthcare services, certain sociodemographic groups become at risk of health inequities.

Sociodemographic groups at risk of health inequities are commonly referred to as 'under-served' (in the UK), reflecting the lack of adequate resources that meets their needs from healthcare, research and the wider society.(34) Health inequities occur amongst under-served groups as they are typically marginalised within society due to cultural/social norms, stigmas, discrimination and power imbalances between social groups.(34,35) For example, culturally and linguistically diverse groups are more likely to face stigmatisation when diagnosed with dementia, as some languages (e.g., Arabic) do not have a term for dementia and instead use words that imply "crazed",(36) and some cultures view those with dementia as a burden on their families and wider society.(37) Homosexual and bisexual men diagnosed with HIV (Human immunodeficiency viruses) have also been historically subjected to stigmatisation and discrimination, including evictions from their home by a landlord, losing their jobs and avoided by healthcare professionals.(38) Such stigmas can reduce access to timely diagnosis, appropriate treatment, and adequate support services,(39,40,41) whilst increasing social isolation for the individual.(42) Furthermore, experiences of social discrimination, such as homophobia or racism, within healthcare reduces health care-seeking behaviours and adherence to medical regimens(43,44) due to a lack of satisfaction with patient-provider communication and relationships.(45)

Research can indirectly reinforce the marginalisation of under-served groups because funding applications and ethical approvals may not acknowledge the appropriate resources needed to engage with these groups. For example, some projects lack the funds needed to hire a translator and interpreter to support those whom English is not their first language, or ethical approvals enforce the need for written patient information sheets to be given even when a potential participant is illiterate.(46) This limits the recruitment of under-served groups into research and reduces the motivation for such groups to participate.(34,35,46) Consequently, their needs are often neglected,(47) resulting in health inequities once an intervention has been implemented within healthcare systems. This was evident during the COVID-19 pandemic as NHS England directed healthcare providers across England to scale back all in-person appointments and only conduct them when absolutely necessary,(48) and many community-based clinics and support services had to be delivered remotely using DHTs. This exacerbated health inequities, as consideration for those without an appropriate digital device or internet connection were not implemented and they were no longer able to access healthcare or support services.(49,50)

One factor contributing to health inequities is digital exclusion (disparities in motivation, access and/or use of DHTs across different demographic groups).(9,51) Digital exclusion can further compound health inequities by adding a further barrier to accessing and/or using healthcare services that are becoming more digitalised.(52) Furthermore, digital literacy (i.e., the knowledge of how to use technologies) and access to internet connectivity have been referred to as the “super social determinants of health” as they affect all other social determinants of health.(53,54) For example, applications for employment are becoming increasingly only accessible online, creating a barrier for those who do not have access to connectivity or an internet enabled device, or do not have the digital literacy skills to navigate digital applications,(53,54) and therefore reducing their opportunities for employment which is vital to generate an income to afford food and medical care.(55)

There are two key interconnected ways in which DHTs contribute to digital exclusion. The first comes from a digital health research design and conduct. For example, historical racial bias inbuilt into artificial intelligence (AI) algorithms can reduce the reliability of the algorithm across different racial groups, resulting in delays in treatment, referrals, and health insurance coverage for racial minority groups.(56,57,58) The type of sensors used to develop the DHT can also result in health inequities when under-served groups are not involved nor considered in DHT design, for example photoplethysmography sensors commonly used in heart monitors are sensitive to skin tone, resulting in a 61.2% reduction in reliability when used by individuals with darker skin tones.(59) The second aspect is the applied implementation of DHT into healthcare services and the extent to which the DHT meets the needs of its intended user. Individuals with disabilities, such as visual impairments, are likely to find on-screen reading challenging and many older adults with hearing impairments have expressed low motivation to take part in telephone health consultations due to their disability.(60) Furthermore, the content displayed on DHTs, such as websites and apps, may be designed in such a way that users are unable to switch or translate to an individual's preferred language, leading to concerns amongst users that entering incorrect information into these digital apps could contribute to delayed treatment.(60) Individual level factors that influence access, motivation and/or use of DHTs can also affect how DHTs contributes to digital exclusion if the design does not consider such factors. For example, those with a lower educational attainment are less likely to be interested and motivated to use DHTs and/or have the skills to use these digital technologies effectively,(61,62) where as those on a lower socioeconomic income are less likely to afford access to smartphones, and those living in rural areas are less likely to have access to reliable internet infrastructure.(9)

1.4 Current policies and strategies

Over recent years, various organisations, governments and regulatory bodies have recognised the need to mitigate digital exclusion within society and healthcare to reduce inequities amongst under-served groups. The recognition of this issue has been triggered by the rapid digitalisation of public services, alongside the acknowledgement that digital exclusion amongst a population can hinder economic growth, slow the progression of political desires,(63) and reduce progress towards the development of an all-inclusive information society.(64) The shift in priorities to tackle digital exclusion has led to changes on a global, national and regional scale, which have influenced regulatory approvals, the development of new policies (an action adopted or proposed by an organisation) and the implementation of digital inclusion strategies (a plan of action designed to mitigate digital exclusion).

1.4.1 Global

In 2017, the United Nations (UN) created 17 global sustainable development goals to address urgent issues such as poverty, hunger and inequities in the hopes of building a fairer, more equitable world by 2030.(65) One such goal focuses on reducing inequities within and among countries.(65) In line with this goal, the Organisation for Economic Co-operation and Development (OECD) (an international policy organisation) recognised the need to develop digital policies that reduce barriers regarding access, motivation and/or use of technologies to mitigate inequities.(66) For example, the OECD promote the development of high-quality broadband networks in G20 countries (intergovernmental forum of 19 sovereign countries, the European Union, and the African Union)(67) to reduce the connectivity discrepancies between rural and urban areas within different countries.(66) The WHO Bellagio eHealth Evaluation Group also released reports recognising the need to mitigate digital exclusion to reduce health inequities.(68) The group recommends DHTs should be evaluated before implementation into healthcare systems to assess any potential inequities, consider the needs of under-served groups and develop appropriate non-digital alternatives to providing the service the DHT is designed to support.(68)

These global goals, policies and recommendations from international public health agencies have influenced national DHT regulatory approval processes across different countries and continents. This includes approval frameworks produced by the European Medicines Agency (EMA) which operates across Europe, the United States Food and Drug Administration (FDA) which operates in America, and the National Institute for Health and Care Excellence (NICE) which operates in the UK.(12,69,70) These approval frameworks now require evidence of user involvement in the design and development of DHTs, to ensure patients understand how to use the DHT and accept the design before the DHT can be approved and implemented into clinical practice.(12, 69,70) For DHTs claiming to address health inequities, NICE also requires evidence to show that the technology can improve access to care among under-served populations, promote equity, eliminate unlawful discrimination and foster good relations between people with protected characteristics (as described in the UK Equalities Act 2010).(12)

1.4.2 National (UK)

Within the UK, digital exclusion was recognised as a "serious problem" by the House of Lords Communications and Digital Committee in 2023.(71) It was reported in 2022 that 1 in 5 of the UK adult population do not have basic foundation-level digital literacy skills,(72) 1 in 20 UK households do not have access to the internet at home,(73) and basic digital skills are "set to become the UK's largest skills gap by 2030”.(71) However, the House of Lords Communications and Digital Committee found the UK government have “no credible strategy” to mitigate digital exclusion,(74) prompting the recommendation that urgent action is needed.(71) The committee highlighted key policy interventions they believed to be most likely to have the greatest impact in improving digital inclusion.(71) These included promoting social tariffs (reduced broadband and mobile deals, starting from £10 per month, offered by connectivity providers for people receiving government benefits) and cutting VAT on these social tariffs to increase affordable internet access.(75,76) They also recommended improving connectivity and coverage in under-served areas, which resulted in the introduction of the Rural Connectivity Accelerator programme in November 2024 which seeks to explore the connectivity needs of those in rural areas of the UK, and examine the potential (in terms of scalability and feasibility) of emerging connectivity solutions to enhance rural digital infrastructure.(77) So far, this programme has awarded over £120,000 to two projects, one led by Dorset Council and the other by Ceredigion County Council, which are exploring the feasibility of using Low Earth Orbit satellites to address current connectivity issues in remote and rural locations.(77)

Voluntary, community and social enterprise (VCSE) organisations often call for the UK government to do more to improve digital inclusivity. For example, UNICEF (United Nations Children's Fund) designed a 10-point action plan they would like the UK Government to implement to mitigate digital exclusion.(78) This plan includes actions such as “work[ing] with teachers and education staff to identify gaps in [digital] skills and support”, “undertake research to better understand the drivers of digital exclusion”, and “develop guidance and resources to establish a local authority level digital inclusion tracker” to identify digitally excluded individuals.(78) Other VCSE organisations, such as The Good Things Foundation (a digital inclusion charity) have took it upon themselves to mitigate digital exclusion in the absence of a credible government strategy by developing a National Databank which provides a free pre-paid SIM card with mobile data to the UK adult population who have insufficient access to the internet.(79)

Within the context of healthcare, there is a growing demand to use technology to meet productivity and efficiency goals.(8) Therefore, there is a particular need to future proof inclusive access to NHS services to avoid exacerbating health inequities via digital exclusion.(71) To support access to healthcare services amongst those who are digitally excluded, the NHS have recently published an inclusive digital healthcare framework to support the design and implementation of inclusive digital approaches,(80) and developed guidance for primary care healthcare practitioners on ways they can reduce digital exclusion amongst under-served groups.(81) Both the framework and guidance include similar key strategies, such as co-designing DHTs with those at risk of digital exclusion to ensure accessibility and user friendliness, and building skills and confidence in using DHTs amongst patients by allocating staff time to support the use of DHTs, and training digital champions (a staff member leading on supporting patients to use DHTs safely and confidently, and can advise their colleagues on how best to promote DHTs).(80,81)

1.4.3 Regional

Across the UK, regional disparities occur in areas such as health inequities,(82,83) digital engagement,(72) and financial resources available to its residents.(84) To meet the needs of those in different regions, local authorities, charities and NHS Trusts (an organisational unit within the NHS serving a geographical area or a specialised service) are taking action to support digital inclusivity. For example, The Seaview Project was a cross-disciplinary initiative between The Good Things Foundation, Seaview (a charity), Hastings and Rother Clinical Commissioning Group, and St John's Ambulance to support homeless individuals in Hastings (East Sussex) to access digital healthcare by deploying an outreach team who used digital devices to record and triage health concerns of rough sleepers.(85) For example, the outreach team would take photos of injuries and share this information with healthcare professionals working for St John Ambulance.(85) This project also supported individuals' who attended a wellbeing centre to use the internet to access online health related information.(85) However, the organisers reported challenges engaging with homeless individuals in this project as the population were found to be volatile and transient, making willingness to engage with staff unpredictable, varying day to day.(85) Another council led project in Nailsea (South of England) purchased a high street shop and established a Digital Health Hub that provided the local community with access to educational digital skills support to encourage the use of DHTs.(86) This project was able to support and engage 253 local residents, but at the start of the project they found it challenging to engage with local residents as it was often not immediately obvious to residents how using digital technology could benefit their health.(86) Furthermore, those running the project found it hard to measure the impact of the initiative on attendees health outcomes, thus making it difficult to evaluate the effectiveness of the project and promote the benefits of engaging with the service.(86) Other strategies to improve digital inclusivity that have yet to be evaluated (as they are ongoing and/or have recently started) include councils, such as Greater Manchester Combined Authority and Leeds City Council, implementing a digital inclusion agenda.(87,88) The agenda strives to reach a 100% digitally-enabled city region by collaborating with local organisations and strengthening digital inclusion infrastructure in communities.(87,88) For example, Greater Manchester Combined Authority's Digital Inclusion Action Network collaborated with a training provider to give standardised training to Digital Champion volunteers (consisting of existing community volunteers and members of the public) to provide local residents with digital literacy support.(82) Furthermore in the North East of England, South Tees Hospitals NHS Foundation Trust maternity service registered with The Good Things Foundation National Databank and National Device Bank to receive pre-paid data plans and pre-used devices to give patients who did not have access to connectivity or a compatible smartphone to support their access to a maternity app.(89)

These different strategies used at global, national and regional levels highlight the breadth of current efforts to improve digital health equity and the demand for an effective strategy to mitigate digital exclusion. However, it is unclear who is most at risk of digital exclusion, specifically within healthcare, and how effective current strategies are at reducing digital inequity amongst different under-served groups and the impact on their health-related outcomes.(9,90) Furthermore, there is a need to understand the facilitators and barriers to the implementation and adoption of existing digital inclusion strategies from the perspective of end-users, specifically under-served groups at risk of digital exclusion and key stakeholders involved in making decisions, implementing DHTs into healthcare, or delivering activities to support under-served groups at risk of digital exclusion. Their combined lived and professional experience can shed light on the facilitators and barriers of implementing various digital inclusion strategies, and what does and does not work in different settings and for different under-served groups, to obtain a holistic view of feasible changes to advance digital health equity.

1.5 Chapter summary

This chapter provided a detailed overview of digital exclusion within society and healthcare. It also described current efforts at a global, national and regional scale to mitigate digital exclusion. The next chapter outlines the aims and objectives of this PhD programme of work, study design, the researcher's theoretical positionality, and the methodologies used to address each objective.

Chapter 2: Study design and methodological position

2.1 Introduction

In Chapter 1, the researcher described the theoretical underpinnings of digital exclusion within society and healthcare settings, including how digital exclusion creates and exacerbates inequalities, and outlined strategies that have been used to mitigate digital exclusion at global, national and regional levels. However, it is unclear who is most at risk of digital exclusion within healthcare, and therefore who these strategies need to be tailored for. In this chapter, the researcher outlines the aims and objectives of this PhD programme of work, the study design, methodological theory and the researcher's positionality.

2.2 Project aim and objectives

To advance digital health equity, this PhD project aimed to identify who is most at risk of digital exclusion within healthcare and qualitatively explore key strategies to promote digital inclusion. This aim was achieved by fulfilling 5 key objectives listed below.

2.2.1 Objectives

1. Identify who is most at risk of digital exclusion within healthcare on an international context. (Chapter 3)
2. Synthesise the literature on the key strategies that have been used to promote digital inclusion and assess the facilitators and barriers to implementing and adopting these in practice, with a specific focus on under-served groups' experiences and perspectives. (Chapter 4)

3. Explore the perspectives of under-served groups on digital health inequities, strategies they used to overcome such barriers and ways they would like to be supported in the future. (Methodology and rational: Chapter 5, Findings: Chapter 6)
4. Explore stakeholders' perspectives on the feasibility of implementing a variety of strategies to promote digital inclusion. (Methodology and rational: Chapter 5, Findings: Chapter 7)
5. Develop a set of recommendations to advance digital health equity for under-served groups at risk of digital exclusion. (Chapter 8)

2.3 Study design and methodological position

A multi-methods approach, using a scoping review, a systematic review and two qualitative data collection methods (interviews and focus groups) were used to fulfil the aims of this PhD project. The use of multiple methods allows the researcher to extend the depth of data beyond what would be achievable using only one methodology,(91) aiding the development of a holistic understanding of digital exclusion. The use of multi-methods can also encourage creativity and innovation,(91) vital for the developing new insights to advance digital health equity.

A detailed account of the researcher's positionality and the methodology used in this PhD programme of work is detailed below, followed by the rational for why each methodology was used to investigate each objective (described in chronological order of the objectives).

2.3.1 Researchers positionality

The researcher's positionality is shaped by her epistemological and ontological stance. Epistemology refers to the *"ways in which it is possible to gain knowledge of reality, or what we can know about reality"*.(92,93) There are various views on epistemology, ranging from positivism (knowledge is gained through objective, observable facts) which is often adopted by researchers who have an objective view on the world and prefer quantitative methodologies,(94,95) to constructivism (knowledge is actively constructed by individuals through their experiences) which is often adopted by qualitative researchers who view the world as subjective and take into consideration inter-personal relationships, an individual's position within society, and participants historical and cultural background.(96,97) The researcher took the latter stance (constructivism), influenced by her background in Psychology, prior qualitative research experience, and knowledge that different population groups experience different levels of inequities within society, such as health inequities and digital exclusion, which influences their experiences, and therefore knowledge.

Ontology refers to nature of being, existence and the constituent units of reality.(98) Ontological stances range from materialism (reality and all phenomena can be explained by physical laws and only physical material things are real)(99) which is the view often adopted by qualitative researchers, to critical social orientation (focuses on elements of social reality and social phenomena, particularly in relation to power, ideology, social injustice and oppression)(100) often adopted by qualitative sociologists. The researcher's ontological stance was composed of critical social orientation, to provide consideration for how an individual's position within society, their cultural background, and the intersection of different sociodemographic groups can affect their experiences, alongside pluralism (the view that reality is composed of multiple entities)(99) to support the development of a holistic understanding of digital health inequities.

2.3.2 Objective 1: identify who is most at risk of digital exclusion within healthcare

As discussed in Chapter 1, digital exclusion is associated with a wide range of sociodemographic factors that are common amongst under-served groups; however, little is understood about the complexities of digital exclusion within and between these factors.(9,90) It is vital to identify exactly which sociodemographic factors are commonly affiliated with digital exclusion to support the identification of population groups most at risk. This will allow researchers, healthcare professionals and policy makers to better understand the complexities of digital exclusion and further enhance the development of tailored strategies to mitigate digital exclusion.(90)

Despite the variety of frameworks that support the identification of demographic groups most at risk of health inequities, such as the PROGRESS PLUS framework,(101) none of these focused on digital exclusion within healthcare. To advance the understanding of *who* is most at risk of digital exclusion within healthcare, the researcher conducted an evidence synthesis using a scoping review to robustly identify sociodemographic factors that could put an individual at risk of digital exclusion within healthcare, explore how digital exclusion affects different under-served groups that share those sociodemographic factors, and produce a novel framework that captures these factors and their intersectionality.

Scoping reviews involve exploring broad research questions, such as whom is most at risk of digital exclusion within healthcare, by assessing and synthesising the scope of peer-reviewed and grey literature and mapping key concepts (e.g., key sociodemographic factors).(102,103) This mapping approach will support our understanding of the complexities within and between sociodemographic factors, and aid the development of a health inequities framework.(104) Scoping reviews are also a useful precursor to a systematic review (conducted later in this PhD project; Objective 2, Chapter 4), as they support the development of a precise research question, strict inclusion criteria, and helps to determine if a systematic review is warranted by identifying what systematic reviews have already been conducted in the area, and/or if there is enough literature to systematically review.(104)

Other methods of evidence synthesis such as systematic reviews, umbrella reviews, narrative reviews, realist reviews, and mapping reviews, were considered but were ultimately rejected, as they would not have enabled the researcher to address the research question being explored in Objective 1, or they involved methods that were deemed inappropriate or unnecessary to achieve the stated objective. For example, systematic reviews are used to identify evidence in the literature that is relevant to a precise research question, using a robust eligibility criteria following the Population, Intervention, Comparison, Outcomes and Study design (PICOS) framework,(105) and use a systematic, standardised approach to searching, screening, reviewing and examining articles.(104) At the earlier stages of the PhD, the researcher was not able to define those most at risk of digital exclusion within healthcare, and as such, a robust eligibility criteria required for a systematic review methodology would not have been possible.

Therefore, a scoping review was required at this stage to refine and confirm the inclusion criteria for the subsequent systematic review conducted later in this PhD programme of work (Objective 2, Chapter 4).

Umbrella reviews involve systematically reviewing existing systematic reviews and meta-analysis, to consolidate the evidence on a topic and provide a holistic overview of multiple interventions for a health condition or identify epidemiological associations for a specific condition.(106) They are suited to instances where existing reviews have been conducted, and can be harnessed to identify research gaps, without the need to conduct a lengthy comprehensive review in its entirety.(106) However, the researcher was unaware of any existing systematic review in this area at this time, and umbrella reviews would not have enabled the researcher to include policy documents or other grey literature that were deemed to be important to gain a more in-depth understanding of digital exclusion in different national or regional contexts that may be lacking in peer-reviewed publications.(107,108,109)

Narrative reviews involve searching a chosen research area, typically in a non-systematic manner, to provide general background and insights as to what is currently known or understood about the area.(110) However, they have been criticised for having a high risk of bias and lacking transparency, reliability and robustness compared to other approaches, and so was excluded.(110)

Mapping reviews are often used to explore the effectiveness of a particular intervention to inform future research priorities or funding and therefore, unlike scoping reviews, would not have enabled the researcher to clarify key concepts (e.g., sociodemographic factors that could put an individual at risk of digital exclusion) and define definitions to support later stages of this PhD project.(111)

Finally, realist reviews are used to explore *"how, why, for whom, in what contexts and to what extent health systems, programmes and/or policies function"* allowing the development of a deeper understanding of contextual influences and their effect on causational outcomes, which is used to develop and/or build a programme theory.(112,113) Development of a programme theory or an overall explanation of the contextual influences and complexities of digital exclusion within and between different sociodemographic factors would provide insight into digital exclusion within a societal context; however, developing a theory was beyond the scope of this PhD project, thus a realist review was rejected.(112,113)

2.3.3 Objective 2: synthesise the literature on the key strategies that have been used to promote digital inclusion

The researcher conducted a systematic review to synthesise the results of various primary studies that explore strategies that have currently been used to promote digital inclusion within healthcare amongst under-served groups at risk of digital exclusion, in a standardised, systematic, reproducible manner. This approach allows the researcher to identify, appraise and evaluate all the available evidence relevant to research question being addressed in Objective 2.(104,114)

Building upon the findings from Objective 1, the researcher was able to generate a precise research question with robust boundaries of the research and an a eligibility criteria following the PICOS framework to systematically searching, screening, reviewing and examining articles in a standardised manner.(104,105) For example, the results from the scoping review helped define the population of under-served groups at risk of digital exclusion, thus providing clear guidance on the eligibility of the **P**opulation criteria of the **P**ICOS framework. The researcher also decided that only articles that discussed the facilitators or barriers associated with the digital inclusion strategy (**O**utcome criteria in PIC**O**S) and used qualitative methodologies (**S**tudy design criteria in PICO**S**) were to be included to gather rich in-depth experiences on what currently worked or did not work. Quantitative studies were excluded as they are designed to test a hypothesis or enumerate events or phenomena,(115,116) which is not the purpose of this review.

Similar to Objective 1, other methods of evidence synthesis were considered but were ultimately rejected, as they would not have enabled the researcher to address the research question being explored in Objective 2, or they involved methods that were deemed inappropriate or unnecessary to achieve the stated objective. For example, the researcher reflected on the findings from the scoping review conducted as part of Objective 1 and decided that it would not be feasible to conduct an umbrella review as there was little to no prior systematic review(s) on this topic focusing on qualitative studies involving under-served groups.(106) Conducting another scoping review or mapping review would have been inappropriate as the research question being investigated in Objective 2 is too precise and narrow for these types of evidence synthesis.(102,103,117,118)

2.3.4 Objective 3 and 4: exploration of under-served groups (obj 3) and stakeholders' (obj 4) perspectives on strategies to promote digital inclusion.

It was important to explore how to implement the key strategies identified in the literature (Objective 2) in different contexts (e.g., different geographical and/or societal context) and how they can be improved to further support digital health equity. Consequently, the researcher conducted two primary data collection studies using two qualitative methodologies (semi-structed interviews and focus groups).

The first study explored the perspectives of under-served groups at risk of digital exclusion (defined by the findings from the scoping review conducted to explore Objective 1) on digital health inequities, and the strategies (Objective 2) that they could potentially used to overcome such barriers and ways they would like to be supported in the future (Objective 3). The second study explored stakeholders' perspectives on the feasibility of implementing a variety of strategies to promote digital inclusion (Objective 4). These studies were kept separate for two reasons. Firstly, if data collection included both stakeholders and under-served groups (e.g., placing them in the same focus group), there is a possible risk of a power imbalance, as under-served groups may perceive stakeholders as holding authority,(119) thus impacting on their willingness to disclose their perspectives.(120) Conducting study 1 (under-served groups) before study 2 (stakeholders) allowed data to be collected from study 1 and preliminary analysis of key themes to aid the development of the topic guide used to guide discussions in study 2. The feasibility of implementing the recommendations raised by under-served groups (study 1) could be explored in further depth with stakeholders, and further changes explored that would be acceptable and feasible to improve digital health equity.

Qualitative methodologies were used to allow rich in-depth experiences to be gathered from those whose voices are rarely heard (Objective 3, Study 1), and those with professional experiences of implementing DHTs or services to support digital inclusion (Objective 4, Study 2), to aid the understanding of this multi-dimensional complex phenomena i.e., digital exclusion.(115,116) A quantitative approach, such as a close-ended questionnaire with predetermined responses, would possibly restricted the amount of data that could be collected and lack detailed insight from those with key experiences.(116) All participants in study 1 (under-served groups) and study 2 (stakeholders) were also given the choice to take part in either a semi structured interview or focus group.

2.3.4.1 Semi-structured interviews

Semi-structured interviews allow the exploration of individuals' views, unique experiences, personal beliefs and/or motivations on specific matters (e.g., the barriers accessing digital healthcare or experiences of implementing DHTs or projects/services to support digital inclusion). This data collection method allows participants to describe their experiences in a private and confidential environment and offer greater flexibility in terms of scheduling. This allows participants to speak with the researcher one-to-one and discuss any challenges (e.g., collaborating with specific organisations) that they felt were important.

Semi-structured interviews were chosen over structured and unstructured interviews due to the ability to use a flexible topic guide containing several predetermined open-ended questions.(121) This provides structure to the conversation, but with flexibility for the researcher to rephrase questions to suit the needs of participants, such as simplifying questions for those with lower educational attainment or for those whom English was not their first language (e.g., using phrases such as 'your Doctor' or 'local GP' instead of 'healthcare professional'). This also allows the researcher the flexibility to ask follow-up questions to gain greater insight and a deeper understanding of the participant's experiences and perspectives.(121,122) In structured interviews, predetermined open questions are asked to all participants in exactly the same way, and they are often used in clinical settings to support diagnostic evaluations. This systematic approach reduces variability and increases the reliability and validity of diagnosis.(123)

However, this programme of work included a range of different individuals from under-served groups and stakeholders, thus asking the same questions in exactly the same way was deemed inappropriate for both qualitative studies.(121) Additionally, the inability to ask follow up questions could result in less rich data being collected about individuals' unique experiences and perspectives.(121) In contrast, conducting an unstructured interview with no predetermined questions could lack focus and reduce the reproducibility of the interviews.(124) The challenges of conducting semi-structured interviews include: (a) the labour intensiveness of extensive planning and rapport building with potential participants to create a safe and supportive environment,(125,126) and (b) actively listening to tailor questions based on participants' responses and having good interpersonal communication skills to adapt quickly and manage the flow of the conversation.(127,128) The researcher planned to conduct no more than two interviews on the same day and no more than four within the same week to allow time to reflect and consolidate thoughts, and identify further areas to explore in subsequent interviews. There was a need to arrange a large number of semi-structured interviews to capture a wide range of perspectives to ensure data saturation was achieved. In comparison to other qualitative methods, such as focus groups, this can potentially increase the length of time needed for data collection.(129)

2.3.4.2 Focus groups

The researcher felt it was important to give individuals the option of participating in either a focus group or semi-structured interview, especially in Study 1. Focus groups allow a social gathering of similar individuals to discuss a particular topic to reveal shared and/or contrasting attitudes, feelings and beliefs within the group.(130) Focus groups provide the opportunity to gather a 'collective consensus' from participants on specific topics,(131) such as solutions to overcome barriers to accessing and using DHTs, and allow data saturation to be achieved with fewer data collection events compared to interviews.(129) Emerging evidence and feedback from engaging with gatekeepers and under-served groups also suggests that some individuals may be more comfortable discussing topics, such as challenges to accessing healthcare and digital health services, in a group setting with those of a similar background and experience.(132)

A limitation to conducting focus groups was the risk of group dynamics introducing biases into the data,(132,133) for example, where participants agree with the social norm rather than voice controversial perspectives within a group setting.(134) Additionally, if there are one or several dominant individuals within a group, only one opinion may be heard, or hostility between participants could occur.(134) To overcome these challenges, the researcher received training to facilitate focus groups as part of her Research Assistant role, and felt confident to be able to manage the group dynamics.

2.3.5 Objective 5: develop a set of recommendations to advance digital health equity

To achieve objective 5, key findings, themes and reoccurring concepts from objectives 1 to 4 (i.e., a scoping review, a systematic review and two qualitative studies) will be compare and contrasted to identify feasible and practical ways in which digital health equity could be advanced in a manner that meets the needs of those most at risk of experiencing digital exclusion. The researcher planned to reflect on these findings within the context of the wider literature to help prioritise areas key areas and further refine her recommendations to advance digital health equity.

By using multiple different methods and examining the findings from each study,(91) the findings from this programme of work would aid the researcher in developing holistic recommendations to advance digital health equity. The use of multiple, mostly qualitative focused methodologies also allows the researcher's positioning to be aligned throughout the PhD project, which has been suggested to play a vital role in producing *"sound, meaningful research outcomes"* when all the data is integrated.(91)

2.4 Chapter summary

This chapter outlined the aims and objectives of this PhD programme of work, the theoretical underpinnings of the study, researcher positionality, study design, and data integration.

The next chapter will provide details of a scoping review that was conducted to identify whom is most at risk of digital exclusion within healthcare (objective 1).

Chapter 3: Identifying those most at risk of digital exclusion within healthcare: development of the CLEARS framework

3.1 Introduction

In Chapter 2, the researcher outlined the aims and objectives of this PhD project and detailed the study design and methodological positionality used to address such aims and objectives. In this chapter, the researcher describes the methodology and results of a scoping review conducted to address Objective 1. This scoping review led to the development of a digital health inequities framework that helps identify sociodemographic groups most at risk of digital exclusion within healthcare. The researcher ends the chapter by describing the strengths and limitations of this review.

3.2 Methodology

Arksey and O'Malley's methodological framework for conducting a scoping review was followed.(103) The framework involves six stages, beginning with the researcher identifying and clarifying the research question (i.e., to explore whom is most at risk of digital exclusion within healthcare). The following stages include: (2) identifying relevant studies by developing a plan for where to search, which terms to use, and which sources are to be searched; (3) selecting studies based on an eligibility criteria informed by the research question; (4) charting the data to extract information from each included article; and (5) collating, summarising, and reporting results in a clear and consistent manner.(103) Details of how the researcher conducted these stages are described below, with stage five split between two sections to improve the flow of the chapter ('collating and summarising' the results is presented in section 2.3.4, and 'reporting results' is presented in section 2.4). The optional sixth stage of Arksey and

O’Malley’s methodological framework, involving consultation with members of the public and stakeholders, allowing them to suggest additional references and provide insights beyond those in the literature,(103) was not conducted due to the time constraints to conduct this scoping review. However, members of the public and stakeholders were involved later in this PhD project (Chapters 4-6).

3.2.1 Identifying relevant studies

Four databases (PubMed, Google scholar, Google and Scopus) were searched on 22nd October 2022 in a non-standardised manner. A non-standardised search strategy (i.e., keywords were not searched in exactly the same way across all databases) was used to provide flexibility to support the use of databases with different search functionalities.(135) For example, Google and Google scholar (used to identify relevant grey literature) support searching of a single word or phrase, whereas optimal searches on databases such as Scopus (used to identify relevant peer-reviewed articles), require the use of Boolean statements.(135)

An initial search including words such as “digital exclusion within healthcare” and “under-served” were applied across all databases. Relevant articles were found, and key words used in their title, abstract and index terms were noted. Recurring key words that were not already used in the initial search, such as “digital divide”, were then applied across the four databases. References and case studies mentioned in the included articles were explored further to identify possible factors contributing to experiences of digital exclusion within and between different under-served groups.

3.2.2 Study selection

3.2.2.1 Eligibility criteria

English language peer-reviewed articles and grey literature (e.g., government reports and regulatory organisation documents) were included if they explored adult demographic groups without any specific health conditions or learning difficulties, and experienced barriers regarding access, motivation and/or use of digital technologies for healthcare purposes, and the possible reasons why a demographic group may be facing such barriers. No limitation was placed on the study design nor the geographical region or population to reduce bias.

3.2.2.2 Screening process

All titles of articles that appeared on PubMed and Scopus were rapidly screened for eligibility. Due to the large number of results on Google and Google Scholar, only titles appearing on the first ten results pages were rapidly screened. These databases automatically sort the articles by 'most relevant' using algorithms that assess relevance in terms of the appearance of key words and associated words in the headings and main text, and/or images in pictures and videos within the article.(136) The researcher found less and less relevant articles per results page, thus it is unlikely any relevant articles would have been found in further pages.

The researcher then screened the peer reviewed abstracts or grey literature summary of the articles that had titles which met the eligibility criteria or did not have enough information to comprehensively judge eligibility. Abstracts of peer-reviewed articles and summaries of grey literature, which seemed relevant (either met the eligibility criteria or more information was required), were then screened at full text. If the full text was not available and the lead author did not respond to a request for the full text, the article was removed. Only full text articles which met the eligibility criteria are included in this scoping review.

3.2.3 Charting the data

The researcher developed a data-extraction sheet on Microsoft Excel to extract and record specific details from the included articles. Such details included the type of article (e.g. systematic review, government policy document etc.), aims or purpose, year of publication, authors, methodology (where applicable) and geographic region published or studied. Key findings that related to the aim of this scoping review were also recorded.

3.2.4 Collating and summarising the results

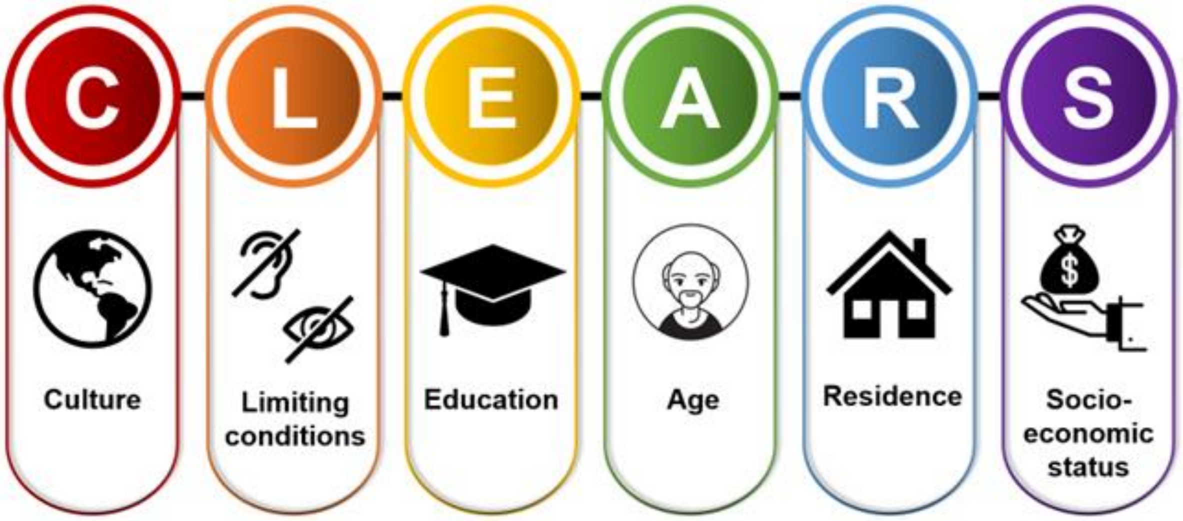
A narrative thematic synthesis of the included articles was conducted.(137) This analysis approach allows the researcher to synthesise the text from the multiple studies that were included in this scoping review.(138) The researcher began by developing a preliminary synthesis of the included articles to identify key population groups and list the unique barriers to digital inclusion and associated possible reasons for these barriers. Factors that might explain any commonalities and differences in the barriers experienced by different population groups were then considered to aid the development of descriptive and explanatory conclusions. Discussions with the supervisory team were conducted throughout the analysis to ensure a clear and coherent narrative that reflected the data. The key findings were mapped to conceptual categories, relating to shared sociodemographic factors that were associated with digital exclusion within healthcare.

3.3 Results

3.3.1 Study descriptions

Twenty-two articles were included in this scoping review. This included peer reviewed qualitative (n=4),(60,139,140,141) quantitative (n=8)(51,56,59,61,62,142,143,144) and mixed methods research papers (n=1),(145) literature and commentary reviews (n=4),(57,58,146,147) systematic reviews (n=2),(148,149) government and public health organisation reports (n=2)(9,150) and regulatory organisation documents (n=1).(151) Analysis of these articles led to the identification of six groups relating to shared sociodemographic factors associated with digital exclusion and the role intersectionality (an individual's identity is influenced by multiple sociodemographic factors)(148,150,151) plays in exacerbating digital exclusion. This forms the CLEARS (Culture, Limiting conditions, Education, Age, Residence and Socioeconomic status) Framework (Figure 1). Details regarding the barriers that each group faced regarding motivation, access and/or use of technologies for healthcare purposes (i.e., the barriers causing digital exclusion), and possible reasons for such barriers are described below.

Figure 1: CLEARS framework: six sociodemographic factors associated with digital exclusion and their connections with each other through intersectionality.



3.3.2 Cultural factors

Cultural factors, including ethnicity and/or race, language and religion, were discussed in 14 articles as a factor that can increase an individual's risk of digital exclusion.(9,51,56,57,58,59,60,140,141,143,146,148) There is growing evidence that ethnicity and/or race can impact the reliability of the technology, limiting access to accurate devices for these individuals. For example, having a higher skin melanin concentration can reduce the reliability of photoplethysmography sensors by 61.2%.(59) These sensors are commonly used in wearable heart monitors as they detect blood volume change in living tissue by measuring the amount of light absorbed by blood; however, darker skin tones (higher melanin concentrations) absorb more light than lighter skin tones (less melanin) resulting in weaker and less reliable signals.(59) Some DHTs may also be unreliable for different racial and ethnic groups due to historical racial bias inbuilt into the artificial intelligence (AI) algorithms, which can result in delays in treatment, referrals, and health insurance coverage.(56,58,147) For example, in one study entering a patient's race as *'black'* into an algorithm designed to estimate kidney function was found to overestimate glomerular filtration rate from serum creatinine (eGFRcr), thus could lead to an inaccurate 'healthier' kidney function than if '*white'* was entered.(56,58) This was believed to occur because the algorithm statistically adjusted for non-GFR factors associated with serum creatinine levels, including a false pre-assumption with that *'black*' individuals have greater muscle mass.(56,58) Although there is growing evidence that an individuals ethnicity and/or race can affect access to reliable devices, it is unclear whether an individual's ethnicity and/or race is likely to affect the use of DHTs.(9,51,148) Some studies found those from racial and/or ethnic minority backgrounds (e.g., black and Hispanic individuals) are less likely to use technology for health-related purposes,(51,148) including video consultations,(148) compared to white individuals after accounting for factors such as education.(51) However, others have found the opposite when examining internet usage, with only 8% of Bangladeshi adults residing in the UK being non-users of the internet compared to 11% of UK residing white adults.(9) This has led some researchers to speculate whether factors, such as age and income, have a greater influence in technology usage compared to ethnicity.(9)

This scoping review found cases where individuals were unable to switch or translate written information on a DHT to their preferred language, or faced challenges understanding the technological terms used.(60,140,148) For example, during the COVID-19 pandemic, individuals whose first language was not English, found that they needed a high level of local language, administrative and medical vocabulary skills to navigate through digital health apps in order to book appointments remotely.(60) They shared concerns about entering the wrong information into these digital apps, which they felt could possibly contribute to delayed health services or treatment.(60) These individuals also struggled to find digital support, and when it was available, it was often inaccessible due to the *"incomprehensible expert language"* that was used during the sessions.(140)

An individual's religious beliefs were also found to influence access and use of DHTs.(141, 143,146)A range of religions were discussed in articles including Christianity,(145) Judaism,(146) and Islamic beliefs.(141) For example, orthodox Jews would avoid using technology on Sabbath, and ultra-orthodox Jewish communities completely banned internet access and device ownership all year round.(146) However, most Jewish families appeared to decide the extent to which they adopted (e.g., using a timing setting instead of manually turning on lights) or limited the use of technologies on Sabbath.(146) Within the countries that hold a strong Islamic faith, such as Pakistan, it is often considered haram (forbidden) for a woman to talk to a man whom they do not have a relationship with to avoid generating feelings of lust (considered a sin).(141,152) This was found to have resulted in restricted opportunities for women to access and learn how to use technologies to minimise the chance of them communicating with men electronically, via email or other communication platforms.(141) This hindered their ability to develop the digital literacy skills needed to efficiently use technology to support their health.

3.3.3 Limiting conditions

Five articles highlighted how living with a limiting condition, specifically hearing or visual impairments, can increase the likelihood of being digitally excluded, due to differences in use, motivation and access to appropriate technologies.(9,57,60,145,151) For example, those with visual impairments relied on memory to locate buttons on devices due to small button sizes,(145) and struggled with on-screen reading due to small font sizes and low contrast if they were unable to adjust the settings or did not know how to make these adjustments, leading to a strong preference for paper-based health information.(60) Individuals with hearing impairments appeared less likely to use a phone call as a remote health service option, due to their hearing difficulties.(60) One study also raised issues with the assistive technology that was supposed to help those with limiting conditions, such as the audio on text-to-speech software being difficult to understand amongst those with visual impairments, leading to the software been abandoned.(145) Furthermore, an Ofcom (2022) report on digital exclusion across the UK found households which included someone with hearing or visual impairments were more likely than average to cancel their broadband service.(151) These individuals appeared to rely either on the data in their phone plan to access the internet, or go without access to the internet at home. The latter situation seemed to be common based on the findings from the Ofcom (2022) report which highlighted out of the 10% of UK adults who do not use or have access to the internet, over a fifth (23%) have a visual or hearing impairment.(151)

3.3.4 Education

Six articles discussed how those with a lower educational attainment (GCSE (General Certificate of Secondary Education) or equivalent or below) were more likely to be digitally excluded than those with a higher educational attainment (A-level (Advanced level qualifications) or equivalent or higher).(61,62,140,141,143,149) This was because those with a higher educational attainment were more likely to have greater digital literacy skills to use complex digital technologies, greater knowledge of how digital technologies can support an individual's health, have more experience of using digital technologies and higher levels of adherence to DHTs (e.g., telehealth) compared to those with lower educational attainment.(61,140,149) This relationship can be seen globally,(143) with many individuals in developing countries, such as Pakistan, lacking access to digital skills educational support.(141)

3.3.5 Age

Age was the most commonly discussed sociodemographic factor associated with digital exclusion, appearing in 15 articles.(9,51,57,60,61,62,139,140,142,143,144,147,148,149,151) These articles suggested older adults (+65 years old or over) were less likely to have access to a compatible device or have the internet at home when compared to younger adults (below 65 years old).(62) When older adults did have access to devices, they often found it difficult to use technology due to insufficient digital literacy skills,(60) or were hindered by age-related physical health problems (e.g., hearing, vision, dexterity and cognitive impairments), especially if buttons on devices were small and/or hard to see.(60,139,144) They also felt anxious when using such devices due to the unfamiliarity of such task(s), fearing that they would encounter a scam, make an irreversible mistake,(51,60,61,147) or held the perception that they were '*too old to learn'* how to use technology.(140) Furthermore, older adults were often unaware of how technology could support their health, and/or feared losing valued in-person contact with their healthcare professionals, leading to an unwillingness to try and/or adopt new digital technologies to support their healthcare.(60,140,149)

3.3.6 Residence

An individual's place of residence was highlighted as a factor associated with digital exclusion across six articles.(9,57,139,141,144,147) Individuals living in rural or deprived areas were likely to experience 'patchy' internet connectivity and slower broadband speeds, insufficient for utilizing digital health services, such as remote video consultations.(9,57) This in turn reduced their motivation to adopt new digital technologies for healthcare purposes because of poor user experience such as slow connection speeds, the video buffering or freezing, and/or reduced audio quality.(57) This contributed to misunderstandings between the patients and healthcare professionals, leading to frustration.(57) In developing countries, such as Pakistan, the urban-rural divide was perceived by residence in rural areas of Pakistan to be more prominent due to a lack of resources to expand the required infrastructure (e.g., internet connectivity) in remote and rural areas. This resulted in many residence in such areas perceiving 'rurality' as the single biggest obstacle to digital inclusion.(141)

Individuals without a fixed address (e.g., homeless people) were also likely to be digitally excluded within healthcare. Those without a fixed address were more likely to have a high turnover of phones, phone numbers, and/or experience difficulties maintaining their phone plans to access the internet.(139,144) These barriers were likely to have contributed to issues relating to longitudinal access to remote healthcare, such as receiving text messages about their appointments.(139,144)

3.3.7 Socioeconomic status

Twelve articles discussed how those of lower socioeconomic status were likely to experience digital exclusion within healthcare.(9,60,61,62,139,141,143,144,148,149,150,151) Those with a low socioeconomic status include households whose annual income is 60% lower than a countries' average household income (according to the UK government),(150) unemployed (receiving state benefits as their only source of income), and those receiving a state pension.(151) These individuals are likely to face affordability issues restricting their ability to purchase up-to-date, compatible devices(151) and fixed broadband.(60,151) Reports highlighted many of those from lower socioeconomic status relied on a smartphone as their only access to the internet,(9,57) which was often on a 'pay-as-you-go' limited data plan.(9) Furthermore, some studies suggested that those who are unemployed were less interested in using DHTs than those on a higher income,(60,149) and lacked digital literacy skills to use digital technologies for healthcare purposes effectively.(60) Low digital literacy may have arisen due to a lack of opportunities to access affordable, new, or more advanced technologies, thereby reducing the opportunity to develop digital literacy skills.(61)

3.3.8 Intersectionality

Although these six sociodemographic factors have been described in isolation above, they commonly overlap in society. Individuals who identified with two or more of these sociodemographic factors (intersectionality) were at even greater risk of digital exclusion.(60,139,144,148,150,151) For example, a report by Ofcom (2022) highlighted how lower socioeconomic status (specifically annual income) was more likely to affect older adults who were retired or unemployed, and those with limiting conditions.(151) As older adults were more likely to have visual or hearing impairments due to age related physical health conditions,(60,139,144) they are likely to face barriers to digital inclusion that are associated with age, limiting conditions and low socioeconomic status. Furthermore, between April 2008 and March 2022, people from ethnic minority groups in the UK (specifically Pakistani and Bangladeshi communities) were most likely to live in low income households,(150) and therefore are more likely to experience barriers to digital inclusion that are associated with cultural factors and a low socioeconomic status. Thus, intersectionality is a key factor that must be considered when examining digital exclusion within healthcare due to the complexities of overlapping sociodemographic groups within society.

3.4 Discussion

3.4.1 Summary of what is known in the literature

The variety of examples described above demonstrate the societal complexities that influence an individual's risk of being digitally excluded, and highlights the necessity to avoid a 'one-size fits all' approach to advancing digital health equity. It is clear from the literature that a wide range of sociodemographic factors, such as low educational attainment and low socioeconomic status, contribute to a greater chance of an individual becoming digitally excluded. To support the identification of whom is most at risk of digital exclusion within healthcare, the researcher compiled key sociodemographic factors that were discussed in the literature as associated with digital exclusion into six groups that are linked via intersectionality, to form the CLEARS framework (Figure 1). By understanding and analysing a wide range of sociodemographic factors, the researcher was able to identify and assess which sociodemographic factors may and may not play a role in digital exclusion. For example, seven articles suggested gender may influence the likelihood of being digitally excluded within healthcare;(51,61,141,142,143,144,149) however, the researcher related these differences to cultural factors (Western vs non-Western stereotypes and religion). Women in non-Western developing countries, such as Pakistan, were less likely to use digital technologies for healthcare purposes due to societal oppression women face regarding the use of technologies.(61,141,149) However, the opposite was observed in Western countries, as men were less likely to seek help due to stereotypes relating to masculinity.(61,141,151,153,154) Furthermore, the LGBTQ+ community, a demographic group known to be under-served within research,(25) were only mentioned in one article (a government scoping review).(9) This Government review highlighted how the LGBTQ+ community might be more likely to use DHTs as digital channels provided a greater sense of anonymity, thus promoting engagement on healthcare topics where they may have experienced stigma or prejudice.(9) Further research is needed to gain a greater understanding of the LGBTQ+ community's access, motivation and use of DHTs.

3.4.2 Strengths and limitations of this review

The CLEARS framework developed from this scoping review has helped identify digitally excluded groups which can be used to inform decision making and policymaking processes and guide researchers, technology developers and healthcare professionals in identifying who they need to consider involving in the design, development and implementation of new DHTs.(90) The development of the CLEARS framework also provides guidance to form a comprehensive, strict eligibility criteria needed to conduct a systematic review (objective 2; Chapter 3), and aided the identification of who should be recruited into qualitative primary data collection studies (objective 3-4; Chapters 4-6) conducted later in this PhD programme of work.

Although the CLEARS framework provides a useful guide to help promote digital health equity, it is not all encompassing. For example, the CLEARS framework does not include population groups with certain health conditions that may be at risk of digital exclusion, such as mild cognitive impairment.(155)

As these groups will likely need additional considerations to tailor digital inclusion support to meet their health needs, the researcher decided to focus on healthy (i.e., those without specific health conditions) demographic groups to ensure this PhD programme of work could be completed on time. In addition to this, under-served groups are less likely to appear in the literature due to a variety of reasons, such as research processes hindering engagement and recruitment of under-served groups.(46) Therefore, the question must be raised whether there are other groups that are critically under-served and omitted from the CLEARS framework due to a lack of evidence and/or understanding of the barriers a particular group experience. A final limitation of this scoping review is the use of a non-standardised search strategy (i.e., the words were not searched in exactly the same way across all databases). Although this approach is in line with Arksey and O'Malley's methodological framework(103) and allowed flexibility to use different types of databases to gather grey literature and peer-reviewed articles, (135) it goes against recent guidelines from the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).(156) A lack of standardisation in the search strategy may have led to the unintentional omission of relevant articles, and without documentation of the whole list of search terms used, the reproducibility of this review is low.(156) Reflecting on this, the researcher acknowledges that taking a systematic, standardised approach to identifying articles would have improved the quality of this scoping review. However, due to pragmatic reasons (e.g., time restrictions) and the need to define those most at risk of digital exclusion in a more robust way than a narrative review of a small number of articles, a non-standardised search strategy seemed sufficient at the time of conducting this scoping review to fulfil its intended purpose.

3.5 Chapter summary

This chapter detailed the methodology, findings, strengths and limitations of a scoping review conducted to identify whom is most at risk of digital exclusion within healthcare. This review led to the development of the CLEARS framework, which is the first framework to support the identification of groups most at risk of digital exclusion within healthcare and acknowledges the role of intersectionality in exacerbating digital health inequities. This framework has shaped the inclusion criteria of the rest of this PhD programme of work, including a systematic review (next chapter) and qualitative primary data collection (Chapters 5-7).

Chapter 4: Systematic review of digital inclusion strategies and their associated facilitators and barriers to implementation and adoption.

4.1 Introduction

In Chapter 3, the researcher described a scoping review conducted to identify sociodemographic factors associated with digital exclusion within healthcare and compiled these into six groups to form the CLEARS (Culture, Limiting conditions, Education, Age, Residence, Socioeconomic status) framework. To develop a greater understanding of how to advance digital health equity for those most at risk of digital exclusion, the researcher conducted a systematic review to explore digital inclusion strategies currently used to support those at risk of digital exclusion and assessed the facilitators and barriers to implementing and adopting these in practice based on under-served groups' experiences and perspectives. This chapter describes the methods used to conduct the systematic review including the eligibility criteria, search strategy, study selection process, data extraction and synthesis. The overarching themes generated from conducting a narrative thematic synthesis are then described, followed by a discussion of the findings in relation to the wider literature.

A slightly edited version of the published manuscript (*Wilson S, Tolley C, Mc Ardle R, Lawson L, Beswick E, Hassan N, Slight R, & Slight SP. Recommendations to advance digital health equity: a systematic review of qualitative studies. NPJ Digit Med. 2024;7(1):173. Published 2024 Jun 29. doi:10.1038/s41746-024-01177-7)* is presented below. Edits were made to support the flow of this thesis and include minor word changes, such as replacing the word "we" with "the researcher" where relevant, removing the introduction section to avoid repetition with Chapter 1, and removing the suggested future practical recommendations based on the findings of this review, as they have been integrated into Chapter 8 (which discusses recommendations to advance digital health equity).

4.2 Method

4.2.1 Search strategy

This systematic review was registered with PROSPERO (CRD42022378199) and followed PRISMA guidelines.(157) The search string utilised terms from two relevant scoping reviews,(9,158) with additional relevant terms included when searching four large online databases (Medline, Embase, PsycINFO and Scopus). The search focused on words associated with digital technologies, health inequities, and the CLEARS (Cultural factors, Limiting conditions, Education, Age, Residence, Socioeconomic status) framework (described in Chapter 3) (Appendix 1).

4.2.2 Eligibility criteria

The eligibility criteria followed the Population, Intervention, Comparison, Outcomes and Study design (PICOS) framework(105) (Table 1), recommended by the Cochrane Handbook for Systematic Reviews,(159) and provided an organising framework to list the main concepts in the search. The Population criteria included any group represented by the CLEARS framework. The Intervention criteria focused on digital inclusion strategies, which are defined as an action designed to alleviate the digital exclusion of individuals by promoting access, motivation, and/or use of information and communication technologies.(9,12,14,160) Articles needed to have discussed the facilitators or barriers associated with the digital inclusion strategy (outcome criteria) to be included. This allowed the researcher to reflect on what currently worked or did not work. Only qualitative studies that provided rich in-depth experiences from CLEARS groups were included to aid our understanding of how a complex phenomenon, i.e., intersectionality, can affect digital exclusion.(115,116) Quantitative studies were excluded as they are designed to test a hypothesis or enumerate events or phenomena,(115,116) which is not the purpose of this review. Only peer-reviewed articles published between 2012-2022 in the

English language were included; this ensured only the latest advancements in digital technologies were considered.

Table 1: Summary of eligibility criteria

	Inclusion	Exclusion
Population	Studies with any of the six groups categorised within CLEARS.	Studies which focused solely on children (under 18 years old) and/or did not include any of the six groups within CLEARS.
Intervention	Studies focusing on digital inclusion strategies to promote CLEARS groups motivation, use and/or access to general healthcare though DHTs' designed for healthcare service users.	Studies which did not focus on digital inclusion strategies, studies that focusing on using DHT to deliver care for one specific aspect of health such as sexual health, nutrition, maternal health, children's health or substance misuse, and/or DHT's designed to be used by healthcare professionals such as electronic patient records.
Outcome	Studies discussing facilitators or barriers associated with digital inclusion strategies for CLEARS groups.	Studies that did not discuss any facilitators or barriers.
Study design	Qualitative methods only (including interviews, focus groups and/or observations).	Quantitative or mixed methods.
Language	Studies published in the English language.	Studies not published in the English language.
Date of publishing	Studies published between 2012 and 2022.	Study published before 2012.
Publication type	Primary research peer-reviewed journal articles.	Grey literature, reviews, letters to the editor, conference abstract or proceedings or posters, study protocols and journal articles that have not been peer reviewed.

4.2.3 Study selection

Results from each database were exported into EndNote (version 20.5, Clarivate, International) and duplicates removed. Remaining articles were uploaded to Rayyan (Qatar Foundation, State of Qatar),(161) where titles, abstracts, and full-texts were screened independently by two reviewers (SW, LL, EB) to minimise bias. The researcher screened all articles, acting as a constant throughout the process. Disagreements were resolved by a third reviewer (RMA). The reasons for excluding full text articles were recorded (Figure 2).

4.2.4 Data extraction and synthesis

The researcher developed a data-extraction sheet with the supervisory team to extract and record specific study details, including participant demographics and a description of the digital inclusion strategy under investigation (Appendix 2). A quality assessment was carried out on the included studies using the Critical Appraisal Skills Programme (CASP) Qualitative Review Checklist.(162) Quality was measured by reporting the frequency of 'yes' (denoting the study met the criteria on the checklist) (Appendix 3).

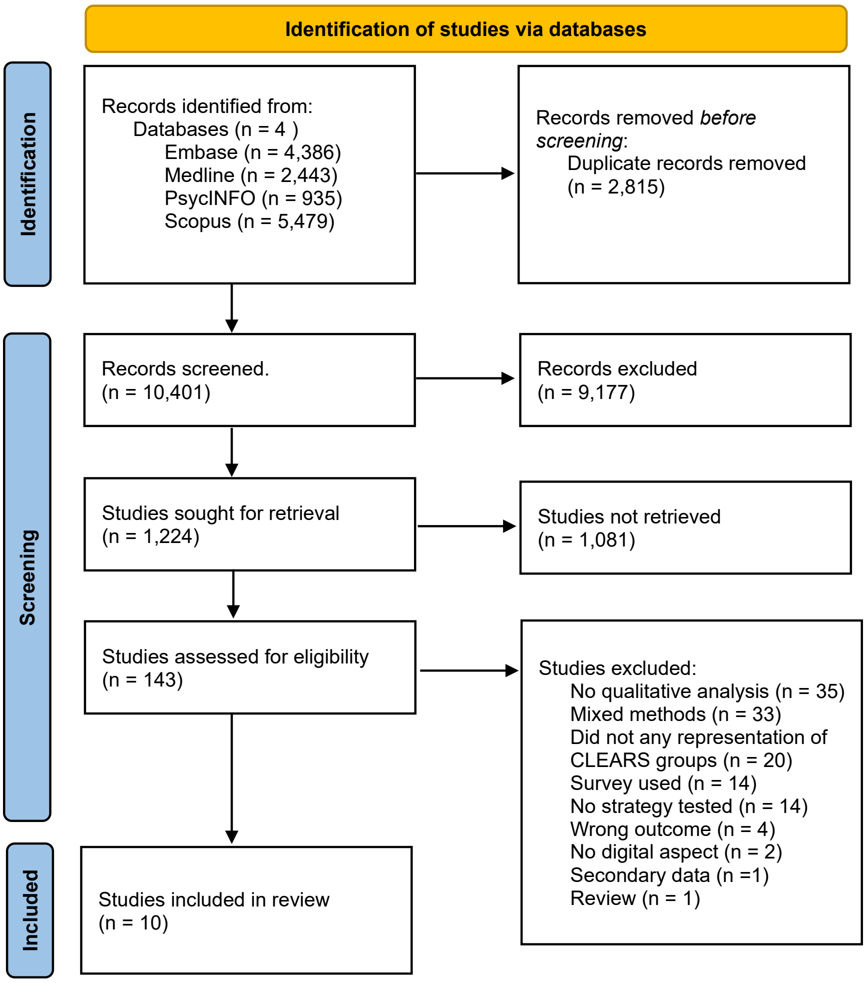
The researcher performed a narrative thematic synthesis of the included studies. She began by developing a preliminary synthesis of findings from the included studies to identify the key strategies and list the facilitators and barriers to implementation and/or adoption. The researcher then considered the factors that might explain any commonalities and differences in the successful implementation and/or adoption of these digital inclusion strategies across included studies. This involved exploring the directly reported verbatim quotations obtained from particular CLEARS groups and seeking to draw descriptive and explanatory conclusions around key themes.(137,138) All data management and analysis was carried out within N-Vivo (version 1.6.1, QSR International). Discussions with the supervisory team (SPS, RMA, CT) were conducted at several stages throughout the analysis to discuss, refine and define themes to ensure a coherent narrative that reflected the data. Detailed descriptions and contextual material from the included studies was kept throughout the analysis to ensure trustworthiness was upheld.(163,164)

4.3 Results

4.3.1 Study descriptions

The search yielded 13,216 results. After removing duplicates (n=2,815), titles (n=10,401) abstracts (n=1,224) and full-texts (n=143) were screened. Ten papers met our inclusion criteria (Figure 3). Inter-reviewer reliability was high with 99.33% agreement at title stage, 99.43% at abstract stage, and 97.89% at full-text stage. All included studies were found to be of moderate- to high-quality (Appendix 3).

Figure 2: PRISMA flow chart



Included studies incorporated a range of participants at risk of digital exclusion, including those from different cultural backgrounds (ethnic diversity, English as a second language or are not fluent in English and/or have a religious belief) (n=8),(165,166,167,168,169,170,171,172) limiting conditions (visual and/or hearing impairments) (n=2),(171,173) low educational attainment (n=4),(165,169,170,173) aged over 65 (n=4),(166,170,171,173) homeless (n=2),(139,169) and those who had low socioeconomic status (n=5)(165,166,167,168,173) (Appendix 4). All 10 studies used interviews,(139,165,166,167,168,169,170,171,172,173) with two studies also conducting focus groups with participants(168,173) (Appendix 5). Digital inclusion strategies were grouped into either outreach programmes providing educational support and/or access to devices (n=2),(169,171) or co-designing DHTs with under-served groups (n=8) to gain feedback on the usability and acceptability of DHTs to enhance inclusivity in future versions of the DHTs (Table 2).(139,165,166,167,168,170,172,173)

Table 2: Summary of digital inclusion strategies explored in the included studies.

Inclusive digital health strategy	**Study**	**Population and type of support (outreach) / technology (codesign) explored**
Outreach Programme	Howells et al.(169)	Homeless individuals' experiences of nurses and community support workers to promote their access and use of DHTs in response to COVID-19.
	Mizrachi et al.(171)	The role of family members in supporting online health services usage amongst older adults (+65 years).
Co-design Approach	Kramer et al.(168)	Use of an embodied conversational agent (an interactive digital healthcare professional avatar) designed to encourage trust in healthcare systems and professionals amongst ethnically diverse groups.
	Yeong et al.(173)	Specifically designed health website to improve accessibility for those with visual impairments.
	Maidment et al.(170)	Specially designed smartphone app to aid those with hearing impairment use hearing aids.
	Asgary et al.(139) Kim et al.(167)	Experiences of homeless individuals(139) and linguistically ethnically diverse individuals with low educational attainment and low income(167) using mHealth (the use of mobile or smartphone devices for health purposes).
	Alkureishi et al.(165) Wikaire et al.(172)	Experiences and opinions of those with low educational attainment, on a low socioeconomic income(165) and ethnically diverse individuals(165,172) when using general digital health services to explore how to support use, access and motivation.
	Choxi et al.(166)	Experiences and opinions of ethnically diverse older adults with a low socioeconomic status on video consultations to explore how to better support their use of this technology.

The researcher's narrative thematic synthesis generated three overarching themes; user-friendly designs (e.g., software and website design elements that promoted inclusivity), infrastructure (e.g., access to DHTs) and educational support (e.g., training to develop digital literacy skills required to use DHTs) (Appendix 5). Facilitators and barriers to the adoption of these themes are embedded in the discussion below and summarised in Figure 3.

4.3.2 User-friendly designs

4.3.2.1 Compatibility & navigation

User-friendly designs were a key theme supporting access and use of DHTs across seven studies.(139,165,166,167,170,171,173) Health-related software and websites needed to be compatible across different digital platforms, operating systems and devices including smartphones and desktops, and assistive technologies (e.g., screen reading software) to accommodate the needs of ethnically and linguistically diverse groups,(167,168,171) individuals with limiting conditions (visual and/or hearing impairments),(170,173) older adults (+65 years),(170,171) those with low educational attainment and low socioeconomic status.(167,168) For example, Yeong et al. noted how older adults with visual impairments and of low socioeconomic status needed websites to be compatible with different magnification levels and assistive technologies (e.g., iOS Voiceover [Apple Inc]; a screen reading software) to aid visibility.(173) The authors also noted how certain features aided navigation and minimised scrolling to help the user find information, such as tables of contents, drop-down menus, and 'jump to top' buttons.(173) Older adults with visual impairments also suggested that navigation features, such as search bars and hyperlinks, needed to be of high contrast (compared to the rest of the screen) to improve visibility.(170,173) Yeong et al. emphasised how search features should be designed in a similar way to commonly visited search engines, like Google, to improve usability and reduce confusion.(173)

4.3.2.2 Content & delivery

Older adults, homeless, ethnically diverse individuals and those with visual impairments all described how digital messages on software, health related websites or text messages should be simple, concise, and presented in a logical manner without time restrictions.(139,168,170,173) For example, older adults with visual impairments described how they did not have enough time to read the information when presented on a timed loop (i.e., rotating between different screens with information), and suggested that the user be able to manually control the timing of this loop.(173) Older adults interviewed in another study described how it would be useful if they could change the font size to improve the visibility of the text, and provide alternative languages for those who are not fluent in English.(171) Personalising information, such as allowing users to choose content that they are interested in, was felt to be one way of increasing the motivation to use health related websites and software amongst those with visual impairments(173) and ethnically diverse individuals.(168) Additionally, providing evidence that supported the key messages in healthcare information, such as the importance of reducing alcohol intake to reduce the risk of developing chronic health conditions, enhanced trust amongst ethnically diverse individuals.(168) Kramer et al. also emphasised how any communication should be culturally appropriate and avoid reinforcing stereotypes, especially for ethnically and linguistically diverse users.(168) For example, the language used to categorise different ethnicities on DHTs should avoid generic terms such as *'men of colour'* as some ethnically diverse men found this offensive; they felt it defined them based on their skin colour and not their ethnic background. Instead, specific terminology should be used that accurately represented their ethnicities (e.g., African American for individuals with an African and American descent).(168) Any imagery should also be inclusive to all cultural groups.(168)

4.3.2.3 *Features*

It was felt that the overall user friendliness and engagement of health related software could be improved with the addition of engaging features.(139,168,170,171) This included interactive quiz elements,(170) notifications encouraging behavioural changes,(168) reminders about upcoming appointments (particularly for homeless individuals as they may not have access to other reminders, like letters),(139) ability to order a repeat prescription and schedule specific appointments (e.g., physiotherapy).(171) Older adults of Jewish faith also suggested simplifying security features, as many found flicking between a text message with the password reset information and the screen (where the information should be entered) challenging.(171)

4.3.3 Infrastructure

4.3.3.1 Devices

Five studies described the need for supportive infrastructure, such as access to devices and connectivity (i.e., Wi-Fi) to support homeless individuals, ethnically and linguistically diverse groups, and individuals of low socioeconomic status.(139,165,167,169,172) For example, Howell et al. explained how community nurses in the UK provided homeless individuals with temporary access to smartphones during the pandemic to enable them to access vital digital healthcare support.(169) In the United States (US), homeless individuals were provided with phones (the Obama phone), credit and data plans financed through a government programme.(139) However, Asgary et al. found that some of these homeless individuals using the Obama phone plan often exceeded their limits when put on hold to schedule medical appointments.(139) They subsequently turned to friends and family for financial support to purchase credit.(139) Other homeless individuals were hesitant to accept this government support, with the authors reflecting on how this may have been due to the homeless experiencing a lack of government financial aid in the past.(139)

4.3.3.2 Connectivity & dedicated centres

Homeless individuals,(136) ethnically and linguistically diverse groups,(132,134,139) and those of low educational attainment and low socioeconomic status(132,134,136) reported relying heavily on free Wi-Fi to access online healthcare. This included accessing free Wi-Fi in public spaces and transport systems, fast-food restaurants, clinics and families' houses. However, they often experienced barriers to this connectivity with time limits set by the specific organisations (e.g., opening hours)(132) or restrictions placed on using shared devices (e.g., computer keyboards due to the risk of coronavirus spreading).(136) Many participants suggested creating dedicated centres for digital health services with suitable devices and free Wi-Fi that would also include some private areas.(132) Access to these private spaces was felt to be important for some ethnic and linguistically diverse groups with low educational attainment and low socioeconomic status, as they were concerned about being overheard when discussing/looking at confidential health information.(134) Many groups suggested that they would like the choice between both digital and non-digital access to healthcare, as this would help mitigate the risk of possibly excluding those with poor digital literacy skills, those who would prefer in-person consultations, or those who lack the resources to access digital healthcare.(132,135,136,139)

4.3.3.3 Policies

To complement infrastructural changes, ethnically diverse adults based in the US advocated for more resources to be provided by local government.(165) This included the introduction of new policies, such as reduced payment plans and regulations on the price of DHTs for lower income earners to make them affordable.(165) Older adults of Jewish faith and ethnically diverse adults with a low educational attainment and socioeconomic status also suggested that financial incentives could help promote greater access to DHTs and encourage motivation to use DHTs.(165,171) Alkureishi et al. highlighted how different organisations, such as hardware and Wi-Fi companies, might need to collaborate to ensure that these different components (e.g., devices, connectivity, financial aid) are jointly available to support successful implementation.(165)

4.3.4 Educational Support

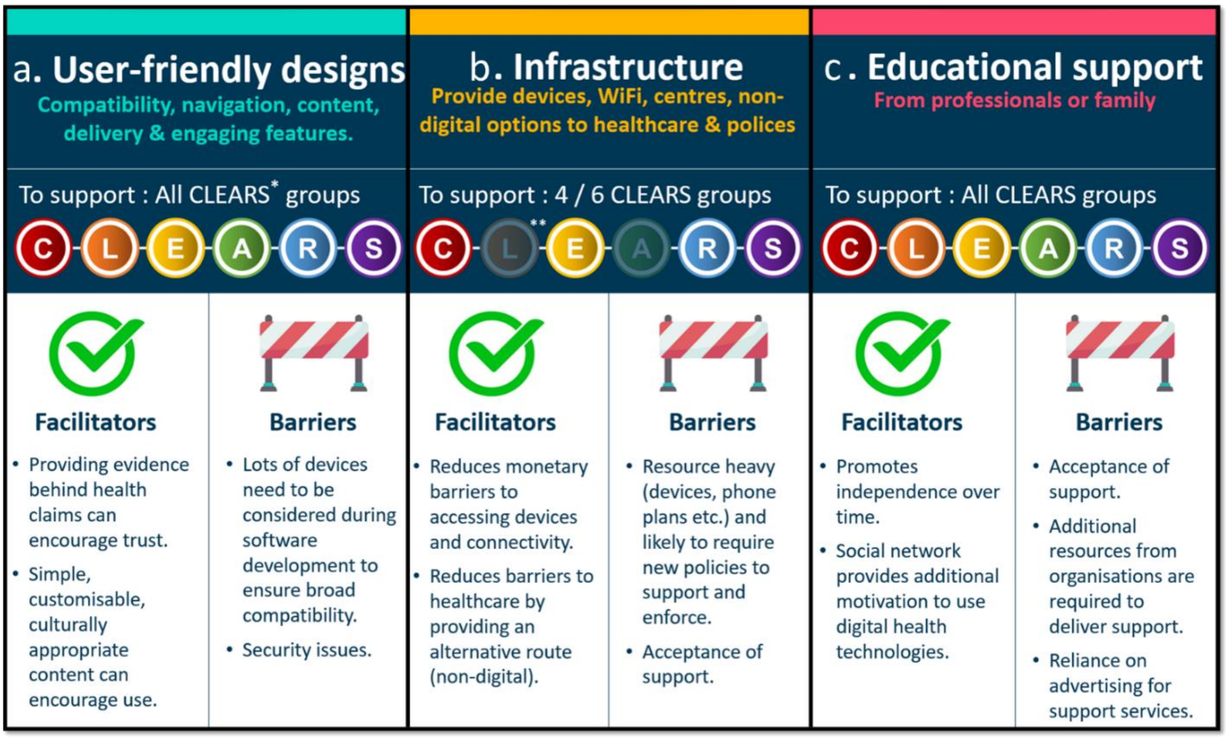
4.3.4.1 Family support

Provision of educational support was important for ethnically diverse individuals and older adults to enable their use of DHTs in five studies.(165,166,169,170,171) Ethnically diverse individuals with low educational attainment and low socioeconomic status, and older adults of Jewish faith commonly reported asking family members to remain close during video healthcare consultations in case of technical issues,(165) or for their guidance with accessing online health information.(171) Mizrachi et al. found this support promoted independence over time as older adults' digital skills developed through learning, and were further motivated to use DHTs on hearing positive experiences from their family and friends.(171)

4.3.4.2 Professional services

Some individuals relied on educational support from professional services to use DHTs.(169) It was felt that in-person educational support from community workers or health care professionals with supplementary materials (e.g., videos and written information) would be beneficial prior to attending virtual appointments, to support ethnically diverse adults (both above and below 65 years) from a low socioeconomic status and low educational attainment.(165,166) Alternatively, Alkureishi et al. noted some participants expressed preference for accessing training classes at healthcare sites (e.g., hospitals) and community centres, where support was provided by 'technology champions and coaches'.(165) However, older adults of Jewish faith highlighted how advertisements to promote awareness of support services would be unlikely to reach individuals in their community and those who were socially isolated and arguably most in need of support.(171) Some studies also highlighted how certain groups (e.g., ethnically diverse adults with low socioeconomic status and low educational attainment, and older adults of Jewish faith) might also be reluctant to accept this educational support due to concerns around burdening others, feeling helpless, and/or reaffirming how they are unable to do something independently.(165,171)

Figure 3: Facilitators and barriers of the three key strategies to support digital health equity



a. User-friendly designs
Compatibility, navigation, content, delivery & engaging features.

To support : All CLEARS* groups

Facilitators

- Providing evidence behind health claims can encourage trust.
- Simple, customisable, culturally appropriate content can encourage use.

Barriers

- Lots of devices need to be considered during software development to ensure broad compatibility.
- Security issues.

b. Infrastructure
Provide devices, WiFi, centres, non-digital options to healthcare & polices

To support : 4 / 6 CLEARS groups

Facilitators

- Reduces monetary barriers to accessing devices and connectivity.
- Reduces barriers to healthcare by providing an alternative route (non-digital).

Barriers

- Resource heavy (devices, phone plans etc.) and likely to require new policies to support and enforce.
- Acceptance of support.

c. Educational support
From professionals or family

To support : All CLEARS groups

Facilitators

- Promotes independence over time.
- Social network provides additional motivation to use digital health technologies.

Barriers

- Acceptance of support.
- Additional resources from organisations are required to deliver support.
- Reliance on advertising for support services.

Note: *CLEARS: Culture, Limiting conditions, Education, Age, Residence, Socioeconomic status.
** Shaded letters represent the CLEARS group not represented in the included studies where the specific strategy was discussed.

4.4 Discussion

4.4.1 Findings in the context of the wider literature

This systematic review is the first to synthesise strategies that promote digital inclusivity and assess the barriers and facilitators to adopting these in practice. The findings highlighted three key themes relating to user-friendly designs, supportive infrastructure, and provision of educational support. Barriers to adopting these strategies included a lack of acceptance amongst some under-served groups to receive such support, whilst facilitators included promoting trust amongst ethnically diverse groups by providing lay term friendly evidence that supports health claims.

The findings described the need for health-related software and websites to be interoperable across different devices to accommodate the needs of under-served groups. This form of user-friendly design is advocated by national healthcare providers and government bodies; for example, the UK and US have legislations in place which mandates that websites and software in the public sector are *'perceivable, operable, understandable and robust'* to ensure that those with visual and hearing impairments, low reading ability (reading age of 9) and/or those who are not fluent in English can access and understand the information provided.(174,175) However, a recent study reported that public health authority websites in only three countries (UK, Italy, China) out of a total of 24 actually adhered to these accessibility standards when checked.(176) Additionally, the wider literature supports our findings on how the use of appropriate language and imagery can improve end-user satisfaction.(168,177) National bodies, such as the US National Institute of Health (NIH), have developed the 'National Culturally and Linguistically Appropriate Services (CLAS) Standards' to assist developers and researchers in developing culturally and linguistically appropriate services.(178) The wider literature also suggests co-designing DHTs with under-served groups at the earliest stages to help ensure that they meet the needs of all end-users.(179)

This involves co-designing security features that are easy-to-use and align with the UK government '*secure by design principles'*, to help overcome any potential future barriers to usage.(180,181)

The findings from this systematic review also highlighted the need for supportive infrastructure to facilitate access and use of DHTs. Government schemes in high-income countries are already available; for example, the 'Obama phone' in the US and the Emergency Broadband Benefits and social tariffs (reduced payment phone plans) in the UK, to support those on a low income to access smartphones and phone plans.(75,139) However, implementing supportive infrastructure might not be viable for low to middle income countries as they may have less suitable centres to provide devices and free public Wi-Fi spots, which high income countries already have access to.(182) Some charity organisations, such as the Good Things Foundation, have started to repurpose donated corporate IT devices and deliver them to those who are digitally excluded.(79) However, better promotion of the support available and a collaborative working environment is needed, especially by healthcare professionals, social services, and charities. Free phone numbers would also help to facilitate access to healthcare services, and some under-served groups would like the option of accessing healthcare via non digital means, thus questioning the temptation to always use technology to potentially address healthcare challenges.(183) Researchers need to consider whether a new DHT will provide an equitable solution to the healthcare problem and whether other means of accessing healthcare should also be provided within healthcare systems.(184)

This systematic review also underlined the importance of providing educational support, from family or professional services, to encourage motivation and capability to use DHTs. There is a need for effective advertising of this support to groups at particular risk of both digital and social exclusion, such as older adults and homeless individuals, in order to increase their awareness of available support.(185) A systematic review conducted by Ige et al.(186) suggested using a combination of two or more strategies to reach socially isolated individuals, including referrals from relevant agencies (e.g., GPs, pharmacists etc), as this might be a more effective approach than relying solely on public facing methods.(186)

4.4.2 Strengths and limitations

This review used a comprehensive and systematic approach to identify relevant literature. Included studies were published within the last decade to remain relevant to the current digital healthcare landscape. The researcher also opted to focus on qualitative research to gather rich detailed information on the facilitators and barriers to each strategy from the perspectives of under-served groups most at risk of digital exclusion. Despite no geographical restrictions being placed on this search, the researcher found that all included studies were conducted in high-income countries, which may limit the applicability of these findings to low- and middle-income countries; this also highlights the importance of further work in this area. Representation of the different religious groups and languages was limited, highlighting a gap in the literature and a need for greater diverse inclusion in research. The facilitators and barriers to implementing government-issued public health website accessibility standards should also be explored to further understand how to encourage the use of these standards.

4.5 Chapter summary

The systematic review described in this chapter identified three key themes relating to digital inclusivity, and associated facilitators and barriers to implementing and adopting these in practice based on CLEARS groups experiences and perspectives. This information will guide individuals when designing, developing and implementing digital health interventions to ensure it is done in an inclusive manner. This review also highlighted the need for further work to explore the feasibility and acceptance of implementing different strategies in different settings (e.g., low-income countries) and different demographic groups (e.g., religious groups) to support digital health equity amongst those most at risk of digital exclusion. However, it is unclear how to implement these strategies in different contexts (i.e., different geographical regions or social situations) and how they can be improved to further support digital health equity. To fulfil this gap, the researcher conducted two qualitative studies, one with under-served groups and another with stakeholders (who had a professional interest in making decisions and/or delivering activities to support under-served groups at risk of digital exclusion), to explore their perspectives on these strategies and the feasibility of using them in practice. In the next chapter, the researcher describes the methodology used to conduct these qualitative studies.

Chapter 5: Qualitive methodology to explore under-served groups' and stakeholders' perspectives on strategies promote digital inclusivity

5.1 Introduction

In Chapter 4, the researcher described a systematic review that highlighted three key digital inclusion strategies; using user-friendly designs, providing supportive infrastructure (e.g., devices, free connectivity, and non-digital options to access healthcare), and providing educational support to help individuals develop their digital literacy skills to support their use of DHTs. It is unclear how to implement these strategies in different contexts (e.g., different geographical and/or societal context) and how they can be improved to further support digital health equity, thus the researcher conducted two qualitative studies to explore the experiences and perspectives of under-served groups (objective 3) and stakeholders (objective 4) on digital health inequities caused by digital exclusion, strategies to promote digital inclusion within healthcare, and how they can be improved to better meet end-users needs. In this chapter, the researcher provides a detailed description of the methodological approach used to conduct both these qualitative studies, starting with a detailed account of the different participants recruited across both studies and how these participants were recruited, techniques used to collect data and analyse the data. The researcher also outlines the steps taken to ensure rigour was upheld when conducting both qualitative studies. The chapter ends with details of the ethical considerations applied when conducting these studies, the use of patient and public involvement to help shape this qualitative research and how the results of this research was disseminated to the public.

5.2 Qualitative Study 1: Perspectives of under-served groups

5.2.1. Aim

The aim of this study was to explore the perspectives and experiences of under-served groups on digital health inequities, strategies they used to overcome such barriers and ways they would like to be supported in the future.

5.2.2 Site location

The North East of England was chosen as the research site due to its high rates of health inequities and digital exclusion compared to other English regions.(72,82,83,90,188,189,190,191,192) For example, the North East of England has the lowest life expectancy, with a difference of 3 years for males and 2.8 years for females when compared to English regions with the highest life expectancy (South East for males and South West for females).(82) The North East also has the highest rates of premature deaths from preventable diseases (23% higher than the national average)(83) and its residents have a higher likelihood of spending more years in ill health compared to the rest of England (for women, this equates to 26% of their life in 'not good/poor' health compared to England's average of 23.3%, and for men it equates to 23.6% of their life in 'not good/poor' health compared to England's average of 20.3%).(83) On a sociodemographic level, the North East has a persistently low average educational attainment,(188,189) high poverty rates,(190,191) and higher proportion of individuals living in rural areas (21.1%), rural towns and fringe areas (14.6%) compared to the rest of England.(192) As previously discussed in Chapter 3, all these sociodemographic factors can put individuals at a higher risk of digital exclusion within healthcare,(193) suggesting residents in the North East are more likely to experience digital exclusion. Therefore, it is not surprising that the region has a high prevalence of low digital engagement (32%),(72) low digital competency (28%),(192) and offline individuals, i.e., those who do not use internet enabled devices or internet based communication routes or information sources (5% in the North East vs England's average of 3.6%).(192) Within certain areas of the North East, such as North Tyneside, certain demographic groups (e.g., older adults) were more likely to face digital inequities as one study reported 94% of digitally excluded residents were over 60 years old.(90) The researcher decided to include North Tyneside as a key area to explore individuals' perspectives and the challenges that they faced relating to digital exclusion, thus aiding the development of effective strategies to promote digital health equity.(83)

An additional benefit of focusing on the North East was the close geographic proximity to where the researcher was based, thus enabling her to attend recruitment sites in person. This was important, as it supported the development of trust and rapport between the researcher and potential participants,(194) and mitigated the likelihood of establishing a rapport 'under false pretences'.(195) As highlighted by Weller, this can sometimes occur when researchers only use remote online interactions.(195)

5.2.3 Eligibility criteria

As mentioned in Chapter 1, under-served groups were defined as those who are often marginalised within society and underrepresented in research,(25,47) leading to a greater risk of digital exclusion due to barriers they face regarding motivation, access and use of DHTs.(9) Common sociodemographic factors associated with digital exclusion within healthcare are summarised by the CLEARS framework (Culture, Limiting conditions, Education, Age, Residence, and Socioeconomic status which are interlinked via intersectionality) (described in Chapter 3).(193) This framework was used to support the identification of those who were most at risk of digital exclusion. Potential participants needed to be over 18 years old, currently living in the North East of England, and met the criteria for at least 2 of the CLEARS groups (Table 3). Potential participants were asked to complete an Expression of Interest (EoI) form (further details provided in section 5.2.4.4 below), which captured a range of details including sociodemographic information and access and use of common household technologies to support the identification of those most likely to be digitally excluded.

Table 3: Criteria for each CLEARS group

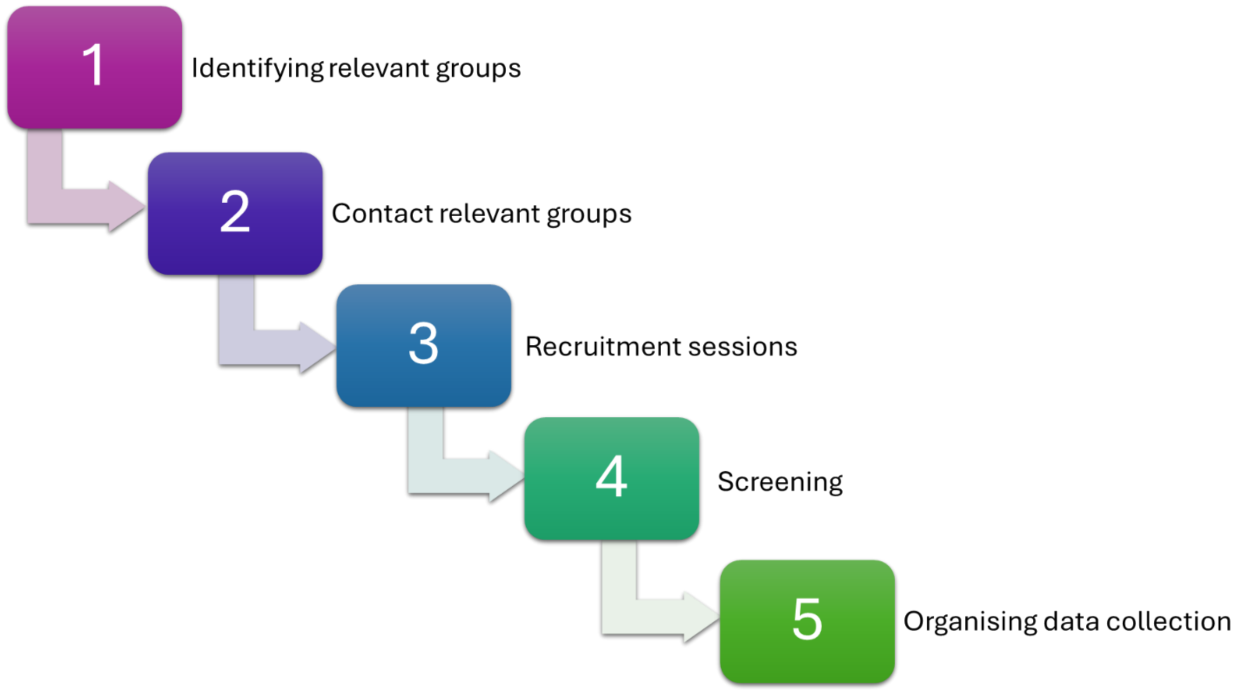
CLEARS group	**Criteria**
Culture	English as an additional language, have a religious faith or identifying as an ethnic group other than White, British. Any religion. Evidence suggests a risk of digital exclusion across a wide range of religions.(141,143,146,193) Additionally, religious groups often do not have their voiced heard in research as this information is commonly not measured or omitted in research,(196) despite The Research Governance Framework(197) promoting the reporting of this information.
Limiting conditions	Have a visual impairment (including any degree of self-reported sight loss or blind that they felt impacted the use of technology) and/ or hearing impairment (including any degree of self-reported hearing loss or deaf/Deaf).
Education	Highest educational attainment achieved is GCSE's (or equivalent) or below.
Age	Over the age of 61 (gathered age in year age brackets, e.g., 61-70, to provide greater confidentiality as advised by Newcastle University Faculty of Medical Sciences Research Ethics Committee).
Residence	Living in a deprived area (IMD* score of 3 or below), live in a rural area or do not have a fixed address.
Socioeconomic status	Annual household income lower than £20,000 (60% lower than a countries' average household income at the time of this study),(150), unemployed and/or state benefits are their main source of income, or on a state pension.

*IMD: index of multiple deprivation.

5.2.4 Recruitment process

It is well recognised in the literature the various challenges associated with recruiting and retaining under-served groups in research.(25,46,198,199) These challenges can occur at the individual level (e.g., feeling unqualified to take part due to a lack of education, or immigration status),(25,198) research level (e.g., protocol design, or lack of effective incentives),(25,199) and societal level (e.g., lack of trust in research, or stigma related to the research topic),(25,198) or a combination of these.(148) Given the key objectives of this study, it would have not been appropriate to try and recruit participants online via online support networks or social media, due to the risk of digital exclusion. Furthermore, recruitment through NHS or other healthcare sites would have not been appropriate as under-served groups are less likely to engage with healthcare services.(200) This may be due to a lack of access to such services (for example, due to the physical distance from remote and rural communities to healthcare sites),(201,202) or holding distrust towards government and public health bodies due to previous experiences of stigma and discrimination from such groups.(200,203) The community based participatory (CBP) approach, which involves engaging with community members and working with organisation representatives as partners, was considered as a more suitable recruitment approach.(204,205) However, CBP was later rejected due to the increasing ethical concerns around ownership of data and research achievements,(206) power imbalance between the researcher and community members,(206,207) and a potentially greater risk of a biased recruitment process.(208) The researcher decided to choose a recruitment approach that used a combination of purposeful snowball sampling(209) and community-based recruitment. The former helped identify access routes to the target population, e.g., existing support groups in the North East for those with limiting conditions, and the latter helped identify interested participants through community-based routes, such as community centres. Five key steps were followed as outlined in Figure 4. The researcher also had the flexibility to move backwards and forwards between each step, in a dynamic fashion, to maximise recruitment. At each step, the researcher placed an emphasis on building a rapport with potential participants, developing and maintaining trusting relationships with gatekeepers, and taking the time to understand the needs and requirements of different participants and community groups by listening to gatekeepers' advice (e.g., the need for interpreters). Further details are provided on each of the key steps below.

Figure 4: Five key steps that were followed in a dynamic fashion to recruit under-served groups at risk of digital exclusion.

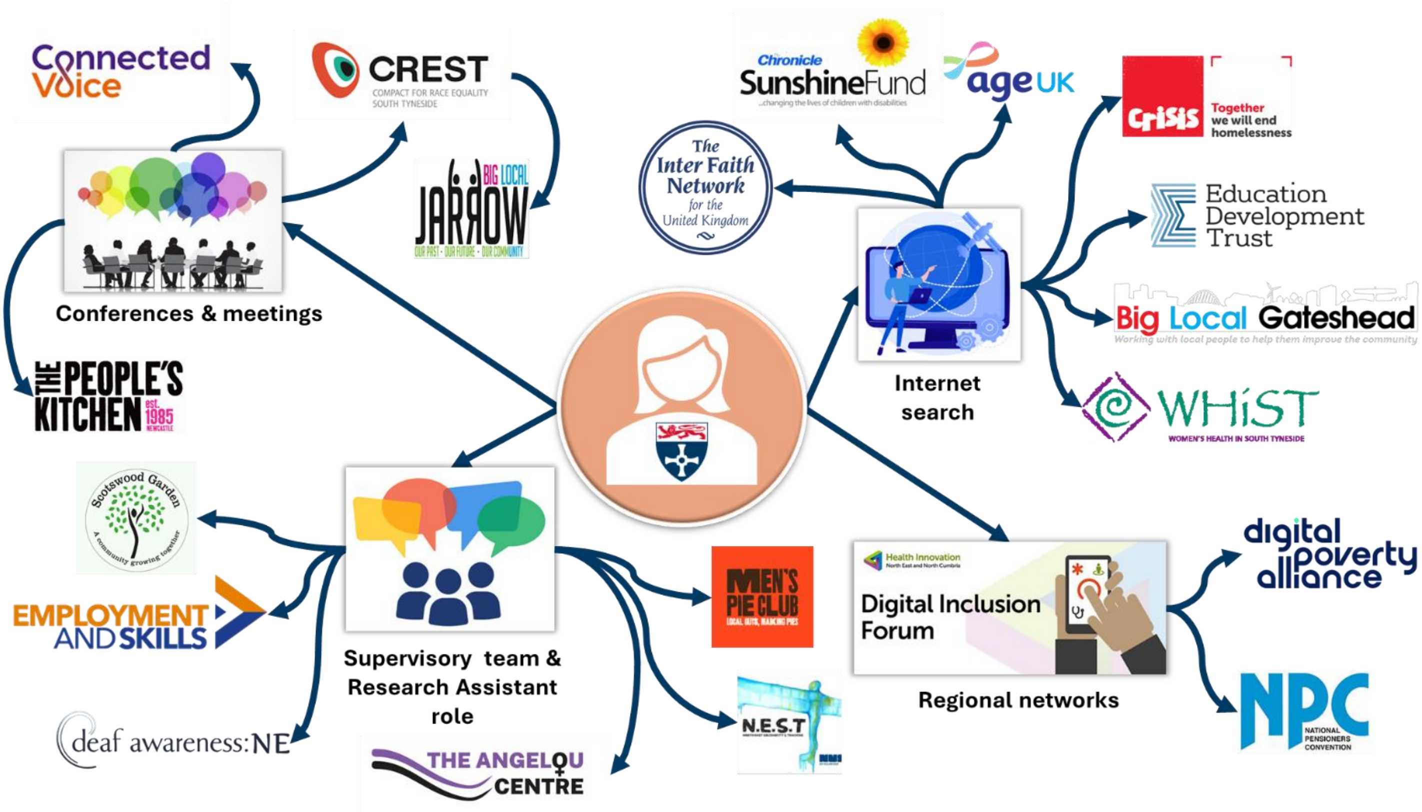


5.2.4.1 Identifying relevant organisations and community groups

The researcher invested a vast amount of time identifying potential organisations, community groups and gatekeepers to support the recruitment of a sample of under-served participants who were at risk of digital exclusion within the context of healthcare (i.e., CLEARS groups). As a result, a large network of organisations and community groups was established to support the recruitment of individuals from under-served groups across the North East of England (Figure 5). The researcher built this network by attending and presenting at local, national and international conferences, such as the Great North Pharmacy Research Conference, the Society for Social Medicine & Population Health 67th Annual Scientific meeting and Alzheimer's Association International Conference (AAIC), to understand the different approaches that had previously been used to recruit individuals from under-served groups. This also helped the researcher identify organisations and community groups who were interested in supporting health inequities research in the North East of England (e.g., Connected Voice, an organization which campaigns for health equity, connects people through events and volunteering, and gives community members skills they need to advocate for themselves). The researcher also presented the CLEARS framework to different regional networks and groups, including the Health Innovation North East and North Cumbria (HI NENC) Digital Inclusion Forum, and further groups were identified, e.g., National Pensioners Committee (brings together trade unionists and others in retirement to organise and campaign to defend and improve their conditions in retirement). Meetings were held with researchers who had previously recruited individuals from under-served groups and this led to the identification of several more groups, such as CREST (Compact for Race Equality in South Tyneside, a charity promoting racial equality, and social justice by improving the social and economic position of Black, Asian and Minority Ethnic communities), and The Peoples Kitchen (supports homeless individuals in the North East with access to shelter and food).

The researcher's role as a Research Assistant on other projects (including a project exploring under-served groups' perspectives on how to communicate the health effects of air pollution (HEALTH project)) introduced her to other relevant groups within North Tyneside and Newcastle, such as Deaf Awareness NE (charity supporting the deaf/Deaf community in the North East) and North Tyneside Employment and Skills Digital Outreach Project (a project funded by North Tyneside council which provides educational digital support to its residence). Recommendations were also provided from the supervisory team, such as Scotswood Garden (community centre promoting learning about nature, the environment and sustainable living), Angelou Centre (specialist community organisation supporting excluded communities of women (e.g., asylum seekers and domestic abuse victims) in the North East), and the North East Men's Pie Club (a support group for socially isolated men and those with mental health conditions). Finally, the researcher conducted an internet search (using terms such as 'charities supporting older adults North East') to identify additional relevant groups, organisations or charities within the North East.

Figure 5: Network of organisations and community groups identified to support the recruitment of under-served groups.



5.2.4.2 Contacting relevant organisations and community groups

Emails were sent to appropriate charities, community groups, and organisations to provide them with a brief description of the study, including the purpose, the activity participants would part take in, an advert (Appendix 6) and a participant information sheet (PIS) (Appendix 7) to see if they thought their group would be interested in taking part. The researcher also offered to meet up with the gatekeeper(s) (in-person or remotely) to provide further information.

5.2.4.3 Recruitment sessions

After the gatekeeper expressed an interest in the study, the researcher liaised with the gatekeeper (via email or phone/video call) to agree on the format of the recruitment sessions (e.g., informal chat or short presentation), how best to approach potential participants, any additional support that might be useful to organise in advance of the recruitment sessions (e.g., interpreters or the language information should be provided in), any ground rules that the researcher needed to be aware of (e.g., only women can attend the Angelou centre), and agreed on a suitable date and time. All recruitment sessions were conducted in person at community centres or the site an organisation delivers its services to the community to avoid excluding any potential participant who may not have access to internet enabled devices to either hear about the study or express their interest to participate. Recruitment sessions were attended by the gatekeeper and attendees of a community group and/ or those who benefit from services provided by a charity or organisation. During the session, the researcher provided a brief 5-minute lay term summary of the project including the background of the project, explained what taking part involved (the choice of taking part in an interview or focus group), the benefits of taking part (including a £20 voucher of their choice and reimbursement for any travel costs after the interview or focus group), how to get involved, and answered any questions about the project. To support individuals with visual and/or hearing impairment(s), a British Sign Language (BSL) interpreter and speech-to-text operator were asked to attend a session. All interested individuals were provided with a PIS (Appendix 7) which included the researcher's contact details (phone number and email address), allowing contact to be made at any point if they had further queries. Additional support was provided to an illiterate potential participant who was unable to read the PIS, by reading the document out loud to them. Verbal consent would have been obtained from this individual before participation if they had took part. For those who were not fluent in English, written information was translated into the individuals preferred language using Chat GPT and validated by a native speaking colleague before the session. Adverts (Appendix 6) were left at community centres and displayed on pin boards (in English and other key languages spoken by those who attend the centre or use the service, as advised by the gatekeepers) to raise awareness of the study amongst those who could not attend the session. The gatekeeper also advertised the opportunity to participate in the study via their newsletters, and suggested other groups, charities or organisations to contact.

5.2.4.4 Screening

Individuals who were interested in participating were asked to complete an EoI form (Appendix 8) and return the form to the researcher at the end of the recruitment session. The form included 15 questions, 13 of which were multiple choice questions asking individuals about their preferred gender, ethnicity, preferred spoken language, religion, any existing limiting conditions (specific to hearing and/or visual impairments), highest educational attainment, age, annual income range (above or below the UK government level of low income (£20,000)), and everyday access and use of common household technologies (e.g., smartphones, laptops, broadband, smart tablets). Two open ended questions asked individuals for their postcode (to calculate Index of Multiple Deprivation (IMD)), contact details (including name) and voucher preference (i.e., which supermarket they would like the £20 voucher for). All questions were optional with a ‘prefer not to say’ option and included a ‘other’ option with space for participants to provide further details in relevant sections. The researcher used responses from the EoI form to identify individuals who met the inclusion criteria. Due to the large quantity of EoIs received, the researcher prioritised those who had limited access to the list of common household technologies (≤ 3 out of 10), and/or used these technologies for limited purposes (≤ 2 out of 7 common uses listed, including for work, study, entertainment, socialising etc.), as individuals with limited access or use of technologies are likely to be experiencing digital exclusion.

5.2.4.5 Organising data collection

Individuals were given a minimum of 72 hours to review the information provided at the recruitment session and ask any further questions. The researcher then contacted eligible participants via their preferred method of contact (SMS message, phone call or email) to arrange an interview or focus group (depending on participant preference) at a mutually convenient time and place (at either Newcastle University or the site they were recruited from). The researcher took responsibility for arranging a meeting space and appropriate assistance to facilitate the focus group or interview, for example, organising a speech-to-text operator and BSL translator, with support from the gatekeeper where necessary. A confirmation of location, date and time was confirmed with the participant, and the day before the interview or focus group, participants were sent a reminder (via their preferred mode of communication). On the day of the interview or focus group, directions were provided to guide participants, if necessary. Before the interview or focus group began, participants were again provided with a quick summary of the study (e.g., aim and purpose) and given the chance to ask any questions. All participants were asked to provide informed consent in writing (Appendix 9), and verbally at the start of the interview or focus group for the discussion to be recorded. Participants were informed they could withdraw at any time during or after the interview or focus group without giving a reason, explaining that any data provided up to the point of withdrawal would be included if it had been anonymised and/or incorporated into the analysis. During the interview and focus groups, particular care was taken when asking questions to those with visual and/ or hearing impairments, older adults, those with lower educational attainment, and with individuals whose English was an additional language to ensure information was communicated appropriately and adapted to participant's individual needs and abilities (e.g., speaking slowly, clearly and taking the time to repeat the question and/or giving additional information, if needed). After the interview or focus group, participants were asked to complete a follow up questionnaire containing three multiple choice questions to gather information on their experience of taking part in research, use of technology specifically for health-related purposes, and if they would like to take part in future research (Appendix 10). Space was provided on the form to allow participants to provide further details and all questions had a 'prefer not to say' option. The £20 voucher was provided upon completion of the questionnaire. Any participant who expressed concerns about the impact the voucher might have on receiving state benefits (e.g., state pension, asylum seeker allowance) where advised by the researcher that they could donate their voucher to the community centre, charity or organisation that they were recruited from, but were not pressured to do so. At the time of this study (November 2023- April 2024), the NIHR payment guidance for members of the public considering involvement in research containing considerations for public contributors who receive state benefits had not been published (published December 2024),(176) and so the researcher was unable to provide any other feasible alternative suggestions.

5.2.4.6 Reflections on the recruitment process

During the recruitment phase, the researcher reflected on various factors that could possibly have affected the success of engagement and recruitment from organisations, charities or community groups. Larger organisations and charities typically provided a generic email address and phone numbers; when contacted, the researcher did not often receive a response. Staff availability at the organisation and/or charity and the demand for their service(s) often negatively affected their capacity to support a small research project. For example, services to support homeless individuals with food and shelter were in high demand and often poorly staffed, thus the researcher found it difficult to obtain contact with them. Groups connected with local councils that encouraged collaborations with research projects appeared more willing to engage.

Continued engagement with organisations, community groups and charities after a positive initial meeting was challenging at times and failed to result in recruitment. Reasons for this included loss of contact with the gatekeeper, due to a job change or change in responsibilities, which meant they could no longer approve or facilitate recruitment sessions. The researcher also commonly encountered last minute requested changes to scheduled meetings or recruitment sessions, sometimes due to circumstances out of the gatekeeper's control, such as building refurbishments. This required the researcher to be flexible and understanding, offering to reschedule to another convenient time to support the development of trustworthy relationships. The researcher also needed to accept compromises to the 'ideal' recruitment approach; for example, some organisations did not have the capacity to support an in-person recruitment session but offered to disseminate information about the project to their service users via newsletters; this proved to be a less effective method of recruitment.

5.3 Qualitative Study 2: Stakeholders' perspectives on the feasibility of implementing digital inclusion strategies into healthcare.

5.3.1 Aim

The aim of this study was to explore stakeholders' perspectives on the feasibility of designing, developing and implementing digital inclusion strategies into healthcare settings, and how digital health equity could be promoted in the future.

5.3.2 Eligibility criteria

The researcher defined a stakeholder as any individual with a job role or professional interest in making decisions regarding the implementation of DHTs into healthcare, or were professionally involved in the development or implementation of services designed to support digital inclusion (e.g., educational digital skills classes). Examples of stakeholders included, but were not limited to, individuals who worked for an integrated care board (ICB), policy and regulatory bodies (e.g. Public Health Wales), local authorities (e.g., North Tyneside council), and gatekeepers (e.g. community workers, charity workers and third-party sector/organisations). Stakeholders outside of the UK (England, Wales and Scotland) were excluded due to the major differences in health systems and infrastructure available across countries, which could influence the feasibility of implementing digital inclusion strategies. Stakeholders could be based in any location within the UK; this enabled a range of perspectives on the feasibility of implementing different digital inclusion strategies across areas facing different regional disparities to be obtained.

5.3.3 Recruitment process

A purposeful snowball sampling approach was used to recruit a range of different stakeholders. (209) This involved the researcher advertising the study via social media (X) (Appendix 11), utilising existing relationships with networks (e.g., HI NENC digital inclusion forum, and North Tyneside Employment and Skills), networking at local conferences (British Society of Gerontology), and contacting organisations who have recently published key documents within the space of digital health inequities, such as the Good Things Foundation and Public Health Wales.

Individuals expressed an interest to take part via X or email. Written consent was obtained, and participants were asked to complete a short questionnaire before taking part in an online (Microsoft teams or zoom) interview or focus group which was organised at a mutually convenient time. The questionnaire contained seven multiple choice questions with space to provide additional information. These questions allowed the researcher to gather information about the stakeholder's professional background, such as their job role, the location of where they worked (postcode), professional sector they worked in, years of experience, relevant experience they held (e.g., implementing DHTs, or providing digital support services to under-served groups), and who the target population and/or service user was that they worked with or supported (Appendix 12). At the start of the interview or focus group, participants provided verbal consent for the discussion to be recorded. After participating, individuals were asked to circulate the advert within their networks and/or recommended others who may be suitable to take part. The researcher emailed recommended individuals, providing them with a summary of the PhD project and inviting them to take part.

5.3.4 Reflections on the recruitment process

The researcher reflected on a variety of different methods to promote the study, such as presenting at regional networks, and posting adverts on social media or network newsletters; these methods were typically less successful than directly contacting recommended individuals via email. Engaging with individuals with busy work schedules was also challenging, with some individuals not having the capacity to take part. Some participants requested that interviews be rescheduled at the last minute, which required the researcher to be flexible and understanding to ensure enough participants were recruited.

5.4 Data collection for Study 1 and Study 2

As mentioned in Chapter 2, two qualitative methods, interviews and focus groups, were chosen to capture experiences and perspectives from a diverse range of under-served groups and stakeholders. All participants, in Study 1 and 2, had the option to take part in either a semi-structured interview or focus group. Participants from under-served groups were offered either an in-person or telephone interview to avoid any potential barriers that they may face relating to digital technology. Stakeholders took part remotely (via zoom or Microsoft teams) which was more convenient for them to schedule alongside other work commitments.

A short descriptive quantitative questionnaire was also used in both studies. In Study 1, an EoI questionnaire which contained predominately closed questions was used to support the screening of individuals and gathered sensitive data, such as participants sociodemographic background (Appendix 8). A second follow up questionnaire was also used after the interview/ focus group, to gain relevant additional data (e.g., experience of using DHTs) to supplement the analysis (Appendix 10). In Study 2, a questionnaire was used to gather information regarding the stakeholder's professional background to supplement data collection and analysis (Appendix 12). Descriptive questionnaires were chosen over an analytical questionnaire, which are used to examine a relationship between variables, and therefore analytical questionnaires would be unsuitable to meet the aims and objectives of this PhD project.(210)

5.4.1 Topic guide development

5.4.1.1 Study 1

A flexible topic guide used to aid the flow of conversation during all semi-structed interviews and focus groups in study 1. The topic guide was developed and informed by the prior systematic literature review, which explored strategies to advance digital health equity for CLEARS groups (Chapter 4).(211) The topic guide was shared with a Patient and Public Involvement (PPI) group (see section 5.8) for their thoughts, and feedback was incorporated to ensure the questions could be easily understood by a diverse range of individuals. The topic guide was piloted in a small study with eight individuals, who represented at least three of the CLEARS groups. Further revisions were made to the topic guide in light of these findings. Table 4 contains some key reflections from this pilot study and the specific changes made to the main study recruitment, topic guide and data collection. The final version of the topic guide (Appendix 13) was used across all interviews and focus groups in Study 1. The topic guide contained two main sections. The first section explored participants' experiences of DHTs, the challenges they have faced using/accessing DHTs and strategies they have considered or used. The second section explored opinions and perspectives on specific digital inclusion strategies and how these could be improved or used in the future (e.g., perspectives on how to improve the infrastructure to support access to resources). PowerPoint slides were also used to facilitate group discussions in focus groups by providing visual stimuli and question prompts (Appendix 14).

Table 4: Reflections from the pilot study and subsequent changes.

Research stage	Key reflections	Impact to the research or changes made to the topic guide
Recruitment	Advertising the study on social media (X) led to a high level of interest from within and outside of the UK. All those who expressed interest had access to an internet-enabled device and were able to use it to express their interest through a digital questionnaire (Microsoft forms). They also had access to some form of connectivity to use the social media platform to see the advert and use Microsoft forms to express their interest.	Non-digital methods were used to advertise the study (e.g., posters at community centres) to maximise participation of those who would fit the eligibility criteria and were likely to be digitally excluded.
Data collection	Interviews were conducted via video call (zoom), suggesting participants had a good level of digital competency.	Interviews and focus groups were only conducted in-person to support the inclusion of those with low digital competency and without access to reliable broadband.
	Connectivity (Wi-Fi) issues occurred in most interviews, demonstrating the lack of access to reliable broadband for these individuals.	
	All participants did not have their camera on during the interview, some responses did not seem authentic (e.g., the participant seemed to have used Google or another search engine to seek answers to the questions asked), and motivation for some individuals to take part appeared to be heavily influenced by the voucher on offer.	The researcher met all potential participants in-person at recruitment sessions and screened expression of interest forms before inviting individuals to an interview or focus group to ensure authenticity. It was made clear during recruitment sessions that the voucher will only be provided after taking part in either an interview or focus group and completing a follow-up questionnaire.
	The wording of some questions was too technical.	Words and phrases were changed to match the reading age of a 7-year-old to improve the understandability of the questions. E.g., initial question, “Have you ever used digital health services or tools?”, was changed to “Have you ever used or heard of any technology, such as an app or video call, that could help you access your doctor or other health information?”.
	Interviews lacked depth and detail.	The interview guide was adjusted to focus more on participants’ lived experiences of issues using digital health services. E.g., initial question, “How would you describe digital health services?”, was changed to “Can you tell me about any challenges you have experienced when trying to access your doctor or any type of healthcare?”

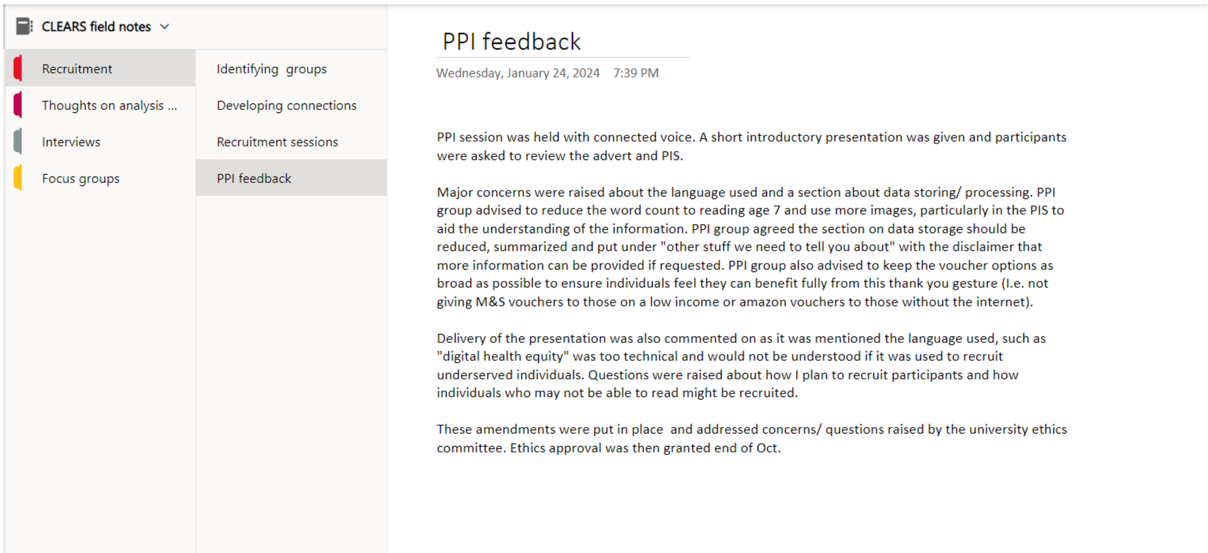
5.4.1.2 Study 2

Preliminary findings from Study 1 informed the development of the topic guide used in all semi-structed interviews in Study 2. Discussions with the supervisory team led to further refinements, so that the guide could be better tailored to each stakeholder's role and experience (e.g., "Can you tell me about your experience involved in [insert project(s) to improve digital inclusivity or the DHT the stakeholder has worked on]?"). The researcher reviewed information provided in the questionnaire and publicly available information about the participant's professional role to support a more tailored conversation. The topic guide (Appendix 15) contained three main sections: (1) professional experience of implementing DHTs, digital inclusion strategies, or supporting under-served groups (to identify and explore any current and/or novel digital inclusion strategies), (2) thoughts on the feasibility of specific digital inclusion strategies identified in the literature (Chapter 4) and Study 1 (Chapter 6) that have not been mentioned, and (3) what they would like to see changed to support the advancement of digital health equity.

5.4.2 Field notes

The researcher documented detailed reflections throughout the recruitment, data collection and analysis phase of Study 1 and Study 2 using Microsoft OneNote. Notes were taken after holding a recruitment session, or conducting interviews/focus groups, and throughout the analysis process, whilst ideas and reflections were still fresh. Notes were organised in a logical manner, with separate sections for different activities, such as reflections on the recruitment process, data collection and analysis. Within each section, notes where further subdivided into relevant categories, such as before or after the recruitment session or interview (see Figure 6).

Figure 6: Screenshot of documented field notes taken during Study 1.



PPI feedback

Wednesday, January 24, 2024 7:39 PM

PPI session was held with connected voice. A short introductory presentation was given and participants were asked to review the advert and PIS.

Major concerns were raised about the language used and a section about data storing/ processing. PPI group advised to reduce the word count to reading age 7 and use more images, particularly in the PIS to aid the understanding of the information. PPI group agreed the section on data storage should be reduced, summarized and put under "other stuff we need to tell you about" with the disclaimer that more information can be provided if requested. PPI group also advised to keep the voucher options as broad as possible to ensure individuals feel they can benefit fully from this thank you gesture (I.e. not giving M&S vouchers to those on a low income or amazon vouchers to those without the internet).

Delivery of the presentation was also commented on as it was mentioned the language used, such as "digital health equity" was too technical and would not be understood if it was used to recruit underserved individuals. Questions were raised about how I plan to recruit participants and how individuals who may not be able to read might be recruited.

These amendments were put in place and addressed concerns/ questions raised by the university ethics committee. Ethics approval was then granted end of Oct.

5.4.3 Data saturation

Data collection was carried out until data saturation was achieved. Data saturation occurs when themes start to repeat and subsequent interviews or focus groups gather no new information that is relevant to the research question.(212,213) To determine data saturation, the researcher reflected on the quality of the interviews (e.g., length and depth of detail captured), number of interviews, and lack of occurrence of new information in interviews/focus groups conducted after data saturation was thought to be achieved. The researcher also considered the range of demographic groups in the sample, ensuring that different perspectives were captured to sufficiently answer the research question.(213,214,215) The researcher observed saturation with 29 participants in Study 1 and 17 participants in Study 2. Data saturation took longer to achieve in Study 1, due to the range of demographic groups within the sample, thus various different experiences and perspectives were obtained. Study 2 contained a more homogenous population with shared professional experiences, allowing data saturation to be achieved sooner.(216) The researcher also noted that some participants in Study 1, typically those from a low socioeconomic status with a low educational attainment and/or English as an additional language, found it harder to articulate their thoughts compared to stakeholders; this meant that the level of detail captured in some interviews and focus groups was low. Therefore, a greater number of interviews and focus groups were conducted in

Study 1 to gather enough data to sufficiently answer the research question. Discussions between the researcher and supervisory team confirmed that data saturation had been achieved.(217)

5.4.4 Transcription

All interviews and focus groups were audio recorded with participant's permission. Audio recordings were sent to a third-party transcribing company, University Transcriptions (TP Transcription Limited), to be transcribed verbatim. Once transcribed, the researcher checked the validity of the transcripts by playing back the audio recording and simultaneously reading the transcripts to identify discrepancies and correct errors. The researcher also deidentified any text (e.g., removed any names mentioned in the transcript) and anonymized the transcripts (e.g., placing a unique participant identification number on each electronic file). Anonymised quotations from the interviews and focus groups included a unique participant identification number and were presented in the findings Chapters (Chapter 5 and 6). Additional information about the participant was also included after the participant identification number to provide further contextual information. For example, in Study 1 the CLEARS domain the participant represented was noted (e.g. P1 ERS = Participant 1 who has a low **E**ducational attainment, lives in a **R**esidency at risk of digital exclusion (e.g., deprived area) and is on a low **S**ocioeconomic income). Quotations appear in italics and quotation marks. Square brackets around an ellipse within a quotation, "[...]", symbolise where the researcher has removed some text from the sentence to improve readability, and text surrounded by square brackets in quotations, "[]", symbolise where additional text has been added to the sentence to improve clarity and/or provide further context.

5.5 Data analysis

5.5.1 Quantitative data

Quantitative data gathered in Study 1 (EoI and follow up questionnaire) and Study 2 (professional background questionnaire) was analysed by calculating the frequency or averages were appropriate (e.g.

frequency of different sociodemographic groups / average number of years of clinical experience). Postcode information from the EoI and professional background questionnaire allowed the researcher to establish if a participant lived/worked in a rural, urban or city area based on public available information and the level of deprivation in the area (using IMD postcode lookup data).(218)

5.5.2 Qualitative data

Reflexive thematic analysis was used to analyse the qualitative data gathered from interviews and focus groups. Reflexive thematic analysis was developed by Braun and Clarke (2012)(219,220) and is defined as *"the researcher's reflective and thoughtful engagement with their data and their reflexive and thoughtful engagement with the analytic process"*.(220,221) This approach supports the analysis of a range of factors which may affect digital exclusion within healthcare, such as an individual's experiences, views, opinions, behaviours or practices, and the factors or processes that underpin and shape particular experiences or decisions (e.g., social norms).(222) Thus, reflexive thematic analysis supported the researcher to reach holistic conclusions that accurately reflect what participants said and why they said it (e.g., due to social context or experiences). Other analytical methodologies were considered but ultimately rejected. For example, the framework thematic analysis approach, defined by its matrix output of rows (cases, i.e., an interview), columns (codes) and 'cells' of summarised data providing a structure into which the researcher can systematically reduce the data,(223) was considered. This approach allows the measurement of inter-coder reliability through the use of a structured codebook and multiple independent coders, often focusing only on reoccurring concepts to form codes.(223) However, the researcher was the only coder, therefore an analysis approach supporting multiple coders was unnecessary, and the framework approach opposes the researchers' theoretical assumptions (section 4.5.2.2) that were purposely selected to support the exploration of a variety of different perspectives and social nuances (e.g., considering meaningfulness to support the generation of codes and themes, rather than only recurring concepts). The researcher also considered using a Grounded Theory approach, which would support the development of theory from a purely inductive analysis of textual data to explain social phenomena.(224) However, the aim of this PhD was not to develop a theory and an exclusively inductive approach, such as grounded theory, would be inappropriate for this PhD project.(225) This is due to the researchers' knowledge of the topic area, gained through exploring the literature on perspectives regarding specific digital inclusion strategies (Chapter 4), and prior research experience (as a Research Assistant exploring the use and acceptance of digital technologies in diverse cohorts and stakeholders (on the EDoN project)),(226,227) which may have unintentionally influenced the analysis process and subsequent construction of codes and themes.(225) Finally, a phenomenological approach which is used to explore the perspectives of lived experience of a phenomena,(228) was considered but rejected as this PhD project goes beyond exploring lived experiences by taking into account other contextual factors that affect digital exclusion, such as their position within society (intersectionality) and the infrastructure available to an individual.

The researcher applied a predominately inductive approach to the reflexive thematic analysis to ensure the analysis truly reflected the content within the data, rather than pre-existing theories or frameworks.(229) The term 'predominantly' is used to reflect the unintentional impact the researchers' experience may have had on the analytical process. A semantic and latent coding approach was used in tandem to ensure explicit meaning within the data (semantic) is captured as well as the researchers' interpretations of deeper levels of underpinning ideologies (latent) that shape the sematic data.(230)

A critical orientation was also applied to the analytical process in such a way that meaningfulness greatly influenced the generation of codes and themes, whilst still acknowledging the importance of recurring concepts.(220)

5.5.2.1 Reflexive thematic analysis process

Reflexive thematic analysis involves the immersion of the researcher into field notes, transcripts and reflections throughout the data collection and analysis process, to question the meaning of participant responses when interpreting the data, to then produce codes and themes that accurately reflect the data.(220) Braun and Clarke proposed six key phases of thematic analysis which are followed in an iterative order, moving back and forth between phases, to develop a deeper understanding of the data and support the identification of important reoccurring aspects.(219,231)

The first phase of thematic analysis is the familiarisation with the data which involved the researcher reading and re-reading the transcripts, without any note taking, to develop a broad understanding of the data. Field notes, such as the location of the interview and focus group and demographic data, were incorporated into the transcript (noted on the top) to achieve greater contextual understanding of the data. In phase two, the initial codes were generated, which were descriptive ideas of the key aspects of the transcript. To achieve this, an 'OSOP' ('one sheet of paper') technique was used, which involved the researcher reading through each transcript whilst simultaneously noting on a sheet of paper any important ideas in each part of the transcript (descriptive codes) with reflections of the transcript.(232) A new sheet of paper was used for each transcript. The researcher then stepped back to identify overarching findings and differences between different groups across all transcripts and topics particular sub-groups of participants were passionate about (Figure 7). This phase was conducted alongside data collection to identify any gaps in the data and probe for further information in subsequent interviews. Phase three of thematic analysis is the generation of themes, which involved the researcher reflecting on the notes in phase two and re-reading the original transcripts to identify deeper connections between the descriptive codes and significant broader patterns of meaning. In phase four (reviewing potential themes), the researcher mapped the developing themes on a white board, with each theme represented in a different colour, to visualise connections between themes (Figure 8) and support the discussion of these themes with the supervisory team. In phase five (defining and naming themes), the final themes and codes were then applied across the whole data set to ensure consistency. The final phase was the process of writing, with the findings presented in the next two Chapters of the thesis (Chapters 6 and 7). The management of data throughout the analysis process was assisted by N-Vivo (QSR, version 14.23.2). Throughout all stages of the analysis, queries, concerns and review of developing themes were discussed with the supervisory team. This process was conducted twice; once to analyse the transcripts produced from Study 1 and a second time for the transcripts produced from Study 2. The analysis for each study was kept independent from each other.

Figure 7: Example of notes the researcher took when conducting the one sheet of paper technique to support the analysis of Study 1

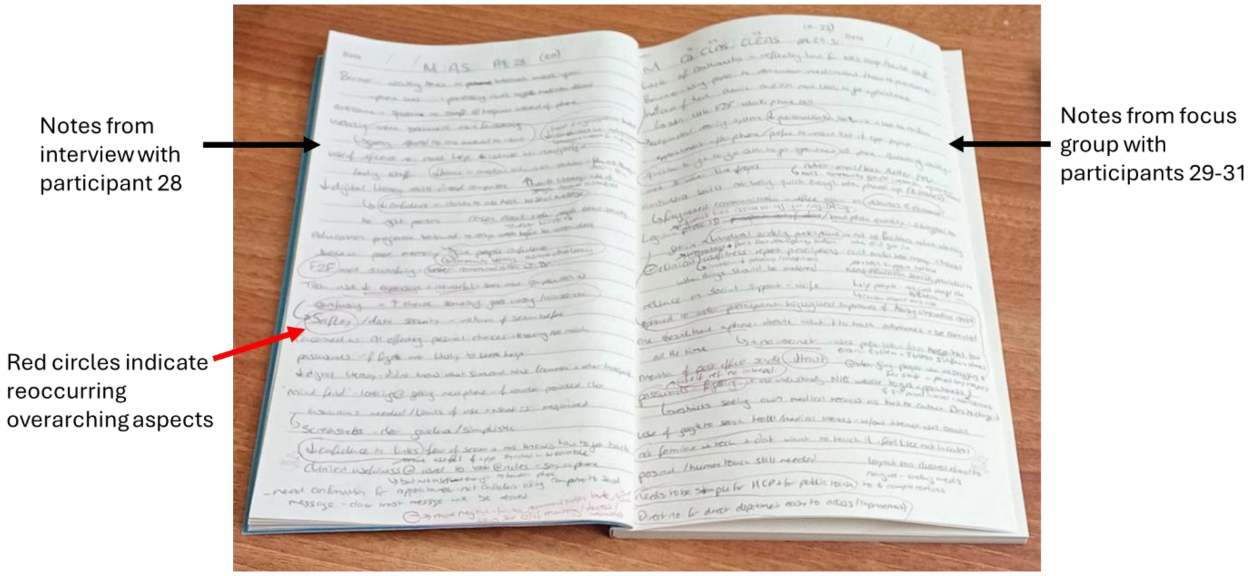
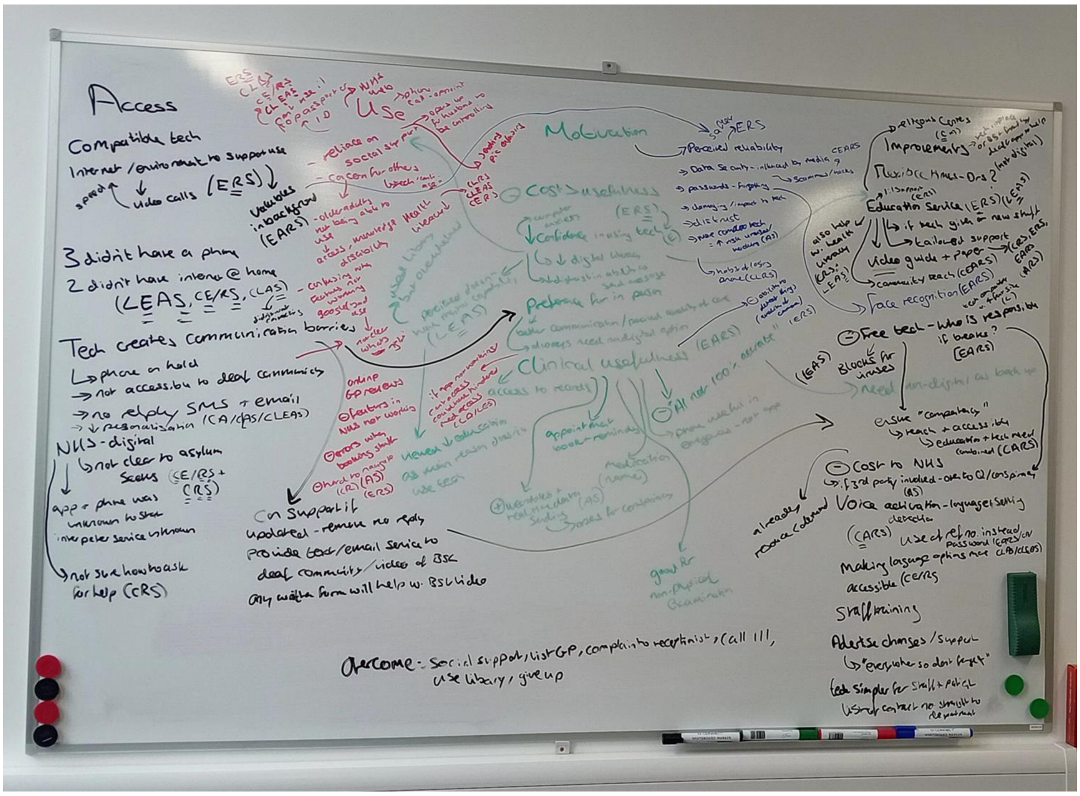


Figure 8: Initial mapping of themes in Study 1.



5.6 Rigour

Various strategies were used during each step of these two qualitative studies to ensure the research was conducted responsibly, accurately and with adequate time provided for reflection. This included following the Standards for Reporting Qualitative Research (SRQR),(233) completing the Consolidated criteria for reporting qualitative research (COREQ) check list for Study 1 and 2 (Appendix 16-17),(234) and ensuring trustworthiness. By upholding rigour throughout this project, bias is reduced, and transparency of the research process was promoted.

5.6.1 Trustworthiness

Trustworthiness plays a vital role in demonstrating rigour, validity, and usefulness of the research.(235,236,237) In this PhD project, trustworthiness was established by ensuring credibility, transferability, dependability, and confirmability as per the guidance set by Nowell et al.(236) The researcher has elaborated further on each of these below.

5.6.1.1 Credibility

Credibility is the accuracy of the data to reflect the participants' reality.(237) To address credibility, various strategies were put in place, such as piloting the topic guide to ensure the questions could be easily understood by participants, which in turn helped them to respond appropriately. To further enhance credibility, data was collected from different participant groups using different methods (e.g., interviews, focus groups, and quantitative survey data) and triangulated, thus reducing the impact of potential bias from a single data source.(237)

The researcher acknowledged and reflected on her personal biases and preconceptions, arising in part from her research experience, throughout the data collection and analysis phases to maintain a predominately inductive approach and minimise the influences. Intersubjective reflection was also considered by the researcher, which involved a conscious reflection on ones self-in relation to others.(238)

The researcher acknowledged her position within society, as a white British young woman who is well-educated and holds an occupation at a higher educational institution, differs from many of the under-served individuals who participated. The researcher took various actions to improve her understanding of others' experiences and mitigate the chances that participants' perceptions of the researcher would negatively influence data collection. For example, she attended various Equality, Diversity & Inclusion (EDI) training sessions, and only shared information about herself that was relevant to the study, e.g., she only disclosed she was a PhD student because the study contributed towards the PhD project (further detail are provided in Chapter 8, section 8.5).

Finally, towards the end of the data analysis process, the researcher produced an image summarising the findings from Study 1 and presented this to PPI members, participants and gatekeepers to obtain their feedback and validate the credibility of the findings (further details are provided in section 5.9 and the final image is shown in Chapter 8).(239)

5.6.1.2 Transferability

Transferability refers to the case-by-case generalisability of the research findings.(240) To support those seeking to transfer the research findings to their own work, the researcher provided a rich description of various aspects of this research, such as specific details on the data collection settings, sampling strategies, eligibility criteria and study procedures, to allow readers to explore similarities/differences, and thus judge the transferability of these findings on a case-by-case basis.(237,241)

5.6.1.3 Dependability

Dependability is the extent to which the research can be replicated to gain the same or comparable results. To ensure dependability, the researcher rigorously documented the research process, data collection techniques and analysis in a logical and traceable manner to give the reader full transparency throughout each stage of the research.(240) This was achieved by creating reflective audit trails which consisted of a comprehensive log of decisions, rationales, raw data, field notes, transcripts and reflections on daily logistics (e.g., organising interviews/focus groups, contacting organisations).(241)

Keeping reflective records of each step of the research process also helped systemise, relate, and cross reference data, aiding the reflexive thematic analysis approach used to analyse the data.(242)

5.6.1.4 Confirmability

Confirmability refers to the ability to demonstrate that the researcher's interpretation and key findings are derived from the data, with minimal research biases or preconceptions, by clearly explaining how interpretations and conclusions have been reached.(240) Guba and Lincoln (1989) define confirmability as established when credibility, transferability, and dependability are all achieved.(243) To further improve the confirmability of the findings from this PhD programme of work, peer debriefing was conducted with the supervisory team and co-authors of publications at several points throughout the project to review decisions, interpretations, conclusions, and provide an external check on the research process to minimise bias and ensure a comprehensive narrative that accurately reflected the data.(241)

5.7 Ethical considerations

Careful attention was given to ethical considerations relevant to the conduct of Study 1 and Study 2. This included using a translator and/or interpreter with a minimum of Level 6 Diploma in Public Service Interpreting (DPSI), where possible. One interview was conducted in the participants' native language (Arabic) by a Research Associate at Newcastle University, whose first language was also Arabic, when an interpreter could not be organised in time to suit the participants availability (Study 1). One focus group was assisted by a BSL interpreter and speech to text operator (Study 1). The rest of the interviews and focus groups in study 1 and 2 were conducted solely by the researcher in English. The use of the participant's family member(s) as a translator/interpreter was avoided due to ethical concerns, such as the information being conveyed incorrectly, or the interpersonal relationship between the family member and participant preventing the participant from disclosing their true opinion or experiences.(244)

Various procedures were implemented to protect both participants and the researcher. To protect participant's wellbeing, the PIS signposted participants to resources and helplines in case the participant found anything discussed in the interview or focus group distressing. Travel expenses were also reimbursed if this facilitated individual's participation. To protect the researcher when working alone off campus, a risk assessment was completed (Appendix 18) detailing measures that were followed when travelling to and from public places (e.g., community centres) to conduct recruitment sessions, interviews and focus groups. Measures to protect the researcher's physical safety included the researcher meeting with a staff member working at the public site before meeting the participant to discuss safety procedures (e.g., if the researcher felt threatened or at risk), and using a buddy system where the researcher notified a member of the supervisory team where and when an interview or focus group was taking place, when she had arrived, and when she had left the external site. To protect the researcher's mental wellbeing when interviewing and conducting focus groups with under-served groups, the researcher was aware of support from Newcastle University student wellbeing services.

Ethical Approval was sought and granted by Newcastle University Faculty of Medical Sciences Research Ethics Committee (project number: 2617_2/35084), on 30th October 2023. Two ethical amendments were submitted after approval based on the researchers' reflections and learnings. One amendment included the use of focus groups to support the recruitment of under-served groups (approved 19th December 2023), and the second amendment included the use of interviews in Study 2 to allow greater flexibility to be offered to stakeholders (approved 10th April 2024).

5.8 Patient and Public Involvement (PPI)

To ensure Study 1 was conducted in an inclusive and understandable manner, the researcher consulted a PPI group at Voice Global (an organisation providing access to community members who volunteer to provide a lay term perspective on research). The group consisted of eight individuals (three females, five males) who were residents of North East England, all white British, middle class and half (n=4) were retired. Although the group did not fully represent all the different sociodemographic groups within the target population for Study 1, they provided valuable insights into the perspectives of North East residents. PPI contributors reviewed key public facing documents (e.g., PIS, advert, topic guide, and recruitment presentation) and provided feedback during an in-person group discussion.

Contributors highlighted the importance of designing the documents with the target population in mind, such as tailoring them to meet the needs of those with low English reading ability, as well as making sure the voucher was sufficient/suitable for their time. The researcher implemented this feedback by reducing the length of the PIS and adding images, ensuring all documents were to a reading age level of 7 (using Chat GPT which was then checked for validity by the researcher), and allowing participants to choose which supermarket voucher they received.

5.9 Public Dissemination

A summary of the findings from Study 1 (Chapter 6) and the systematic review (Chapter 4) were sent to a professional artist at an organisation called *More than Minutes*, which helps portray research findings through visuals. The researcher emailed six PPI members (on a related project; the HEALTH project), participants who had provided an email address, and gatekeepers to invite them to provide feedback on the image produced. Four PPI members, three participants and one gatekeeper completed a feedback form which was provided via email in both a word document and PDF. The form consisted of six questions to identify aspects people liked about the image, whether they would like to add any further content, and areas that could be further improved (Appendix 19). A £20 voucher of their choice was provided after returning the form (via email or post) as a thank you for their contribution and time. Feedback was summarised into actionable recommendations and sent to the professional artist. The final version of the image (shown in chapter 8) was shared via email to all the gatekeepers at organisations, charities and community groups who supported recruitment of participants for Study 1, Voice Global, the PPI group the researcher invited to comment on the image, and participants who had provided an email address. Gatekeepers were asked to distribute the image to those who regularly attend their centres to help disseminate the findings.

5.10 Chapter summary

This chapter provided details of the participant recruitment processes, methodological and analytical approaches used, and ways in which rigour and trustworthiness was upheld during the two qualitative studies conducted as part of this PhD programme of work. Due to the reflexive nature of the analytical process used (reflexive thematic analysis), the researchers' observations, thoughts and perspectives were also noted in relevant sections. The researcher ended the chapter by discussing the processes of ethical approval, PPI involvement and public dissemination. The next two chapters describe the findings obtained from Study 1 (Chapter 6) and findings obtained from Study 2 (Chapter 7).

Chapter 6: Perspectives of individuals from under-served groups on digital health inequities

6.1 Introduction

In Chapter 5, the researcher described the methodology used to conduct the qualitative primary data collection and analysis involved in this PhD programme of work. In this chapter, the researcher describes the findings of Study 1 (objective 3) which explored the perspectives and experiences of individuals from under-served groups living in North East of England on digital health inequities, strategies they have used to overcome barriers associated with digital health inequities, and ways they would like to be supported in the future.

6.2 Participants from under-served groups

Twenty-nine individuals participated in either a focus group (4 focus groups, n=18) or semi-structured interviews (n=11) between 25th November 2023 and 11th April 2024. The focus groups lasted between 1 hour 30minutes to 2 hours (with a 5-10min break when required), and the interviews lasting between 40 minutes to 1 hour. Twenty participants were female and nine male. All CLEARS groups were represented, and all but one self-reported as representing at least two groups. The cultural group (n= 38) was the most prevalent followed by low socioeconomic status (n=24) (Table 5 and 6). The least represented group was limiting conditions (n= 10) (Table 5 and 6). Participants also represented a range of different boroughs across the North East including North Tyneside, Newcastle and South Tyneside (Table 6). One participant withdrew on the day of the interview without reason.

Data gathered from the EoI (completed by all participants before an interview or focus group) revealed self confidence in using technology was generally low across participants, with many reporting how they did not feel confident using any technologies (n=8) (Table 7). However, all participants had access to at least one device (such as a smartphone/ mobile phone (non-internet enabled phone)/ smart tablets etc.) and many (n=21) owned their device(s) and did not share it with others in their household (Table 7).

Data gathered from the follow up questionnaire (completed by all participants after an interview or focus group) revealed most individuals (n=22) had not previously taken part in research, and many (n=12) had not previously used technology for any healthcare purposes (Table 7). Those who had used technology for healthcare purposes described using the NHS app (n=11), GP websites to book appointments (n=3), wearables (e.g. glucose monitors) prescribed by their doctor (n=2), a video call for a health consultation (n=2) and/or used technology to assist communication during in-person consultations with a healthcare professional (e.g., the individual who was hard of hearing used speech to text software during consultations) (n=1) (Table 7).

Table 5: Summary of CLEARS domains represented in Study 1.

CLEARS domain	Frequency	Subcategory	Frequency
Culture	38	Diverse ethnicity (not White British) English as a second language Have a religious belief	14 4 20
Limiting conditions	10	Sight impairment Hearing impairment Both	2 4 5
Education	12	GSCE level	3
		Below GCSE	9
Age	12	61-70 71-80	8 4
Residence	19	Rural area Deprived area Homeless Sheltered accommodation	0 12 0 7
Socioeconomic status	24	Retired Household annual income below £20,000	2 22

Table 6: Study 1 participant demographics

Participant ID	**Recruited from**	**Data collection method**	**Gender**	**CLEARS domains represented** (number of groups represented)	**Ethnicity**	**Language**	**Religion**	**Limiting condition**	**Educational attainment**	**Age**	**Residence** IMD* score: 3 or below= deprived (region of North East)	**Socio-economic status** Household annual income below £20,000
9	Snowball	Interview	Female	ERS (3)	White	English	N/A	N/A	GCSE (or equivalent)	41-50	1 (South Tyneside)	Yes
10	Snowball	Interview	Female	EARS (4)	White	English	N/A	N/A	GCSE (or equivalent)	61-70	3 (South Tyneside)	Yes
11	WHIST	Interview	Female	LEAS (4)	White	English	N/A	Wears a hearing aid and has alternating vision	No qualifications	61-70	Postcode not provided to get IMD score (South Tyneside)	Yes
12	North Tyneside Council Employment and Skills Digital Outreach Project	Dual interview	Male	CEARS (5)	White	English	Greek Orthodox	N/A	No qualifications	61-70	3 (North Tyneside)	Yes
13	North Tyneside Council Employment and Skills Digital Outreach Project	Dual interview	Female	CEARS (5)	White	Greek (fluent in English)	Greek orthodox	N/A	No qualifications	61-70	3 (North Tyneside)	Yes
14	North Tyneside Council Employment and Skills Digital Outreach Project	Interview	Female	CA (2)	Asian / Asian British	English	Hindu	N/A	postgraduate	61-70	10 (North Tyneside)	Preferred not to say
15	North Tyneside Council	Interview	Male	CARS (4)	Mixed / Multiple	English	Christian (Catholic,	N/A	postgraduate (PGCE)	61-70	1	Yes

	Employment and Skills Digital Outreach Project				ethnic groups		Protestant or any other Christian denominations)				(North Tyneside)	
16	Angelou centre	Focus group	Female	CES (3)	Asian / Asian British	English	Hindu	N/A	Level 2 English as 2nd language	51-60	4 (Newcastle)	Yes
17	Angelou centre	Focus group	Female	CLERS (5)	Asian / Asian British	English	Muslim	Visual impairment	No Qualifications	31-40	Sheltered accommodation (Newcastle)	Yes
18	Angelou centre	Focus group	Female	C (1)	Asian / Asian British	English	Muslim	N/A	First degree (e.g. BA, BSc)	31-40	6 (Newcastle)	No
19	Angelou centre	Focus group	Female	CLRS (4)	Asian / Asian British	English	Hindu	Hearing impairment	postgraduate degree or professional qualification	31-40	1 (Newcastle)	Yes
20	Angelou centre	Focus group	Female	CRS (3)	Asian / Asian British	English	Muslim	N/A	First degree (e.g. BA, BSc)	21-30	Sheltered accommodation (Newcastle)	Yes
21	Angelou centre	Focus group	Female	CERS (4)	Asian / Asian British	English	Muslim	N/A	Level 2 English as 2nd language	31-40	Sheltered accommodation (Newcastle)	Yes
22	Snowball	Interview	Female	CR (2)	Arbab	Arabic (trained colleague conducted interview)	Muslim	N/A	First degree (BSA or BSc)	41-50	2 (North Tyneside)	No
23	Angelou centre	Focus group	Female	CERS (4)	Black / African / Caribbean / Black British	English	Christian (Catholic, Protestant or any other Christian denominations)	N/A	BTC (bar training course / barrister)	21-30	Sheltered accommodation (Newcastle)	Yes
24	Angelou centre	Focus group	Female	CRS (3)	Asian / Asian British	English	Muslim	N/A	postgraduate degree or professional qualification	31-40	Sheltered accommodation (Newcastle)	Yes

25	Angelou centre	Focus group	Female	CRS (3)	Asian / Asian British	English	Muslim	N/A	postgraduate degree or professional qualification	21-30	Sheltered accommodation (Newcastle)	Yes
26	Angelou centre	Focus group	Female	CLR (3)	Iranian	Farsi (interpreter supported)	N/A	Both hearing and sight impairment	prefer not to say	31-40	1 (Newcastle)	No
27	Angelou centre	Focus group	Female	CERS (4)	Taiwanese	English	Budish	N/A	No qualifications	31-40	Sheltered accommodation (Newcastle)	Yes
28	North Tyneside Council Employment and Skills Digital Outreach Project	Interview	Male	AS (2)	White	English	N/A	N/A	A level (or equivalent)	61-70	9 (North Tyneside)	Yes
29	North Tyneside Council Employment and Skills Digital Outreach Project	Focus group	Male	CLEAS (5)	White	English	Christian (Catholic, Protestant or any other Christian denominations)	Slight hearing loss	GCSE (or equivalent)	71-80	8 (North Tyneside)	Yes
30	North Tyneside Council Employment and Skills Digital Outreach Project	Focus group	Male	CLS (3)	White	English	Christian (Catholic, Protestant or any other Christian denominations)	Yes	First degree (e.g. BA, BSc)	71-80	9 (North Tyneside)	Yes
31	North Tyneside Council Employment and Skills Digital Outreach Project	Focus group	Male	CA (2)	White	English	Christian (Catholic, Protestant or any other Christian denominations)	N/A	postgraduate degree or professional qualification	71-80	4 (North Tyneside)	Preferred not to say

32	Men’s Pie Club	Interview	Male	LRS (3)	White	English	N/A	Visual impairment	A level (or equivalent)	41-50	3 (Newcastle)	Yes
33	Men’s Pie Club	Interview	Male	ERS (3)	White	English	N/A	N/A	level 1 maths and English	31-40	1 (Newcastle)	Yes
34	Deaf Awareness NE group	Focus group	Female	CLA (3)	White	English	Christian (Catholic, Protestant or any other Christian denominations)	deaf in one ear following neurosurgery operation	postgraduate degree or professional qualification	61-70	10 (North Tyneside)	No
35	Deaf Awareness NE group	Focus group	Female	LARS (4)	White	English	N/A	Severe hearing loss	postgraduate degree or professional qualification	71-80	3 (North Tyneside)	No
36	Deaf Awareness NE group	Focus group	Female	CLRS (4)	White	English	Christian (Catholic, Protestant or any other Christian denominations)	deaf and visual impairment	postgraduate degree or professional qualification	51-60	3 (North Tyneside)	Yes
37	Deaf Awareness NE group	Focus group	Male	CLS (3)	White	British sign language (interpreter supported)	N/A	Profoundly Deaf and short sighted	A level (or equivalent)	21-30	4 (North Tyneside)	Yes

*IMD: Index of Multiple Deprivation

Table 7: Study 1 participants access to technology, use of technology for healthcare purposes and experience of taking part in research.

Participant ID	**First time taking part in research**	**Experience of using technology for healthcare purposes**	**Do you own or have access to any of the following digital tools?**	**How do you have access?**	**Do you feel confident when using technology?**
9	No	GP website used to make appointment	Smartphone, broadband, smart TV	I own it and do not share with someone in my household	Not at all
10	Yes	Apparatus to test for sleep apnoea	Smartphone, broadband, laptop	I own it and do not share with someone in my household	Slightly
11	Yes	No but have been asked to use it in the past	Mobile phone	I own it and do not share with someone in my household	Not at all
12	Yes	NA	Smartphone, broadband	I own it and do not share with someone in my household	Not at all
13	Yes	Used the NHS app	Smartphone, broadband	I own it and do not share with someone in my household	Not at all
14	Yes	NA	Smartphone, broadband	I own it and do not share with someone in my household	Slightly
15	Yes	GP website used to make appointment	Landline, mobile, smartphone, broadband, smart TV	I own it and do not share with someone in my household	Only with tech I am familiar with
16	Yes	GP website used to make appointment	Smartphone, ipad or smart tablet, broadband	I share it with someone in my household	Only if someone is helping me
17	Yes	NA	Smartphone, broadband	I own it and do not share with someone in my household	Slightly
18	Yes	Used the NHS app	Smartphone, laptop, broadband	I share it with someone in my household	Completely
19	Yes	NA	Smartphone, broadband	I share it with someone in my household	Somewhat
20	Yes	Used the NHS app	Smartphone, laptop	I own it and do not share with someone in my household	Somewhat
21	Yes	No but have been asked to use it in the past	Smartphone, broadband	I own it and do not share with someone in my household	Fairly
22	No	No	Smart phone, ipad or smart tablet, broadband	I own it and do not share it with somebody in my household	Somewhat
23	Yes	Used the NHS app	Smartphone	I own it and do not share it with somebody in my household	Only with technology I am familiar with
24	Yes	Used the NHS app specifically for repeat prescription	Smartphone, broadband	I own it and do not share with someone in my household	Completely
25	Yes	Used the NHS app specifically for appointment	Smartphone, broadband	Via family or friend	Completely
26	Yes	Used the NHS app	Smartphone, broadband	I own it and do not share with someone in my household	Somewhat

27	Yes	No	Smartphone, ipad or smart tablet	I own it and do not share with someone in my household	Only if someone is helping me
28	No	No	Mobile phone	I own it and do not share with someone in my household	Not at all
29	No	Used health apps, NHS app and evergreen heart monitor	Smartphone, broadband	I own it and do not share with someone in my household	Not at all
30	Yes	No	Prefer not to say	Prefer not to say	Not at all
31	Yes	No	Prefer not to say	Prefer not to say	Not at all
32	Yes	Uses a blood glucose monitor	Smartphone; broadband; computer smart TV	I own it and do not share with someone in my household	Fairly
33	Yes	Used the NHS app	Smartphone	Prefer not to say	Slightly
34	Yes	Used a video call with a GP and NHS app.	Landline, smartphone, broadband, ipda or smart tablet, laptop, smart tv, smart home technology	I own it and do not share with someone in my household	Fairly
35	No	Uses speech to text software in consultation and uses the NHS app	Smartphone, broadband, ipad or smart tablet, laptop, smart home technology (e.g. Hive)	I own it and do not share with someone in my household	Only with technology I am familiar with
36	No	No	Mobile phone, ipad or smart tablet, laptop, computer	I share it with someone in my household	Only if someone is helping me
37	No	Used a video call for mental health services	Smartphone, broadband, laptop, broadband	I own it and do not share with someone in my household	Fairly

6.3 Qualitative findings

The researcher identified four key themes through the process of an in-depth reflexive thematic analysis of the focus groups and interview transcripts. The themes centred around (1) accessing healthcare exclusively via digital means, (2) using technology for healthcare purposes, (3) accessing educational support to aid the use of technology for healthcare, and (4) participants' perspectives on the clinical usefulness of technology (Table 8, Figure 9). Key themes and subthemes are described in detail below using direct quotations from the transcripts. Participants names have been replaced with their participant identification number (chronologically assigned starting from number nine, as the participants from the pilot study were assigned numbers 1-8) and the CLEARS group they represented. For example, a participant who was interviewed first (post-pilot study) and has a low Educational attainment, lives in a Residency at risk of digital exclusion (e.g. deprived area), and lives on a low Socioeconomic income is referred to as P9 ERS.

Table 8: Description of the key themes and subthemes generated from Study 1.

Theme	Subtheme	Description
Accessing healthcare exclusively via digital means	Barriers to digital access	Barriers that occurred when accessing healthcare that was only available via digital means e.g., appointments could only be booked via a phone call, or upcoming appointments could only be confirmed via a weblink.
	Perceived solutions to improving access	Providing benefits (a payment or scheme provided by the government) to support access to devices and connectivity, and the need to provide non-digital access routes.
Using technology for healthcare purposes	Low digital literacy	A lack of understanding on how to use technology which leads to digital anxiety and difficulties when navigating health apps and websites.
	Security barriers and concerns	Aspects of authentication during the registration and login process of health apps that caused issues and general concerns regarding data security of digital health technologies.
Accessing educational support	Overreliance on peer support	Issues that occur when an individual relies on support from their social network to aid the use of technology for healthcare purposes.
	Delivering educational support services	Key areas limiting the scalability of educational support services within communities and recommendations to provide in app /website guidance and healthcare provider staff training to increase access routes to educational support.
Experiences of DHTs* affecting perceived clinical usefulness		Positive experiences of using DHTs enhanced perceived usefulness of technology but reflections on the limitations of current technology within healthcare raised concerns about their use in some clinical situations.

*DHTs: Digital Health Technologies

6.3.1 Theme 1: Accessing healthcare exclusively via digital means

6.3.1.1 Barriers to digital access

Most CLEARS groups observed multiple situations where healthcare providers and healthcare professionals had assumed everyone had the required knowledge, desire and ability to access healthcare exclusively via digital means. This included the appropriate technologies and necessary connectivity. These assumptions were particularly prominent during the COVID-19 pandemic when in-person consultations with healthcare professionals were restricted, resulting in situations where patients were required to send a photograph (e.g., of a wound) to a healthcare professional but they did not have the appropriate technology to take the photograph and/or send the photograph to be able to receive an online consultation or appropriate treatment.

> *"I was asked [by a healthcare professional] to send a photograph of a wound [for a remote consultation][...]I automatically said, "Well so for you to help me I've got to go out and buy a camera, then I've got to take a photo and then I've got to go and get that photo developed then I've got to post it to you, is that what you're saying?" and he [healthcare professional] said, "Well just send me a photo online." [...] [but] I do not have any form of the internet, no communication with the internet, no smartphone."* (P11 LEAS).

These assumptions made by healthcare professionals appeared to persist after the pandemic, with many participants describing how they had received automated no-reply SMS messages containing a weblink recipients needed to follow to confirm upcoming hospital appointments. The weblink required access to the internet but no alternative option was available for those without access to the internet. In these situations, participants described asking their primary care provider for assistance. This involved calling the GP surgery, explaining to the receptionist what they had received from the hospital and their inability to follow the link as they did not have access to the internet. One participant described how when they spoke to the GP receptionist over the phone, the receptionist explained how the SMS message from the hospital was *"an automated message we can't tell you anything"* (P11 LEAS) as they did not have access to the relevant information regarding the hospital appointment. This participant later reflected on the receptionist response, saying how *"I'm sure they don't mean to be unhelpful but that's a brick in the wall to communication"* (P11 LEAS). This made the participant feel like they were *"being forced into having the internet [to be able to access healthcare], and that's not going to happen [as they do not have the confidence to use it]. I don't think it's right that my communication with consultants and doctors should be affected by the fact that I don't have the internet*" (P11 LEAS).

Digital appointment booking systems also appear to have created other issues for participants when trying to access healthcare. Participants who were hard of hearing described situations where appointments at their local GP surgery were only available to book via a phone call, which they could not do independently due to their hearing difficulties. One Deaf participant described how he had to rely on his parents: "*to phone them [healthcare professionals] and then I wait[ed] for them [healthcare professionals] to contact me through text [to book an appointment] […] which means I am not able to be independent and do things myself*" (P37 CLS). Others described how they had tried explaining to their local GP surgery that an alternative option to booking appointments that does not require the ability to hear is necessary to support their inclusion, however "*trying to get them [healthcare providers and professionals] to understand I can't hear on the phone, it doesn't seem to register [with them]*" (P35 LAR). Participants who were not hard of hearing, also appeared to face difficulties as they recounted how the appointment booking phone lines were often very busy, with some reportedly being cut off (due to poor signal and/ or lack of minutes on their phone plan) before an appointment could be made. In an attempt to overcome these issues, participants tried to book a GP appointment in person at their local GP surgery but were told by the receptionist that they needed to book via the phone line or via the online GP appointment system, with one participant recounting: "*the hell I could do [use] that [the online system]"* (P14 CA) so they resorted to persisting with the phone line. For those participants who reportedly used the online GP appointment booking system, they found it unreliable. One participant described attending *"the [GP] surgery [for the appointment they made online] and the receptionist says I can't find an [their] appointment"* (P22 CR). However, this participant knew how to take screenshots on their smartphone and decided to "*keep a screenshot of my appointment"* so that they could *"show it to the receptionist when I come to my appointment"* (P22 CR) as proof of booking.

6.3.1.2 Perceived solutions to improving access

Financial barriers were perceived as a key factor inhibiting access to appropriate technology and connectivity amongst participants. However, many digitally excluded participants believed healthcare providers should be able to provide the necessary tools and/or assistance (e.g., vouchers) to be able to promote access: *"they've [healthcare providers have] got to give, […] them [digitally excluded individuals] Wi-Fi, give them the stuff, so they can do it, so it's possible to do the medical things online"* (P29 CLEAS), or at least provide a *"voucher that we could actually get something to replace your old phone"* (P34 CLA). However, some participants raised concerns about the financial pressure this would place on the NHS, with one participant describing the "*NHS is a sinking boat and if we put too much stress and we will lose it more sooner than later*" (P14 CA). This participant also questioned whether it would be possible to provide free connectivity (using the example of a SIM card) to a large number of patients at a GP practice, as this would require time to set up and resources to support: *"could you imagine if somebody had 1200 people in their surgery and how they can set up and get that SIM card [to provide free connectivity] ready for 1200 people? It's quite expensive for them to run in that manner"* (P14 CA). Another participant suggested phone companies might be able to provide support, but others appeared hesitant to have "*any private sector"* involvement as *"I'd [they'd] always be thinking about [the companies] ulterior motives*" (P28 AS). Some participants questioned how a GP practice would distribute possible digital devices and connectivity to individuals and decide who they would distribute them to. One participant shared a concern about the potential inappropriate use of these benefits if eligibility to access the support was not regulated by healthcare providers, for example if *"people that don't really need it, start using it, and it takes it away from the people that really need it*" (P29 CA). One participant proposed recording an individual's ability to access digital healthcare services on their electronic healthcare record, so that "*when it comes up with your name and your date of birth [on the healthcare professionals' screen] [...] they just put on their screens, 'no internet connection'*" (P11 LEARS) to help identify who should be provided with benefits. Some participants suggested the implementation of free-to-use messaging platforms, such as WhatsApp, to communicate with healthcare professionals. They explained how this could help individuals as it *"doesn't matter who you phone, it doesn't cut your cost and doesn't cut your minutes"* (P14 CA) and provides additional benefits, including the ability to send a picture to a healthcare professional: *"you can't send [a] picture to a[n] [NHS] landline number. I could have sent it on a WhatsApp"* (P10 CA). However, WhatsApp does require internet access. Most participants felt that there was a need to provide non-digital alternatives for those who are digitally excluded, to enable them to access healthcare and to mitigate concerns that *"if it all goes technology I don't know how I will cope*" (P34 CLA), and to reduce the impact of instances where *"the system [such as digital booking systems] wouldn't work, if you didn't have an alternative, there'd be no way [to book an appointment]"* (P31 CA).

6.3.2 Theme 2: Using technology for healthcare purposes

6.3.2.1 Low digital literacy

Many culturally diverse individuals and older adults were not motivated to use technology for healthcare purposes. This appeared to relate to digital anxiety, where some participants felt overwhelmed when trying to learn how to use technology and the "*internet, it's like fireworks are coming inwards to my brain because I don't understand it"* (P11 LEAS). One participant described a sense of losing control when they go on a computer for the first time. This participant explained how when the computer does not load straight away, but they continue to click on software *"the computer sort of takes over and you can't always control it, and I think that's what worries a lot of people. Still worries me at times"* (P31 CA). Another participant was worried about going on websites and making *"a mistake and spoils[ing] something*" (P14 CA) such as deleting the webpage or content. Many believed their low digital literacy ability was "*down to a lack of education and understanding, [...] I don't think I have [the] mental capability to learn about the internet*" (P11 LEAS). Having a low digital literacy ability made many feel-like targets for online scams or fraud as they struggle to identify them, and subsequently many were victims of such scams; *"I was £180 down when the team [of scammers] just told me I had Trojans on my computer and it was a load of rubbish"* (P28 AS). This experience further exacerbated their digital anxiety.

Some participants showed a little more confidence in using technology but perceived the technology as unreliable. One participant described how the NHS app would not always load her upcoming hospital appointments, and when it did, the appointment date and time was incorrect; *"here [in the NHS app] it say 20th the something I've got appointment. I don't understand why [as it was different to the appointment date given by her secondary care healthcare professional]. So sometimes the technology doesn't work for the purpose it has been designed [for]"* (P14 CA). This lack of trust in the reliability of technology led some participants to reflect on other types of technology that had been portrayed in the media as not working. One participant referred to: "*the great post office scandal"* (P15 CARS) as an example of a computer system that did not work. Although unrelated to healthcare, this participant reflected on the unintended consequences that this had on users of the computer system: *"well that's a wonderful example [of how] people's lives are being absolutely destroyed, their reputations, people have committed suicide, people have gone to prison"* (P15 CARS). Another participant described how they were unsure whether to trust a message that they had sent to a primary care provider via email would be received, stating how they "*feel more confident [with] face-to-face [communication]"* (P34 CLA) as they know the GP will have heard them.

Some participants who considered themselves as having low digital literacy skills described health related apps and websites that they had used previously as over complicated and hard to navigate. For example, when using a GP website to book an appointment online, a participant felt frustrated when "*what you're trying to find out, doesn't come up on the list [drop down menu] [...] you don't know which one to press. Then you normally press the wrong one and after half an hour, you've got to start from scratch again*" (P31 CA). Some participants put forward suggestions on how these apps and websites could be improved, such as being able to increase the font size of text in a manner which is compatible with small smartphone screens to avoid "*lose[losing] half of the text"* (P35 LAR) when larger font settings are enabled on an individual's device causing the website layout to shift dramatically cutting off sentences. Another participant described how enabling a *"talk back facility [where] you can talk to it [an app] and it will talk to you"* (P15 CARS) could potentially avoid the need to manually navigate through an app or website. Other participants suggested that *"more people from the community"* come together with *"some of these technology experts"* (P35 LAR) when designing and developing technologies, so that the products are more inclusive.

6.3.2.2 Security barriers and concerns

Participants who had low educational attainment, lived in a deprived area or sheltered accommodation, and/or on a low socioeconomic income, described various security barriers when using online health accounts. Participants explained how they needed photographic identification (e.g., passport or driving licence) to register for the NHS app, which many did not have. Some participants recalled how this was due to the cost of obtaining these documents and/or how these documents were not in their possession: "*passport is with Home Office. I'm an asylum seeker, so I don't have any ID proof for booking to NHS*"

(P21 CERS). Participants who did have photographic identification found it difficult to upload a suitable picture of their documentation to complete the registration process for the NHS app. They described how the instructions were unclear that the picture of their documentation had to show *"the full [four] corner of the passport, but not everyone understand that"* (P17 CLERS), leading to frustration as they had to repeat the process of taking the photo and uploading it. Many were unaware where to seek help from, resulting in participants giving up trying to register on the NHS app.

Other participants found it hard to remember their passwords and faced a barrier when logging on to their NHS account online: "*the bloody passwords and passcodes all the time [...] my brains full. I can't be bothered, and you have to write stuff down, well when you write stuff down you have a security issue*" (P15 CARS). One participant who was in possession of a smartphone with a front facing camera and had facial recognition set up by a family member described using facial recognition to overcome issues regarding password recall, as they found using facial recognition to be "*much easier [...] [for] anybody who wasn't good at remembering them [passwords]*" (P10 EARS).

Some participants raised concerns regarding the safety and security of access to their health information via DHTs as they *"wouldn't want anyone to know what medication you're on or what treatment you've had, or what operations you've had [...] you wouldn't want that to leak"* (P9 ERS). Other participants also shared their concerns around medical data being transferred or contained on their digital device: *"don't want any medical data sort of on me phone, I could lose the phone"* (P32 CLRS) and their lack of trust with these devices: *"don't trust technology not to release my information"* (P36 CLRS). Additionally, if remote monitoring devices were provided to healthcare users, one participant questioned what type(s) of data would be collected and across which locations: if *"the technology in actual fact traces you. Especially if you're being monitored, where you are. [...] I think it would cause problems to a lot of people"* (P30 CLAS).

6.3.3 Theme 3: Accessing educational support

6.3.3.1 Overreliance on peer support

To facilitate the use of technologies for healthcare purposes, many participants turned to their social networks (e.g., family, friends or others in their community) for support. Some participants did not know where else to access support and asked neighbours and/or friends to help them. One participant described feeling uncomfortable asking her neighbour for help to send a picture of a rash to a healthcare professional as she had to share personal information with someone else and considered herself a burden: *"it was terrible [having to ask someone for help] because then I was sharing my private information with someone else, [and] I [she] felt sorry for my neighbour [who was helping her send the image]"* (P14 CA). Another participant described how she would like to learn how to book appointments on the NHS app, but her husband did not have the time to show her: *"my husband do[es] everything. Then when I ask, can you teach me? He says, he's busy, and then he goes on the app and books for me"* (P16 CES). Participants who had experienced controlling relationships often mentioned how their partners would forbid them from accessing support at local digital skills classes to prevent them from learning and developing their digital skills; *"before my husband [...] not teach me nothing [...] not let me go to the class [...] but now [that she does not live with her husband] I go to the [digital skills] class on Monday, she teach me with the computer."* (P17 CLERS).

Those who received one-to-one training from a family member or friend on how to use a device, often struggled if the family member or friend used particular terminology that they did not understand. For example, one participant asked their daughter to "*explain [how to download and use an app] to me over the phone and then [...] if you don't know the terminology, you are stuck*" (P14 CA). Another participant highlighted how it might not be easy to apply what they had learnt to different apps or websites: "*because not all the apps or websites have the same system to work...so many times each app or system has it's own steps to follow, some of them are pretty similar, but others are not[...] but it is so confusing and sometimes I just log off the app and leave it*" (P22 CR). A few participants asked their healthcare professionals for additional help in using technologies for healthcare purposes, with one participant experiencing different levels of support from different healthcare professionals. She described contacting staff at the GP practice who, in her view, did not seem "*trained [...] to use the online system. [...] [But] when you call a call centre like the 111, I feel that they received better training on online stuff"* (P22 CR) and were better able to help.

6.3.3.2 Delivering educational support services

Some participants described attending digital skills classes to help improve their digital skills. All participants who had been recruited through the North Tyneside Council Employment and Skills Digital Outreach Project (n= 8), had attended the digital skills classes provided by the project. These participants found the classes useful and helped reduce their digital anxiety, increase their confidence and improve their digital literacy skills. However, many reflected on the limited awareness of local digital skills classes as they usually heard about the project through family or friends who had attended. Some believed the use of digital advertising techniques, such as social media posts, limited the awareness of such services as those who do not have access to the internet and/or an internet enable device could not see the advert. Some participants who did have access to connectivity and compatible devices did not trust digital advertising due to fears of it being false information, believing *"anything can be fake news [...] sometimes they use big names [celebrities, brands and companies] and it ends up being fake news"* (P9 ERS). Several participants felt that advertising educational support services in a number of different ways would be better, like through *"doctor's surgeries and libraries, bus stops, which everybody uses, or schools as there's lot of people [parents and guardians] coming, children coming and they can take that information and give it to their family"* (P14 CA). This participant also suggested advertising through places of worship as *"you get massive communities there in churches"* (P14 CA).

Some participants, who were aware of local digital skills support services, perceived a need for more government funding if these services were to be expanded and offered to more people: "*we all know that it is [are] community groups where there are libraries where they will try and teach you how to use a computer and stuff. But unless it's funded more by the government you are not really going to move forward [to reach more people] very quickly*" (P35 LAR). Another participant described how it might be useful to have *"BSL [British Sign Language] videos on the [NHS and Local GP] website on how to book an appointment, and also translated into English, so they [users] could watch the video"* (P37 CLS). This view was shared by other participants who described how there was little support provided on these NHS websites: "*when I go online I find the information about the booking but not how to use the online system itself [...] I can't find any guiding or helping tool"* (P22 CR). This participant also suggested providing healthcare staff with "*more training on how to address our [technology related] query's to be able to help us"* (P22 CR).

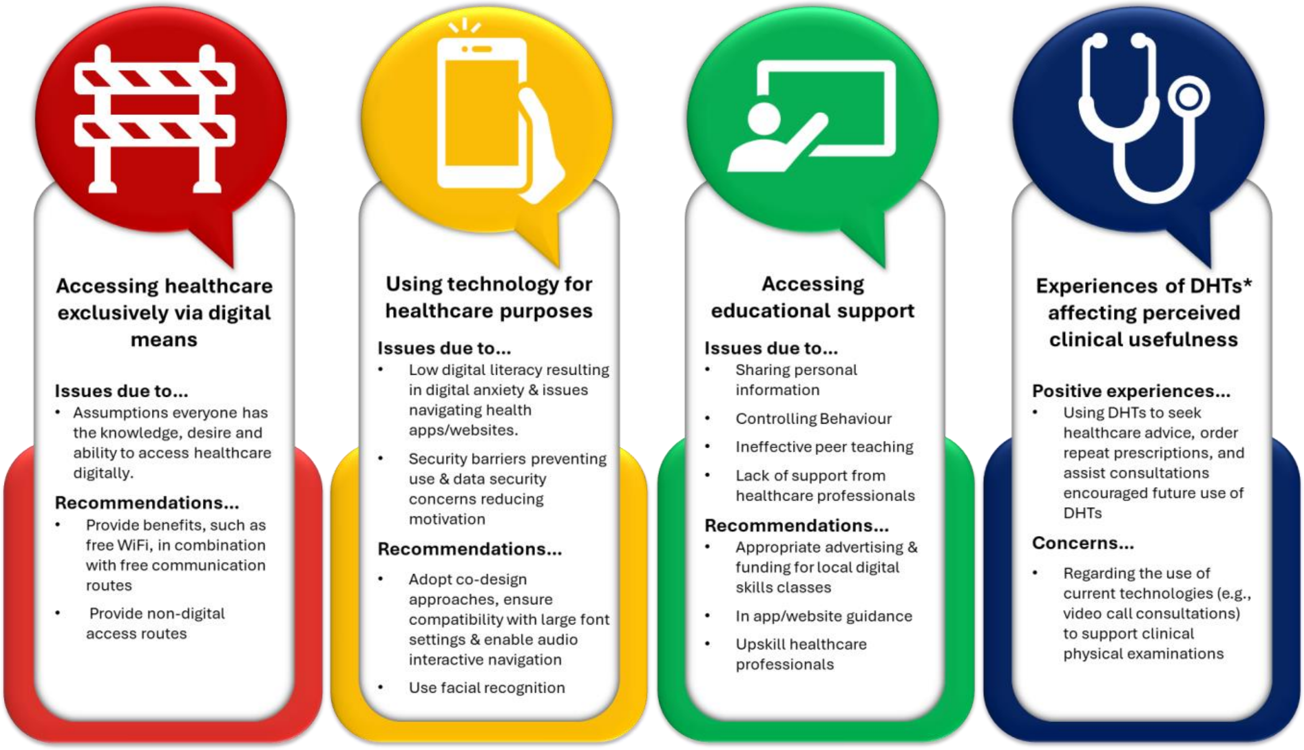
6.3.4 Theme 4: Experiences of DHTs affecting perceived clinical usefulness

Some participants reflected on their positive experiences of using DHTs in the past and how these positive experiences had encouraged them to continue using technologies for healthcare purposes. Some participants liked the ability to be able to access healthcare information on different diagnoses via the NHS website at any time that they wanted, particularly: *"if somebody is telling you a diagnosis or you are a bit worried about oneself, you can look that up on that [NHS] site and it will advise you [...]. So it is quite good for that."* (P35 LAR). Another participant enjoyed the ability to use the NHS app to keep track of their repeat prescriptions as it "*gives you past dates that you've ordered the prescription before"* (P10 EARS) and allowed you to "*change where you collect your prescriptions"* (P10 EARS). A few participants also described positive experiences of using technology to support a consultation with a healthcare professional. For example, one participant who was hard of hearing described how the technology supported her face-to-face communication with a consultant as it enabled *"the consultant to type questions [directed for the patient on their computer]"* (P36 CLRS) and increase the font size, which she found *"really helpful"* (P36 CLRS). Another participant used the NHS app to access their recent medical records during a face-to-face consultation as she found it hard to remember what treatment she had been prescribed previously. She also explained how English was her second language, and the technology enabled her to show the list of medication directly to her doctor: *"I feel embarrassed because, "Oh, why don't I remember? Is it because of the language [barrier]?" And it* *makes me feel stupid sort of thing. [...] [When its] all there and the doctor could just read it, it's a lot better"* (P13 CEARS). One participant who had experience of using video health consultations felt that the technology had enhanced her consultation as she was able to submit a reason for why she needed her appointment in advance and felt the healthcare professional was more prepared for the consultation: *"request[ing] this [video] call and you tell them why [the consultation is needed] so at least, he [the healthcare professional] came on knowing what I wanted to talk about and had access to relevant information. […] It didn't feel rushed at all. […]it was about medication, so we had a good chat about it. So I think it [technology] has its place [in healthcare]"* (P36 CLRS).

However, some raised concerns regarding the limitations of current technologies in certain clinical situations, for example if a physical examination was needed then a video call would not be able to support the consultation.

> "*I told her [a GP] all about it [her neck/ throat pain], she did initially say to me I think it's caused by the muscles […] she then had a good feel around. And then she agreed with what she [initially] said, […] its muscle pain.[…] I felt much more reassured. But if that had been video she wouldn't have been able to feel there and I wouldn't have felt the service was as good"* (P36 CLRS).

Figure 9: Summary of the key themes and subthemes generated from Study 1



Accessing healthcare exclusively via digital means

Issues due to...
- Assumptions everyone has the knowledge, desire and ability to access healthcare digitally.

Recommendations...
- Provide benefits, such as free WiFi, in combination with free communication routes
- Provide non-digital access routes

Using technology for healthcare purposes

Issues due to...
- Low digital literacy resulting in digital anxiety & issues navigating health apps/websites.
- Security barriers preventing use & data security concerns reducing motivation

Recommendations...
- Adopt co-design approaches, ensure compatibility with large font settings & enable audio interactive navigation
- Use facial recognition

Accessing educational support

Issues due to...
- Sharing personal information
- Controlling Behaviour
- Ineffective peer teaching
- Lack of support from healthcare professionals

Recommendations...
- Appropriate advertising & funding for local digital skills classes
- In app/website guidance
- Upskill healthcare professionals

Experiences of DHTs* affecting perceived clinical usefulness

Positive experiences...
- Using DHTs to seek healthcare advice, order repeat prescriptions, and assist consultations encouraged future use of DHTs

Concerns...
- Regarding the use of current technologies (e.g., video call consultations) to support clinical physical examinations

*DHTs: Digital Health Technologies

6.4 Chapter summary

This chapter detailed the barriers experienced by under-served groups living in North East of England when trying to access healthcare exclusively via digital means. Participants suggested possible solutions to overcome these barriers, such as healthcare services providing benefits (e.g., free devices and/or connectivity) and ensuring non-digital access routes are available. The researcher also described the challenges under-served groups experienced when trying to use technology for healthcare purposes due to low digital literacy skills and security issues. To overcome these challenges, participants suggested a co-design approach should be used to ensure technology is designed, developed and implemented in a more inclusive manner. This included changing the design of the technology in various ways to improve the user's ability to navigate the app or website and reduce the use of passwords. Many participants also reflected on issues that can occur when relying on others to assist them in using DHTs and expressed the need for more funding to support existing and future educational support services. Other suggestions were put forward such as implementing video tutorials on NHS apps and websites and upskilling existing staff to provide better digital support to healthcare users. The researcher ended the chapter by describing participants' positive experiences of using DHTs which enhanced their motivation to continue to use it, and the perceived limitation of using DHTs to support clinical physical examinations. The next chapter explores the perspectives of stakeholders on the feasibility of implementing strategies to promote digital inclusion within healthcare (Study 2, objective 4).

Chapter 7: Stakeholders' perspectives on the feasibility of implementing strategies to promote digital inclusivity within healthcare.

7.1 Introduction

In Chapter 5, the researcher described the perspectives of under-served groups living in the North East of England on digital health inequities, strategies they used to overcome such barriers and ways they would like to be supported in the future. To explore the feasibility of implementing different strategies to promote digital health equity in different contexts (e.g., regional/ societal), the researcher conducted a second qualitative study with stakeholders to explore their professional experiences and perspectives on the feasibility of implementing such strategies. This chapter contains a description of the participants and the findings of this second qualitative study. By understanding stakeholders' views on a variety of strategies, the researcher obtained a holistic view of changes that are acceptable and feasible to improve digital health equity.

7.2 Description of participants

Stakeholders in the context of this PhD project are individuals with a professional interest in making decisions and/or delivering/ implementing DHTs or projects/ services to support digital inclusion amongst under-served groups at risk of digital exclusion. Seventeen stakeholders were interviewed between 10th May 2024 and 10th September 2024 to: (1) explore any digital inclusion strategies or DHTs that they have been involved in planning, designing, delivering or implementing, (2) gather their perspectives on strategies suggested by under-served groups (Chapter 6) and/or identified in the literature (Chapter 4) and, (3) understand how well these strategies worked (or did not work) when implemented in practice. Interviews lasted, on average, 50 minutes. Although they were offered the choice between participating in either a semi-structured interview or focus group, all stakeholders chose to take part in a semi-structured interview as the flexibility allowed them to fit this in with their busy work schedules.

Ten participants were female and 7 male. The length of time that participants had worked within a particular professional sector ranged from 1.5 to 32 years (Table 9 and 10). Most participants (n=12) worked within the North East and North Cumbria region, whilst a few worked in Yorkshire (n=2) or Wales (n=3) (Table 10).

Table 9: Summary of professional sectors participants in Study 2 were affiliated with.

Sector	**Description**	**Rational for inclusion in this study**	**Frequency**
North East and North Cumbria Integrated Care Board (ICB)	An NHS organisation responsible for planning health services for the local population of North East and North Cumbria.	Involved in planning and making decisions that can affect health equity of under-served groups across the North East.	2
Digital transformation consultancy groups	Third party organisations hired to support the implementation of new digital technologies and services.	Involved in making decisions and designing health-related software, such as apps and websites, with an aim to support inclusion of digitally excluded groups.	2
Health-related network organisation	Collaborative group of stakeholders coming together to share knowledge, good practice and/ or support the delivery of health services.	Involved in making decisions and delivery of healthcare, typically for a specific population, including different under-served groups.	3
Digital inclusion charities,	Non-for-profit organisations established to support public digital inclusivity.	Deliver activities, such as digital skills training, to support under-served groups at risk of digital exclusion.	3
Local authorities,	Regional councils responsible for a range of public services within a defined area.	Plan and deliver activities, such as digital skills training, to support under-served groups at risk of digital exclusion.	2
Public health agency	An organisation, often at a regional or national level, dedicated to protecting and improving the health of the population	Involved in making decisions about health services and recommendations to use certain health-related software, to support population health.	1
Academia	Institutes in pursuit of research, education, and scholarship.	Specifically focused on academics with a professional interest in under-served groups at risk of digital exclusion and trying to get their research to inform decision making and/or the delivering activities to support digital health equity.	2
Healthcare professional	Provider of health care treatment and advice based on formal training and experience.	Involved in making decisions and delivery of healthcare, for a range of populations including under-served groups.	2

Table 10: Study 2 participant demographics

Participant ID	Gender	Sector	Years experience in sector	Region	Projects, roles & responsibilities (self-reported from professional background questionnaire)	CLEARS****group typically support or deliver services to
1	M*	ICB***	21	North East and North Cumbria	Developed and delivered a wide range of transformational systems and services using Digital Data and Technology to the vast array of consumers that create our regional population.	All CLEARS groups
2	M	Digital transformation consultancy group	28	North East and North Cumbria	Supported the implementation of digital technologies such as new websites, mobile applications, wearables, XR (immersive tech), AI and Robotics.	All CLEARS groups
3	F**	Health-related network organisation	12	North East and North Cumbria	Implemented digital projects from cradle to grave such as hypertension in pregnancy, gestational diabetes, children with type 1 diabetes, care homes, carers, assistive technology for independent living, tech into general practice. Supported user groups and aligned access to support and sim cards so patients could use the device not just for health but also for wellbeing Created a digital champions programme in general practice supporting patients to use tech and the practice to be more engaged.	All CLEARS groups
4	M	Health-related network organisation	7	North East and North Cumbria	Supports the design, development and implementation of websites, Robotic Process Automation and digital pathway systems.	All CLEARS groups
5	F	ICB	32	North East and North Cumbria	Project management office lead for a digital inclusion project in maternity amongst other work streams, providing guidance and support to executives, project managers, and staff.	CLERS
6	F	Health-related network organisation	11	North East and North Cumbria	Support access to diabetes technologies for children and young people living with diabetes.	CERS
7	M	Digital transformation consultancy group	7	Yorkshire	Support teams who will then implement technology, help others use technology or help other access technology.	NA
8	F	Charity	1.5	Yorkshire	Work on projects that try to understand some of the barriers and facilitators to helping people engage with digital services, including digital healthcare and technologies. The wider charity she works for delivers digital inclusion support via a large national network of community-based organisations, who provide face-to-face support to many different communities.	All CLEARS groups
9	M	Academia	5	North East and North Cumbria	Supported others to use various technologies, most prominently accessing web information such as GP websites. Support access and inclusion policy and service design, but this is typically at a very abstract level and not concerning specific individual technologies.	All CLEARS groups

10	F	Public health agency	3	Wales	Conduct research such as scoping reviews to provide evidence for the NHS and Welsh Government regarding digital exclusion and health inequalities.	CEARS
11	M	Local authority	5	North East and North Cumbria	Support individuals by teaching them how to access to their health records, book appointments and order repeat prescriptions on their mobile phones/laptops. The vast majority of these people were new to digital devices in general and needed support with using the device before looking at specifics like access healthcare services online.	All CLEARS groups
12	F	Healthcare professional	2	North East and North Cumbria	Work with vulnerable patients to support them to access healthcare apps (as a social prescriber).	A
13	F	Academia	15	Wales	Research focuses on loneliness and social isolation in later life and since COVID has started to look into Technology-Mediated Communication amongst older adults.	A
14	F	Local authority	3	North East and North Cumbria	Coordinates the Digital Outreach Project that provides free, tailored and flexible digital skills courses and workshops to address digital confidence and challenge digital isolation.	All CLEARS groups
15	M	Charity	5	Wales	Digital Communities Wales - Our focus and aim from April 1st, 2024 – 30th June 2025 is to embed and mainstream digital inclusion within identified thematic areas ensuring ownership of digital inclusion. Our support is free and covers a range of different thematic areas: Health, Social Care, Social Housing, Older People, Ethnic Minority Communities, and Gypsy, Roma, and Traveller Communities. We are here to work with organisations within these thematic areas to support them to embed digital inclusion, ensuring ownership and collective resilience. We know that the best way to reach communities experiencing digital exclusion is to work with the trusted faces and organisations that directly support them. Our support will reflect this as we work with organisations to ensure their staff and volunteers have the necessary skills to support others.	All CLEARS groups
16	F	Healthcare professional	9	North East and North Cumbria	Implemented Badgernet - a maternity electronic paper record which replaced the maternity handheld notes at our Trust. As part of this project, she has developed an equity and inclusion plan for the maternity services, working with non-for-profit organisations in our local community and nationally to allow me to provide service users with data SIMs and mobile devices to access the maternity app Badgernotes.	CERS
17	F	Charity	3	North East and North Cumbria	Deliver two regular drop-in sessions at two North Tyneside libraries for a project called Help Me Be Digital. Help Me Be Digital is a project supported by North Tyneside VODA and NHS North East North Cumbria ICB. The project offers basic one-to-one digital support to residents in North Tyneside to help them feel more digitally included. Help Me Be Digital aims to give digitally excluded residents in North Tyneside some basic digital skills and offer them basic advice and support using their smart devices.	All CLEARS groups

Key: *M = Male
**F= Female
***ICB= Integrated Care Board
****CLEARS: Culture, Limiting condition, Education, Age, Residence, Socioeconomic status

7.3 Qualitative findings

The researcher identified four key themes relating to the feasibility of implementing digital inclusion strategies into healthcare (Table 11, Figure 10). These centred around: 1) the design principles of digital inclusive services, 2) the importance of building a supportive system network across different healthcare organisations and third-party sectors, 3) key considerations relating to the delivery of digital inclusion support, and 4) challenges of adopting strategies and design principles into practice. Across these themes, contextual factors and implementation processes of embedding a digitally inclusion strategy are captured. Themes and subthemes are described below using direct quotations from the transcripts. Participant names have been replaced with their participant identification number and sector they worked in (e.g. P1 ICB= participant who was interviewed first and worked in the integrated care board) to maintain participant confidentiality and provide context to their professional background.

Table 11: Description of the key themes and subthemes identified in Study 2.

Theme	Subtheme	Description
Design principles	User centred design	Involving under-served groups at the very beginning of the DHT design process and at subsequent stages, with various iterations of the digital technology.
	Registration and login processes	Importance of achieving an appropriate balance between security complexity and ease-of-use login and registration systems, such as reducing the amount of documentation needed or making multi-authentication systems easier to use.
	Technological considerations	Designing technology in a manner that requires low technical specifications and low data signal to improve access to under-served populations.
	Considerations for healthcare services and systems	Standardisation of services and systems across the NHS to promote accessibility and provide non-digital access routes to healthcare alongside digital routes.
Building a supportive network across different healthcare organisations and sectors	Collaboration	Opportunities for collaboration, which stakeholders perceived as important (e.g., voluntary sector).
	Challenges of building connections	Difficulties of building strong connections across different organisations.
Key considerations relating to the delivery of digital inclusion support	Repurposing devices	Facilitators and barriers to repurposing pre-used devices for those who do not have devices.
	Supporting access to connectivity	Facilitators and barriers to supporting access to connectivity such as Wi-Fi and data plans.
	Educational digital skills support	Considerations regarding the delivery of educational support to advance an individual's digital literacy skills
Adopting strategies and design principles into practice	Perceived value of adopting digital inclusion strategies and inclusive design principles	Challenges regarding organisations, professionals and under-served groups perceived value of DHTs and/or digital inclusive strategies and design principles, and solutions to increase perceived value.
	Unintended consequences of improving digital inclusion	Concerns regarding the unintended harms of using digital inclusion strategies to support an individual access or use of technologies.
	Awareness of digital inclusion support amongst under-served communities	Different approaches used to increase awareness of digital inclusion support available to under-served groups.

7.3.1 Theme 1: Design principles

7.3.1.1 Importance of user centred design

To ensure any DHT meets the needs of under-served groups, stakeholders recommended involving them at the start of the design stage and throughout subsequent stages, including prototype development because when *"you actually see people testing and you see people using that tool and going, I'm really struggling to find this [...] that's where the power [referring to gained knowledge to improve the DHT] comes from"* (P4 Health-related network organisation). This user involvement supported the development of DHTs that required a very low level of digital literacy (e.g., websites that were easy to navigate and interact with), and avoided reinforcing stereotypes, as older adults sometimes perceived DHTs as: *"ageist because it's somebody else's version of what an older person might want, rather than what they actually need"* (P13 Academia). One participant also described how involving users in the early design stage could help identify useful content, as they reflected on a project which did not engage with users when designing a maternity app, leading to lower than expected engagement as users did not find the content useful; *"scanning appointments don't show in there [the maternity app], which are kind of the ones that most expectant parents are most excited about*" (P7 Digital transformation consultancy group).

Despite an awareness of the benefits of involving users to support the development of a user-centred design, some stakeholders believed that the approach is not adopted effectively within healthcare because the "*people who make decisions in the NHS don't always realise [understand] the people that they're supporting and what that kind of demographic looks like"* (P16 Healthcare professional). To help identify and understand those who are likely to be digitally excluded, a digital inclusion charity recently developed a criteria called the *"Minimum Digital Living Standard"* (P8 Charity), a 'proof of concept' UK benchmark for digital inclusion. One participant described the Minimum Digital Living Standard as: *"the absolute basic requirement to be able to function in today's society essentially in terms of access to digital resources. So [...] if you don't have this [level of access to different devices and connectivity] you're kind of below the minimum living standard, and you are digitally excluded in some* *way"* (P8 Charity). This standard is the first phase in the charities work to develop a framework of minimal digital needs to inform and improve UK digital inclusion policies.

Other participants felt current policies within healthcare can hinder the incorporation of under-served groups views, opinions and perspectives in the design and development of DHTs. One participant described how it is important to find a balance between upholding, informing and reassuring users about the quality of the healthcare service and the ease of use of healthcare websites, but *"there's a bit of a conflict which you have to try and appease between [...] patient demand and the ease of access and ease of use to get the systems [e.g., online booking system], but you've also got certain criteria that as a practice or a public sector [...] CQC [Care Quality Commission] requirements, all those sorts of things. The patient doesn't really care about all of that. They just care about how do I get an appointment? How do I get a prescription?"* (P4 Health-related network organisation).

Some participants described the challenges that they had experienced involving under-served digitally excluded groups into the design and development of DHTs during the COVID-19 pandemic. They reflected on the need to provide *"lots of opportunity to practise getting on to Zoom and so forth"* (P13 Academia) when in-person engagement with researchers was restricted. Not all stakeholders had the time to provide such opportunity and had to seek advice from digital inclusion charities who had experience working with specific under-served groups to find alternative ways of supporting their participants, such as outsourcing the task of teaching them how to use zoom. Others did not have the time, nor financial resources to outsource additional support, so resorted to engaging with community representatives (e.g., staff at community centres) instead of involving under-served groups themselves.

7.3.1.2 Registration and login processes

Participants who supported under-served groups use DHTs described how registration and login processes to access health-related apps and websites need to be simplistic and require minimal personal details from the user. One participant from a charity organisation who provided one-to-one digital support to North Tyneside residents often observed those who attended her support services struggling with the registration process on the NHS app. They provided an example of how this app needed individuals to upload a picture of their photographic identification: *"it [NHS app] needs a driver's licence, you need to be able to take a photo of that. It needs to do a face scan. [...] It feels like a huge thing to be asked okay, we need your date of birth, your NHS number, your this, your that. All these steps and people go oh, it's easier not to"* (P17 Charity). Another participant who had volunteered at a community centre providing digital skills support observed individuals from under-served groups forgetting their passwords when trying to log into their NHS account. This resulted in them writing down the password on a piece of paper and/or telling staff at the community centre all their passwords, which puts the staff members *"in a lot of kind of compromising positions where someone will be handing you like the password for their bank account without you requesting anything remotely like that"* (P9 Academia). A participant who worked within a local authority delivering educational digital skills support via the North Tyneside Employment and Skills Digital Outreach Project described how some login screens would hide the password that had been entered by the user so they could not see what they had put in, without the option of been able to see what had been typed. This resulted in some instances where an individual with a *"disease that would affect their fine motor skills [...] type in what they know their password to be, but they've missed a key [...] they're getting told it's wrong it's incorrect and then you know that breeds frustration"* (P14 Local Authority). One participant explained how the multifactor authentication used to access various accounts, such as emails, was *"a real big problem for them [older adults] because it was switching between the screens. They were like, "I just can't do it. I'll forget where I am""* (P13 Academic). Another participant felt that the use of facial recognition in the future might be able to help overcome these challenges experienced by older adults, explaining *"as our technology improves, [...] especially facial recognition and other things, I think that would be a big advantage to just bypassing that problem we have with people forgetting passwords, or just getting frustrated with the login process"* (P2 Digital transformation consultancy group). However, this requires users to have a compatible smartphone with a working front facing camera and digital literacy skills to use facial recognition. Current policies reinforce the development of overly complex registration processes, as a digital transformation consultant admitted *"we often do implement login frameworks and other things that can be too complex. [...] That's driven by NHS service standards [regarding data security]"* (P2 Digital transformation consultancy group).

7.3.1.3 Technological considerations

Many stakeholders highlighted the importance of considering the minimum technological specification of operating systems needed to use a health-related software, such as an app, on a smartphone. One participant who worked in a children's diabetes network organisation that provided young families with compatible phones to use an NHS diabetes recommended glucose monitoring app, explained how the app required high processing power and was only compatible with the operating systems on the latest, more advanced smartphones. She also explained how with each update to the app, the user would need the latest operating system to support the processing power of the update.

> *"It [the diabetes app] get[s] updated because they have to, to stay safe [referring to data security][...] but as they get updated, the calibre of phone that can hold that update increases and the kind of baseline phone that is needed for this type of equipment is pretty high anyway"* (P6 Health-related network organisation).

As smartphones with greater specifications are more expensive, some participants worried that certain patients may be unable to download and/or use these applications, especially if they did not have access to or could not afford a compatible smartphone. One participant described how it was important that there was a *"spread of life on the application"* (P1 ICB), which he explained as the application being able to work across a variety of devices with different specifications (e.g., operating systems or processing power): *"whatever apps we develop, it's not dependent on the age of the technology [i.e. the technological specification] [...] because the majority of people out there won't have the latest version of everything"* (P1 ICB). However, some stakeholders raised concerns about the level of skill and amount of time required from technology developers to ensure broad compatibility of an app.

Another participant also highlighted how it was important to consider the amount of data signal (i.e., internet connectivity) that was needed to download a health related app as some users from under-served groups might not have access to reliable connectivity and/or cannot afford it, such as those in rural "*parts of Wales, [...][who] aren't able to access broadband or the price is still prohibitive"* (P15 Charity).

7.3.1.4 Considerations for healthcare services and systems

Participants felt it was important to standardise digital services and systems across the NHS to reduce variation in accessibility between healthcare providers. For example, one participant described how they had asked all GP practices within a small region to all use the same website supplier to improve harmonisation between the websites and improve accessibility; *"we shifted all our [Sunderland GP] [web]sites [to a single supplier] which are an average of like 56% [accessibility score] up to like 80-odd % [using an accessibility assessment tool]"* (P4 Health-related network organisation). However, many participants reflected on their own personal experiences where digital services were not standardised across the NHS, with one participant describing how in order to book appointments through the NHS app the GP practice would also need to register with the app to make appointments available, but not all practices are registered; "*personally I want to be able to make GP appointments on the NHS app, [...] I know other people can do it but I can't do it, because my GP surgery hasn't registered for it"* (P8 Charity). One possible reason for a lack of standardisation of digital services is the logistics and man-hours needed, particularly across large regions where there are *"a lot of people to coordinate in the same direction"* (P5 ICB), which can be further complicated by the use of different electronic records, digital systems and vendors (e.g., website suppliers etc) that different healthcare providers use across the UK.

A second key consideration was recognising *"that not everyone can, will or want to interact digitally"* (P1 ICB). One participant highlighted how healthcare providers should be promoting the use of digital access routes due to the benefits they can provide to healthcare systems but felt this should be provided as a choice to patients, with non-digital access routes still being available.

> *"Digital first but not digital only, that there should always be a non-digital pathway, and that those options should be openly explored. (...) There should always be space for some discussion about, "How would you like to access the service?*" (P8 Charity).

One participant involved in providing digitally excluded groups with support using DHTs described how providing only a single digital option "*frighten[s] people into feeling they have to be online [...]*

that immediately rubs up people the wrong way" (P17 Charity) and may result in them not using the healthcare service. By taking a *"digital first but not digital only"* (P8 Charity) approach, another participant described how you could potentially ease capacity on some healthcare services as those who can use the digital access route could seek health advice and information online (e.g., websites), which could hypothetically provide healthcare professionals more time to spend with those who cannot access digital routes.

> "*Push[ing] as many patients to use digital who can, it frees up [time] for the patients who can't [use digital services] but who also need to be seen [by a healthcare professional]. So, your frail person now gets a 20 minute appointment instead of a 10 minute appointment because we've created the time to do that*" (P3 Health-related network organisation).

To support the adoption of these design principles (i.e., user involvement to develop user-centred designs, user-friendly login and registration processes, consideration for technical specifications and providing non-digital access) in practise, some stakeholders suggested "*developing tools to help people to design more digitally inclusive and accessible health services […] kind of, a checklist essentially […] what does a good digital health service look like"* (P8 Charity). However, an academic highlighted how *"we have fantastic [website accessibility] standards for this, if only they were followed"* (P9 Academia), questioning if creating more guidelines to improve digital inclusivity will be effective.

7.3.2 Theme 2: Building a supportive network

7.3.2.1 Collaboration

Many stakeholders recognised the importance of collaborating with various organisations, such as VCSE groups (e.g., digital inclusion charities) and technology developers, to build a supportive network to aid the delivery of a digital inclusion strategy. One participant described how it was beneficial to "*raise that awareness [of digital exclusion] and build that capacity [to support under-served groups] within organisations"* (P15 Charity). Stakeholders recommended raising awareness through webinars and regional networks to share learnings (e.g., how to engage with certain population groups, reflections on past and current digital inclusion projects) across organisations, including healthcare, VCSE groups and local authorities. Capacity building within organisations supporting under-served groups was often discussed in terms of increasing resources, such as obtaining compatible devices to give to digitally excluded individuals, distributing the devices, and/or one organisation providing services that another organisation cannot provide due to pragmatic (e.g., funding) or technical skill constraints. For example, one participant described a situation where there were smartphones that had been donated to a diabetes network to then be distributed to patients in need of a device, but the smartphones were not compatible (in terms of the operating system and processing power) to support the use of a diabetes app, so they spoke to the app developers to explore the possibility of making the smartphone model compatible. Originally, it *"wasn't a priority [for the diabetes software company to make the app compatible with the phone model, however], because we had about 300 of them and this was going to change the lives of potentially a few hundred people, they bumped it up the list and then they made these phones compatible"* (P6 Health-related network organisation).

Other participants mentioned how they would like to see more signposting from healthcare providers to VCSE organisations that deliver digital inclusivity support (e.g., education digital skills classes, providing repurposed devices etc.,), to reduce the burden on healthcare systems. Furthermore, VCSEs (e.g., staff at community centres) "*already have trusted relationships with people who feel safe and comfortable to kind of seek help and support [from them] for various other things within their lives [referring to support for things such as registering for government benefits and finding employment]"* (P7 Digital transformation consultancy group). One participant felt it was important to explore *"how we map out some of those services"* (P3 Health-related network organisation) that offer digital inclusion support in different geographical regions to support signposting to the services. However, this participant also described how mapping out these services could be a difficult task to maintain as "*it's [the database containing all the services offering digital inclusion support] only as good as the people who've entered the information to say we have this"* (P3 Health-related network organisation). Another participant explained how maintaining such a database of services would require *"a funded position* *where someone can actually manage it for a given region, possibly multiple people based on the labour involved"* (P9 Academia) to keep the database updated with local changes in the services available.

7.3.2.2 Challenges of building connections

Building connections between different stakeholder organisations was challenging, with one participant describing how their charity had: *"a team of advisors, who lead on a lot of the relationships with organisations"* (P15 Charity). Another participant who also worked at a different charity explained how it was difficult to identify the right person to contact at an organisation and it can take time to build these connections: *"getting that first foot in the door of a different organisation and getting that connection with somebody (...) these things take a long time, it takes quite a few conversations"* (P8 Charity). Once these connections had been made, another participant found that different NHS trusts can work differently and an agreed work practice would need to be put in place: *"every Trust works differently, [...] [they] have different contracts and different audit times. So we've got to unpick all of that [to reach agreed working practices]"* (P3 Health-related network organisation). Furthermore, one participant reflected on his time working at a local community centre providing local residents with educational digital skills support, and observed the difficulties of small VCSE organisations to meet the standards and bureaucracy required to collaborate with the NHS to support the signposting of digital inclusion support.

> *"The NHS for understandable reasons, if they're going to refer people to a third sector organisation [to receive digital inclusion support or wider social care support], they want them to have done safeguarding training and have an emergency plan in place and all this stuff to an NHS standard. If these organisations were to achieve that level of bureaucratic sophistication they would be doing nothing else. They don't have the resources [staff] to achieve that"* (P9 Academia).

Another participant described an additional challenge that their local authority faced when trying to expand an educational digital support service they offer to North Tyneside residence to neighbouring regions, but neighbouring regions' local authorities were unwilling to let them deliver such services "*on their turf, [...] [even though] they didn't offer anything similar themselves*" (P14 Local authority).

7.3.3 Theme 3: Key considerations when implementing strategies

7.3.3.1 Repurposing devices

Many stakeholders were involved in various strategies that distributed pre-used devices such as smartphones, electronic tablets, chromebooks, and/or laptops to those who needed them. Participants described four key steps to implementing a device repurposing strategy in their different organisations, which included: 1) acquiring and 2) preparing devices, 3) identifying individuals in need and 4) distributing devices. Two charities purchased pre-owned and new devices, whilst other charities and health network organisations relied on donations from businesses and healthcare providers who replace their technologies on a three or five-year cycle to minimise data security threats. To facilitate the agreement of healthcare providers to donate their old devices (e.g., smartphones) instead of recycling them, one stakeholder described waiting until the NHS trust was at a time where existing contracts with device recycling companies were coming to an end and the trust was *"in a situation where they were kind of tweaking their contracts that they had with their [...] device disposal company that they were currently using, [...] [and] they agreed to trial this idea of donating the mobile phones"* (P6 Health-related network organisation). This participant explained how some decision makers in the NHS trust were initially hesitant about donating their devices because when the devices go to the disposal company to be recycled, they "*sell it [used technology] off for parts or whatever, and there's a 10% return or something [to the NHS trust]. And so that's an income for the trust. So we're potentially asking them to forfeit some of that income"* (P6 Health-related network organisation). The participant was not sure what swayed the final decision to trial donating the devices.

Once pre-used devices were acquired, they needed to be prepared for further use. However, it was found that not all pre-used phones could be repurposed. Participants explained how some devices were not compatible with a health-related software (e.g., the diabetes application mentioned previously), were unrepairable (e.g., water damage) or needed repairs (e.g. broken screen), resulting in organisations often struggling to receive enough donated devices that are suitable for repurposing.

> *"We don't have enough [donated devices] coming in, and that refurbishing and refreshing process doesn't happen as quickly as we would want it to because it takes a long time. And also the amount that we can send out the door isn't as high as the amount coming in"* (P8 Charity).

Many participants from charities and organisations involved in device repurposing strategies described how the '*refurbishing and refreshing process'* of devices takes time as all devices needed to go through a data cleaning process to: *"ensure that anything on the phone has gone. [...] It gives the hospital trusts [donating the devices] in particular the reassurance"* (P6 Health-related network organisation). This process ensured that any patient data has been completely removed from the device. However, the '*refurbishing and refreshing process'* of devices raises financial considers for the organisations (e.g., VCSE organisations) repurposing the devices. Participants described costs associated with *"shipping them [devices] out to third sector intermediary organisations [to wipe data from the devices]"* (P9 Academia), service charges from third parties for wiping the device*, "buying charging wires because the device often comes and it doesn't have a charger"* (P3 Health-related network organisation), and staff time to oversee this process.

Once the devices had been prepared, individuals in need were identified. For example, healthcare professionals involved in a digital inclusion maternity project described how they changed their practice when meeting new patients in their clinic. They would ask any new patient as *"a normal part of a conversation, just as we'd say, Are you okay? Are you alright for devices?"* (P5 ICB) to support the identification of those who need a repurposed device. However, another participant reflected on how some patients might have worried about accepting a device, as it could have been perceived as vulnerable: *"people don't want to admit that they don't have the money or whatever, and I think that because we're clinicians and we're midwives and they're having a baby, I think they'd be worried to admit it in case there's like a bit of a taboo over are you going to take my baby off me*" (P16 Healthcare professional). Individuals who were identified as needing a device were often given one as a gift. One participant described how this was the preferred way, as giving the devices out on loan created the need for a loan agreement to be put in place. This overwhelmed and frightened some recipients; *"when someone is in this very vulnerable position, you're handing them this big scary loan agreement and then they'll just say no because [...], it could be expense, but also time, [and] attention"* (P9 Academia) required to learn how to use the device. Furthermore, giving the device out on loan placed greater liability on the organisation who owned the device *"because loaning means that you still hold responsibility for that device, whether it be the maintenance of it, [or] keeping it updated"* (P7 Digital transformation consultancy group). Gifting the device to an individual was a much more accepted approach as it is *"theirs [recipients] to keep. There's no liability back [to the organisation], it's being donated to them, no different to them going on Amazon [to buy a device if they had the financial resources to do so]"* (P3 Health-related network organisation).

Regardless of how the devices were distributed, some participants highlighted their concerns around the inappropriate use of a repurposed device, including the potential risk that *"people who will then go and sell it on eBay because they need to have, whatever addiction they've got"* (P3 Health-related network organisation). This participant described how they had fitted security systems into the repurposed devices they gave to under-served groups, so in the event of a device going missing or being sold, the organisation was able to 'wipe' the device; *"Mobile Device Management Systems [was installed on devices] so we could track them [the device], we could wipe them if they went missing or the device was sold, so the patient's data was protected"* (P3 Health-related network organisation). This provided reassurance for the organisation in terms of data security. Another participant explained how when they receive a case of a device being reported as lost, stolen or damaged they reviewed individual's situations on a case-by-case basis, taking into consideration the desired purpose of providing the device (e.g., to allow the individual to use a diabetes app); if the device is *"having a massive quality of life outcomes and health outcomes and they're really engaging with it and then they're using it and it's just unfortunate that they've broken a couple or they've lost a couple, then obviously we need to replace it"* (P6 Health-related network organisation). However, in situations where *"the device* *isn't[wasn't] being used particularly well and they've lost two, maybe it just isn't for them"* (P6 Health-related network organisation).

After devices were sent to under-served digitally excluded individuals, issues arose when individuals did not have the digital literacy skills to confidently use the repurposed smartphone, nor download and use a diabetes app that the repurposed smartphone was primarily given for. This led the provider of the repurposed devices (in this case, a diabetes network organisation) receiving a high number of phone calls from recipients asking for support on how to use the smartphone and diabetes app. The diabetes network organisation decided to create and information pack to help guide recipients on how to use the smartphone and app, as well as signposting them to appropriate support (e.g., if they are having difficulty with the app they could call the app developers for support, if it was an issue with the device itself they could call an individual within the diabetes network).

> *"We kept getting a lot of calls initially [...] about that kind of thing [trouble shooting issues with repurposed devices] and it was like we can't manage this number of calls, so we kind of created a pack that was like a step-by-step guide: if this is the problem phone this person, if this is the problem phone that person. So that helped a lot"* (P6 Health-related network organisation).

7.3.3.2 Supporting access to connectivity

A previous government election manifesto had promised to support access to connectivity: *"universal broadband in the UK was first promised in a manifesto by Tony Blair the first time"* (P9 academic). Many local councils and charities have also tried to increase individuals access to connectivity by providing *"things like data cards, [and] free Wi-Fi access"* (P3 Health-related network organisation). For example, one participant who worked for a health-related network organisation described how the local council in Sunderland (a deprived region in the North East) had implemented a low broadband system across the city centre to provide residence and those visiting the city access to the internet: "*you can't watch Netflix or anything like that [using the free broadband] [...][but it helps to ensure] that* *we're not marginalising people because of their income levels"* (P3 Health-related network organisation).

Many stakeholders from charity organisations and health-related networks described their experience of being involved in projects where SIM cards with a pre-paid data plan were provided to those struggling to afford broadband or data on their existing phone plan. The SIM cards were acquired from a digital inclusion charity, The Good Things Foundation National Data Bank, who received them via *"donations from O2, Vodafone and from Three"* (P8 Charity). Stakeholders at the charity or health-related network organisation providing SIM cards to digitally excluded individuals often helped to administer and set up the SIM cards on the individuals phone, and reflected on how the different regulations and processes each phone company operate on can complicate the process, with one participant describing how the *"three different SIM cards operate in slightly different ways. [...] The Vodafone ones apparently are the most straightforward to administer, but when they tried to do the O2 ones and it's slightly different, and the people they're supporting find it more complicated to understand"* (P8 Charity). Complications were often related to a lack of clarity "*whether somebody has to change their number to be able to use it [the SIM card]"* (P8 Charity), and recipients of the SIM cards, particularly those *"whom English is not their first language, find it particularly difficult to understand, "What am I supposed to do each month?" [despite the support and guidance provided]. [...][as] they'll get [an automated] text messages from the provider saying, "Top up now," when they don't need to top up because they've got free data"* (P8 Charity).

Many stakeholders questioned the suitability of this strategy for some under-served groups. For example, those with low digital literacy skills who lack the knowledge on how much data certain digital tasks use, as the data plans on the SIM cards were often limited between 40-60GB, and those with poor digital literacy skills often reached their data limit very quickly. Other individuals needed assistance with inserting a SIM card into a device as they were unsure on how to do this or were unable to do this due to a physical disability, such as fine motor control issues or visual impairment(s). Some digitally excluded groups may also be excluded from receiving such support due to the eligibility criteria put in place by The Good Things Foundation National Data Bank, as a healthcare professional who worked in a maternity digital inclusion project described how individuals under 18 years old were ineligible to receive a pre-paid SIM card:

> "*The problem with the National Data Bank, […] is that to qualify for a SIM card you have to be over the age of 18. It just takes a little bit of ownership away from that woman, and if she's a young person and she's having a baby and she's starting a family, she should be able to get access to her data just the same as somebody who's over the age of 18*" (P16 Healthcare professional).

7.3.3.3 Educational digital skills support

The final digital inclusion strategy discussed by stakeholders was the implementation of educational digital skills support for both end-users and the staff providing the DHT (e.g., healthcare professionals). It was noted how some healthcare staff did not feel confident in using new software and have a *"fear of using it [new DHTs, such as electronic patient records or a new maternity app] and I suppose, in a work context, the fear if you mess up [for example, inputting incorrect information about a patient on the DHT] you might not have your job"* (P13 Academia) if the error resulted in harm to a patient. The stakeholder further highlighted how the healthcare professionals who feared the use of new software *"were really competent carers, they know what they're doing, but if you put a bit of tech in front of them it's like, no, I can't do that"* (P13 Academia). It was common for under-served digitally excluded groups to hold similar fears towards technology as "*they will say 'I am scared to use it [their smartphone given to them by a family member], I don't want to break it' […] they feel anxious because they don't know how to use it"* (P12 Healthcare professional) as they have not been given any guidance on how to use the device. Under-served digitally excluded groups that attended educational digital skills support from VCSE organisations often mentioned in their first training session that they felt *"embarrassed, [and] […] ashamed that they don't know how to do it, or feel like they're so far gone [in terms of very low digital literacy skills] that they don't know where to start [to build their digital literacy skills]"* (P17 Charity). To support those with digital anxiety, stakeholders felt it was vital to promote confidence building during educational digital skills support services as they observed some under-served individuals *"won't touch it [a device] unless they're in the sessions [educational digital skills classes]* *with me for a while. So, they won't do anything at home because they're scared they're going to break it"* (P11 Local authority).

To encourage engagement during educational digital support services, stakeholders followed a tailored approach, allowing the individual to discuss the topic(s) they would like to work on to help generate initial interest *"and then once you've got that foundation you can start building on the more pragmatic day-to-day life skills [e.g., keeping safe online]"* (P14 Local authority). An individual's capacity to learn certain digital skills was also considered when tailoring educational digital skills support to ensure expectations were clear, appropriate content was delivered, and frustration was minimised, especially for those with learning disabilities or have a low educational attainment. One healthcare professional who worked in a maternity ward explained what types of skills patients often lacked and should be covered in educational digital skills classes, this included: "*how to turn your device on, how to access the internet, how to create an email address, how to download an app, navigation around the app"* (P16 Healthcare professional). Another participant who worked for a charity who provided educational digital skills support described how *"one of the biggest challenges that we help people with is email attachments. How do I send a picture? How do I send a file"* (P17 Charity). Participants who provide educational digital skills services mentioned how they often have to explain to under-served groups what different icons mean, technical terminology such as 'cookies' and 'megabyte', and how to access settings on a device to carry out actions, such as increasing the font size. Stakeholders recognised the need to offer multiple digital skills classes, as one participant highlighted how: *"a one-off class isn't gonna develop those skills, those skills are the product of a lifetime of practice and reinforcement and confidence building"* (P9 Academia). In addition to these skills, many stakeholders highlighted the importance of teaching under-served groups about online safety and data protection. One participant who delivered an educational digital skills support service mentioned how some students described being scammed in the past, and they requested learning about how to spot a scam and identify the legitimacy of a website. As a result, this stakeholder covered online security within his teaching sessions, using an analogy to describe the importance of having different passwords for different accounts and keeping these passwords confidential.

> *"[I use] a keys analogy for your [online] password. Treat your password as like you treat your keys. You don't give them out to people. And in an ideal world, your front door key is different to your back door key, which is different to your car, your shed, your bike lock. So, your password should be different for everything. […] You wouldn't just give your house keys to a stranger"* (P11 Local Authority).

These educational digital skills support services for under-served groups were delivered by VCSE organisations, local authority members working on a digital outreach project, and a healthcare professional (a social prescriber, P12), in various in-person settings including an individual's home, community centres in low income and high unemployment rate areas, homeless shelters and retirement homes. One participant who worked for a local authority and provided educational digital skill support to under-served groups during the covid-19 pandemic, reflected on the challenges of supporting individuals with low digital literacy skills remotely (via Microsoft Teams). He often had to talk them through how to join Teams via a phone call and some individuals found it difficult to accurately describe what was on their computer/ laptop screen, making it difficult for him to guide the individual.

> *"It's really hard to teach people how to use a computer through a computer. […] The first hurdle was just getting them on Teams. So, it was quite common for me to ring the learner through their phone and try and talk them through steps to join. Which worked a lot of the time, but then if it's someone completely new [to technology] and you're trying to describe where things are on the screen and they're trying to describe what they can see in front of them to you, it is tricky"* (P11 Local authority).

Participants discussed who should be responsible for delivering educational digital skills support in the future to further advance digital health equity. It was agreed that relying on an individual's close social network was not the best option as *"we get a lot of people who really feel like they can't ask [their families] for help because people are really impatient with them or they're embarrassed"* (P17 Charity). Various alternatives were discussed including university students on a volunteer basis, and healthcare admin staff such as *"doctor's surgery receptionists or hospital receptionists, things like that are better placed to support people with their digital skills [than medical healthcare professionals, such as GPs]"*

(P14 Local authority). However, this is based on the assumptions that healthcare admin staff have more time than medical healthcare professionals, and they have the necessary skills to support digitally excluded individuals. Some stakeholders felt a paid job position was needed to provide sufficient digital inclusion support to under-served groups, such as having a "*digital champion in each practice and each hospital [to support patients], […] almost like they have a carers champion […] [and]to also highlight and support those who are vulnerable because they are digitally excluded"* (P12 Healthcare professional). Currently, VCSE organisations are typically the ones responsible for delivering educational digital skills support services but find their scalability to deliver such services to different under-served groups (e.g., those who are not fluent in English) is hindered by the limited number of available staff with the required skills. For example, a participant at a small charity providing educational digital skills support reflected on having to use Google translate to facilitate a conversation with an under-served digitally excluded individual who did not speak English, as the charity did not have any staff who spoke the same language as the individual.

> "*It was a huge challenge when you've got two people who don't speak the same language trying to use a device together. […] We used Google Translate, that kind of thing. We sort of got somewhere at the end"* (P17 Charity).

7.3.4 Theme 4: Adopting strategies and design principles

7.3.4.1 The perceived value of adopting digital inclusion strategies and inclusive design principles

Participants often reflected on a lower-than-expected adoption of the digital inclusion strategies and design principles (described in previous themes) amongst healthcare professionals and healthcare decision makers. One participant who worked for a health-related network organisation perceived healthcare professionals and healthcare decision makers as extremely busy, and felt that those tasked with maintaining and updating their practise website did not prioritise this task as they perceived the value of ensuring accessibility of their website was low compared to other work tasks.

> *"It's [referring to maintaining their practise website] kind of down the list [of important things to do] and not looking at it as a tool to enhance what they've got. They're almost thinking, oh, it's another thing for me to do and think about, particularly in relation to practice websites and that sort of side of stuff"* (P4 Health-related network organisation).

The same participant reflected on a project where they had offered to pay for GP practices websites for the duration of a project, to explore the use of applying the same website supplier (chosen due to their awareness of accessibility features) across all GP practises within a given region (Sunderland) to try to improve accessibility standards across their websites.

> *"Pay[ing] for [GP] practice websites for the duration of the project and that was a really good enabler to help people come on board with the project and actually then [...] we've proved the benefits of having the websites to a standard [in terms of accessibility]"* (P4 Health-related network organisation).

Participants also highlighted the importance of evaluating the effectiveness of digital inclusion strategies and design principles to help demonstrate the value of adopting them, and suggested that this evaluation should comprise of two key aspects. The first is to understand the *"effect [the strategy or design principle is having] on how services are being designed to make them more digitally accessible"* (P8 Charity), with clear examples of how the needs of under-served groups have been met. This could include evidence of how their content on health-related websites and DHTs, such as information about a healthcare service or health advice, has been *"written in a culturally appropriate way"* (P9 Academic). Secondly, the evaluation should explore the "*effect that's [digital inclusion strategy or design principle] is having on people's health"* (P8 Charity), and concrete health outcomes as current evaluations typically only focus on *"how many more people have devices or how much they have improved their access to the Internet but [...] because we are Public Health Wales, we are interested obviously in health and wellbeing"* (P10 Public health agency). Various methods to measure the outcomes for such evaluation were discussed, with some stakeholders suggesting the use of a longitudinal questionnaire to assess the direct impact a strategy or design principle is having on an individual's health or other aspects of their life over time. However, some participants cautioned against asking digitally excluded individuals to do too much, as they perceived a risk of overburdening them. An alternative approach suggested by one participant was to speak to *"people on the ground [e.g., VCSE staff who] have a really good qualitative understanding that what they're doing is helping"* (P9 Academic), and to avoid the use of quantitative approaches as he felt this would not provide an holistic evaluation of the strategy and instead "*what you end up doing is measuring how many laptops you've handed out to gather dust in someone's cupboard"* (P9 Academic).

One participant highlighted how limited resources available to deliver digital inclusion strategies is a major challenge to evaluating these strategies. Organisations often have to prioritise obtaining enough repurposed devices and/or staff to provide digital skills support to under-served groups, over conducting any evaluation of the strategy: *"resources are limited and you know they cannot spend a lot time evaluating things [digital inclusion strategies] when they need to be giving devices"* (P10 Public health agency).

7.3.4.2 Unintended consequences of improving digital inclusion

Participants described organisational concerns that were often raised by decision makers, and they had to navigate to gain approvals to implement the delivery of repurposed devices to under-served digitally excluded groups. These concerns centred around the unintended harms that the introduction of an internet enable device may have on an individual's mental wellbeing. One participant who worked for a health-related network organisation described an example of providing a DHT to a diabetic patient which monitored their blood glucose levels every minute can overwhelm the patient with too much information about their health: *"it's very intense using diabetes technology. You get a lot of data, the sensors are reading the blood glucose like every minute, [...] it's overwhelming. [...]it can lead to health burnout, but it can also lead to mental health issues"* (P6 Health-related network organisation). Another participant who had previously collaborated with addiction support services also mentioned how an individual's existing mental health may be harmed by providing access to an internet enabled device which may allow access to sites they are not allowed access to (e.g., gambling websites), and explained how addiction services "*have to be very careful to make sure that they're not encouraging things that could be detrimental to people, such as providing access to the internet, and therefore online gambling*" (P7 Digital transformation consultancy group). Despite these concerns, all participants agreed that individuals who received repurposed internet enabled devices should be able to use them for legal non-healthcare related things that do not cause harm to themselves or others, e.g., using social media to communicate with family and friends; *"if you're giving somebody a mobile phone, you can't then expect them not to use it for other [non-healthcare related] things"* (P6 Health-related network organisation).

7.3.4.3 Awareness of digital inclusion support amongst under-served communities

Participants involved in providing educational digital skills services, repurposed devices and/or pre-paid SIM cards to under-served digitally excluded communities often reflected on the lower-than-expected uptake of these services amongst under-served groups. Some participants highlighted how this may be due to a lack of awareness of how the digital inclusion services (e.g., educational digital skills support, free devices and SIM cards) can benefit them in terms of access to healthcare, and how more needs to be done to advertise "*those real-world impacts and the real-world benefit [DHTs can provide] to them*" (P14 Local Authority), such as using the NHS app to order-repeat prescriptions. One participant highlighted another potential contributing factor to the lower-than-expected uptake, describing how attending educational digital skills support services may not be a priority for some individuals from under-served groups as their focus may be on maintaining their basic needs, such as access to food, water and shelter: *"so many other things that they need to think about to be in a position where they can go, right I can think about that [using technology] now. […] It's just nowhere near the top of their priority list"* (P7 Digital transformation consultancy group). A healthcare professional also mentioned how there is little awareness amongst under-served communities of the digital inclusion support available, as it was common for her patients struggling to access internet connectivity to mention how they "*don't think that there's anything that we can offer them [to support their access to the internet]*" (P16 Healthcare professional).

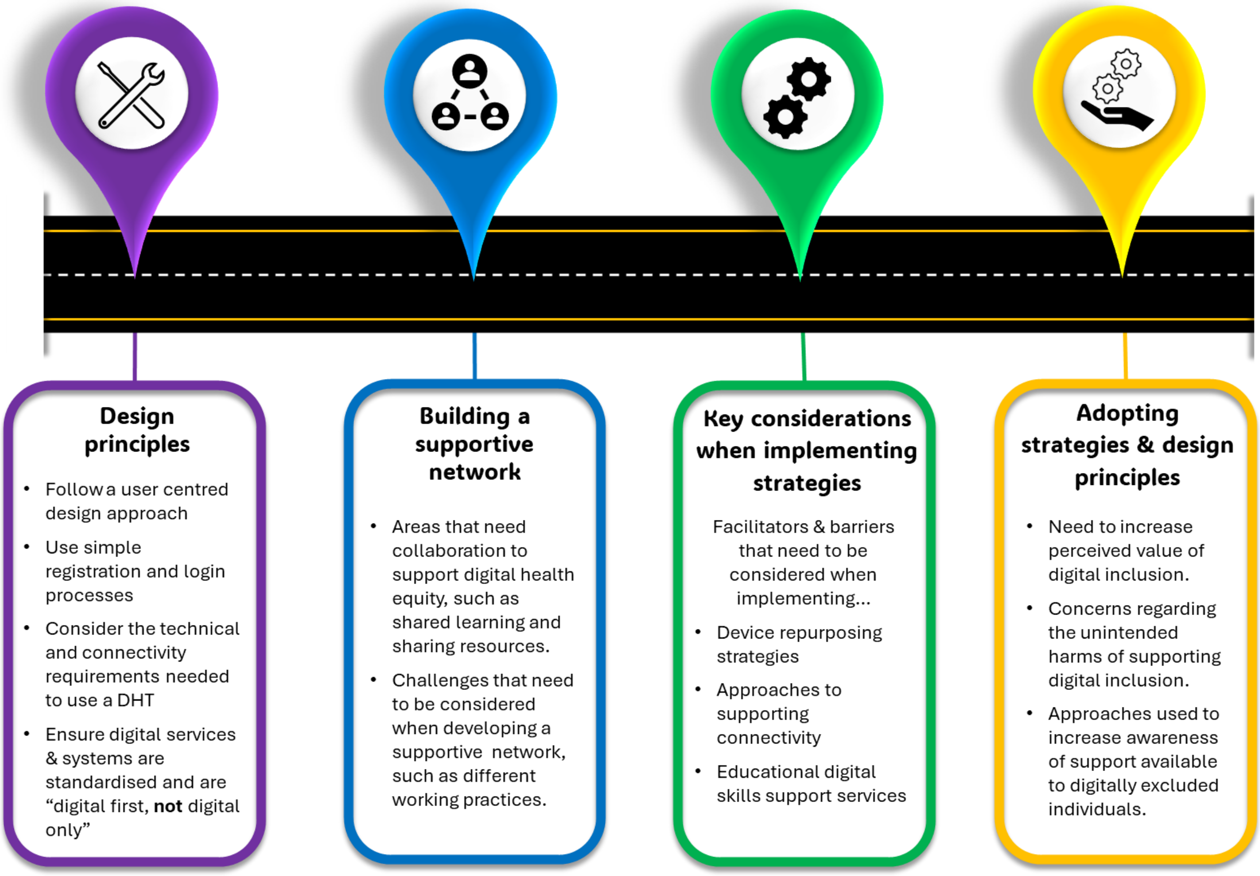
A wide range of approaches were used by participants to raise awareness of available digital inclusion support, with some being more effective than others. One participant reflected on the ineffectiveness of using digital online advertising approaches (e.g., a post on social media) to directly target individuals who may need educational digital skills support, as "*the people that wanted the help were the people that weren't online. [...] So, it was hard to actually find the people [who were digitally excluded]"* (P11 Local authority). This participant also described using a different approach (e.g., posting leaflets to households in the local area) and the low number of people who signed up for educational digital skills services: *"a leaflet drop [...] it went to like thousands and thousands of houses. And I think we had three people sign up [for his digital skills class through this approach]"* (P11 Local authority). He perceived the most effective approach to raise awareness of the service and get more people attending his educational digital skills services was to collaborate with different organisations within the local area, such as community hubs ran by the local council that provides various support services to local residence (e.g., employability skills), where staff at such organisations would signpost those struggling with digital skills to his educational digital skills services.

> *"One of the main ways I get people now is referrals from that [community hub]. So, people will go in [the community hub] and ask about, help with employability and the employment team there will see how their IT skills are and if they need a bit of support with IT, [...] they'll then forward on the [contact] details [of the resident with low digital literacy skills] to me"* (P11 Local authority).

Once the digitally excluded community has been identified *"word of mouth [was an effective advertising approach]"* (P11 Local authority). Advertising digitally inclusive strategies through mass media sources and posters in public areas was also discussed by a few stakeholders, who recommended that particular care should be given to the wording and framing of these advertisements to avoid contributing to ageist stereotypes:

> *"It's almost like a self-fulfilling prophecy that they [older adults] were limiting themselves because of that more dominant narrative. […] "The Daily Mail says I can't use tech, so obviously I can't. It's too complicated for me because I'm over 50""* (P13 Academia).

Figure 10: Summary of the key themes and subthemes identified in Study 2



Design principles

- Follow a user centred design approach
- Use simple registration and login processes
- Consider the technical and connectivity requirements needed to use a DHT
- Ensure digital services & systems are standardised and are "digital first, **not** digital only"

Building a supportive network

- Areas that need collaboration to support digital health equity, such as shared learning and sharing resources.
- Challenges that need to be considered when developing a supportive network, such as different working practices.

Key considerations when implementing strategies

Facilitators & barriers that need to be considered when implementing...

- Device repurposing strategies
- Approaches to supporting connectivity
- Educational digital skills support services

Adopting strategies & design principles

- Need to increase perceived value of digital inclusion.
- Concerns regarding the unintended harms of supporting digital inclusion.
- Approaches used to increase awareness of support available to digitally excluded individuals.

7.4 Chapter summary

This chapter provided stakeholders' insights into the feasibility of implementing strategies that are currently being put into practice, those suggested by individuals from under-served groups in Chapter 6 and the wider literature (Chapter 4). This included discussions regarding the need to consider digitally inclusive design principles when designing and developing DHTs, the importance of cross organisational collaboration as well as the barriers that may hinder collaboration, and the unique facilitators and barriers to implementing specific strategies to support digital inclusion within healthcare. This chapter also discussed the factors that affected the adoption of such digital inclusion practises within healthcare, such as healthcare professionals and healthcare decision makers perceived value of digital inclusion strategies, concerns regarding the unintended consequences of providing access to internet enabled devices and DHTs, and the public awareness of the digital inclusion support available.

The next chapter discusses the key findings of this PhD project (Chapters 3, 4, 6 and 7) within the context of the wider literature and outlines a set of eight practical recommendations that a variety of stakeholders, such as researchers, VCSE organisations, regulatory bodies and healthcare professionals, can use to advance digital health equity for under-served groups at risk of digital exclusion. The strengths and weaknesses of this PhD project are also described, followed by reflections on how the researchers' characteristics may have influenced the project, and the strategies used to minimise such influences. The researcher ends the final chapter with suggested areas for future research, and a concluding statement summarising this PhD programme of work.

Chapter 8: Discussion and recommendations to advance digital health equity

8.1 Introduction

The aim of this PhD programme of work was to identify those most at risk of digital exclusion within healthcare and qualitatively explore strategies to promote digital health equity. To fulfil this aim, the researcher conducted a scoping review to identify the sociodemographic factors that could put an individual at risk of digital exclusion within healthcare (Chapter 3). These factors were compiled into six groups to form the CLEARS (Cultural factors, Limiting conditions (visual and/or hearing impairments), low Educational attainment, area of Residence (rural, deprived or homeless), low Socioeconomic status) framework, which also acknowledged the role of intersectionality in exacerbating digital exclusion. To provide an understanding of the key strategies currently used to promote digital inclusion amongst CLEARS groups, the researcher then conducted a systematic review and narrative synthesis of 10 qualitative studies exploring digital inclusion strategies (Chapter 4). This review highlighted the importance of using user-friendly designs, implementing a supportive infrastructure (e.g., providing free devices, free connectivity, and non-digital access routes to healthcare), and providing digital educational support. However, the feasibility of implementing these strategies in different contexts (i.e., social situations) was unclear and whether more work was needed to adjust or improve them.

To address this knowledge gap, the researcher sought the perspectives of individuals who represent the CLEARS groups on these specific digital inclusion strategies (Chapter 5-6). However, there are recognised challenges to the recruitment of under-served groups into research due to various individual (e.g., lack of trust in researchers) and system level (e.g., ethical procedures) barriers. To overcome these barriers, the researcher used an inclusive multistep community engagement recruitment approach, which emphasised building rapport with gatekeepers and potential participants (Chapter 5). This supported recruitment of 29 participants into a qualitative study (Chapter 6), with 28 participants representing at least two CLEARS groups. The qualitative study used interviews and focus groups to explore participants' experiences of digital exclusion within healthcare, and their perspectives of strategies to support digital inclusion. Four key themes were identified and described in detail in Chapter 6. The first theme, accessing healthcare services exclusively via digital means, discussed the challenges participants experienced when healthcare services was only accessible via digital routes (e.g., only being able to book a GP appointment via an online booking system or phone call). Participants felt healthcare providers should provide benefits (e.g., free devices or connectivity via pre-paid SIM cards) and ensure a non-digital option is always available to support their inclusion. The second theme describes the challenges under-served groups experienced when using DHTs, such as struggling to navigate health related apps and websites, and the barriers presented by security features (e.g., recalling passwords to log in to online health accounts). To aid the use of DHTs to access healthcare services, the third theme (accessing educational support) revealed how many participants relied on their close social networks (e.g., family, friends, neighbours) to complete health related digital tasks, which had the potential to contribute to other issues, such as controlling behaviours from partners. Participants who attended educational digital skills classes within their local community found the tailored classes useful but reflected on the lack of awareness of this available support within their community. Finally, the researcher highlighted a theme around participants perceived usefulness of DHTs. Having positive prior experiences using DHTs increased motivation to use DHTs in the future, however many participants had concerns regarding the usefulness of current technologies (e.g., video consultations) to support physical medical examinations.

A further qualitative study was then conducted to gain further insight into the wider societal context (e.g., organisational and community levels, and political and regulatory aspects), that may influence the feasibility of implementing digital inclusion strategies. The researcher interviewed 17 stakeholders including commissioners of healthcare services, digital transformation experts and VCSE organisations (Chapter 7). Interviews explored their professional experiences and perspectives towards implementing various digital inclusion strategies. Four key themes were identified. The first highlighted the importance of following key design principles, which included: involving end-users in the design and development process of DHTs and healthcare systems, ensuring registration and login processes are user friendly, considering the technical capability (e.g., operating systems) of a device needed to support the use of a DHT, and ensuring digital healthcare systems are standardised and non-digital access routes are always available. Secondly the researcher identified the benefits of building a supportive system network across different healthcare organisations and third-party sectors. This helped to ensure enough resources (e.g., devices and staff) were available to deliver digital inclusion support to under-served communities. The third theme described key practical considerations when delivering digital inclusion support, such as implementing risk mitigation strategies to protect patient data if a provided device was stolen/lost. The final theme revealed the challenges of adopting digital inclusion strategies into practice, such as the barriers to demonstrating the impact and benefit of digital inclusion support services.

In this final chapter, the researcher describes the main findings of this PhD project within the context of the wider literature. The researcher then outlines a set of practical recommendations that various stakeholders (e.g., researchers, healthcare decision makers, policymakers etc.) could implement to help support digital health equity at the population (e.g., policies), community (e.g., providing resources to specific areas to develop infrastructure) and individual level (e.g., enhancing digital skills). The strengths and weaknesses of this project are also described, followed by reflections on how the researcher's own characteristics may have influenced the project and how this was addressed. Finally, the researcher provides several suggestions for future research.

8.2 Main findings in the context of the wider literature

The systematic review and two qualitative studies conducted as part of this PhD project highlighted five key strategies to promote digital health equity. Three strategies centred around direct support to under-served groups, such as: (1) providing educational digital skills to support independent use of DHTs, (2) providing resources to support under-served groups overcome the potential physical barriers relating to accessing DHTs and connectivity (e.g., purchasing compatible devices), and (3) using non-digital advertising techniques to raise awareness of the support that was available. The remaining two strategies centred around organisational level approaches to indirectly support under-served groups, such as: (4) involving under-served groups in the design and development of DHTs and digital health services to ensure their needs are considered and accommodated for, and (5) using evaluation tools to help demonstrate the benefits of adopting digital inclusion strategies into practice to gain the approvals of decision makers (e.g., integrated care boards or funding bodies). These five key strategies to promote digital health equity are described in turn below with further context from the wider literature.

8.2.1 Educational digital skills support

Educational digital skills support was identified throughout this PhD project as an important approach to support under-served digitally excluded groups improve their digital literacy skills and confidence in using DHTs. Various approaches to deliver digital skills support was discussed, including an individuals' close social network (e.g., family, friends, neighbours), healthcare professionals, or VCSE organisations at local community centres.

8.2.1.1 Support from close social networks

This PhD project found educational digital skills support delivered via an individual's close social network to be commonly used across all CLEARS groups. However, under-served groups, particularly older adults and culturally diverse groups, often experienced family members or friends 'doing' the digital health-related task for them, instead of teaching them, thus preventing the individual from learning how to do the task independently and reinforced their continued dependence on others (Chapter 3 and 5). The wider literature suggests family members often find it easier and quicker to 'do' the task instead of teaching older relatives, and quickly become impatient and frustrated if they do try to teach their relatives how to use technology, resulting in behaviours such as using condescending language that can make older adults feel stupid and diminishes their digital self-efficacy (an individuals perceived ability to successfully complete a digital task independently).(245) This reliance on family and friends to complete digital tasks resulted in under-served participants in this PhD project feeling like a burden on others, feeling embarrassed as they had to share personal health information with others to complete health-related digital tasks (Chapter 6), and/or feeling helpless as their reliance on others reaffirmed how they were unable to do something independently (Chapter 4).

Ethnically diverse women from a low socioeconomic status, low educational attainment and/or seeking asylum also experienced controlling behaviours when receiving digital skills support from their partners (e.g., refusing to teach them how to do the task or not letting them seek educational digital skills support elsewhere) (Chapter 6). Such behaviour may have been influenced by cultural factors as some cultures hold social norms that confer control of technology to men and limit women's opportunity to learn, use and benefit from technology.(246) However, as the participants who described such behaviours from their partners were recruited from the Angelou centre (an organisation supporting excluded communities of women such as domestic abuse victims), there is likely an element of technology-facilitated domestic abuse (the use of digital technologies to threaten, harass, control, or punish an individual).(247) Technology-facilitated domestic abuse can further exacerbate digital exclusion within healthcare as it removes an individuals' independence, choice and control over the DHTs they can access and use.(248) Research has found this can reduce engagement and utilisation of DHTs, such as a digital maternity app.(249) However, very little research has been conducted to explore all the unique barriers domestic abuse victims experience regarding digital exclusion within healthcare (no articles identified in the scoping review focused on those most at risk of digital exclusion within healthcare discussed domestic abuse (Chapter 3)). Nor has there been any research exploring appropriate, effective digital inclusion strategies to support digital health equity amongst domestic abuse victims.

8.2.1.2 Support from healthcare professionals

Some culturally diverse groups living in deprived areas tried to obtain educational digital skills support from healthcare professionals, including non-emergency operators (e.g., 111 health advisors) and primary care staff with patient facing roles (Chapter 6). However, some healthcare professionals did not know how to use their DHT or feel confident using it, so were not able to provide support to a patient (Chapters 6 and 7). Some stakeholders and under-served participants suggested providing all healthcare professionals with digital skills training to help them provide support when a patient asked for help (Chapter 6 and 7). Such training has been suggested in the wider literature to increase healthcare professional's self-efficacy when using DHTs.(250) However, digital skills training for healthcare professionals is not always freely available. For example, a recent study conducted in Spain found 59.82% (n=972) of healthcare professionals (physicians and nurses) surveyed had not received any digital skills training from their workplace, and nearly a third (32.62%, n=427) paid to receive their own training from a third party organisation.(251) This demonstrates how some healthcare professionals are highly interested in receiving digital skills training, but healthcare organisations are failing to meet the needs of their professionals.(251) The availability of digital skills training from healthcare organisations has been suggested to be affected by a countries policies and national strategies.(252) A study conducted by Kaihlanen et al.(252) used primary data collected via surveys and secondary data from published journal articles and policy documents to map how digital skills training for healthcare professionals was organised and implemented in 25 EU (European Union) countries. They found countries with well-defined national strategies regarding digital skills training for healthcare professionals had executed more comprehensive digital skills training strategies, covering specialised training and mandatory continuing education, compared to countries lacking such systematic coordination.(252) Therefore, governments, policy makers and local authorities must design and implement national strategies that promote and support the delivery of mandatory digital skills training for healthcare professionals via healthcare organisations to help them provide support and guidance to patients using DHTs.

Another barrier preventing healthcare professionals from giving educational digital skills support to under-served digitally excluded groups is the limited time they have during a standard consultation (in the UK this is 10 minutes).(253) Although the NHS has produced a recommendation that primary care general practices should provide additional time to support patients struggling to use DHTs, the guideline document that states this recommendation, titled 'Supporting digital inclusion in general practice: 10 top tips', does not provide any practical guidance on how to do this alongside their busy work schedules and operating hours of the practise.(81) To reduce the burden on healthcare professionals, this PhD project (Chapter 6 and 7) and the Good Things Foundation,(254) suggest creating user guides (e.g., printable guides, video tutorials) that can be given to patients for them to follow in their own time. It is important that this information is available in different languages, and accessible in both a non-digital paper format and digitally within health-related apps and websites to accommodate for individual differences (e.g., those who are not fluent in English, and differences in preferences for following guidance online or offline) (Chapter 6).

8.2.1.3 Support from VCSE organisations

Under-served participants in this PhD project advocated for tailored educational digital skills support from VCSE organisations at local community centres (Chapter 6). Those who had attended such support reflected on how attending one to one or small group in-person digital skills classes tailored to their individual needs (e.g., existing digital skills) and interests (e.g., what they wanted to use technology for, and the technologies they wanted to be able to use), helped to reduce their digital anxiety, increase their confidence and improve their perceived digital literacy skills. These findings were consistent with those in the wider literature, which suggests educational digital skills support from VCSE organisations in community spaces, designed around personalised regular support and trusting relationships with staff members, is necessary to support the inclusion of older adults, those with low educational attainment and low socioeconomic status.(255) The Good Things Foundation report titled 'Basic Digital Skills: Expert Overview' also highlighted the importance of delivering such support in an informal manner (e.g., a relaxed atmosphere without the use of any formal assessments or assignments to test learning), to support those with poor past experiences of educational systems and/or lack confidence to learn how to use technologies.(256) However, the researcher found that not all under-served groups were able to access and benefit from the support offered by VCSE organisations. For example, a stakeholder interviewed in this PhD project reflected on the challenges of supporting an individual who was not fluent in English, when none of the staff at the community centre spoke the individual's native language; this made it difficult to communicate with the individual and guide them on how to use a device (Chapter 7). The Good Things Foundation have recognised the challenge that language barriers can pose to VCSE organisations providing digital skills support, and how such barriers can further disadvantage culturally diverse under-served groups from developing their digital skills.(257) As such, they developed a set of recommendations to support digital inclusion of adults with low English language skills, which were based on insights from VCSE staff delivering educational digital skills support, commissioners and policy makers.(257) These recommendations endorse the use of pictures, emojis and icons to facilitate communication and learning, for example using a thumbs up emoji to indicate the correct way of doing a digital task, and using screenshots when developing handouts to support learning outside the educational digital skills session.(257) Such a picture heavy approach will also support those who are illiterate, as demonstrated in an ethnographic study conducted with three communities of illiterate domestic labourers in India.(258) This study found all communities involved preferred text-free instructions guiding users on how to navigate a prototype digital app, and supported them in using features on the app.(258)

Furthermore, those residing in rural areas are likely to struggle with accessing educational digital skills support from local VCSE organisations, as the Good Things Foundation map of local Digital Inclusion Hubs (community centres offering free educational digital skills support) in the UK showed a concentration of hubs in urban areas, with very few scattered across rural areas.(259) Providing digital skills support in rural areas is often challenging due to various barriers. These barriers include: poor internet access making it difficult and frustrating to guide individuals on how to use online content (e.g., how to navigate websites or download an app), difficulties in identifying and advertising services to digitally excluded individuals who may be spread across a large geographical area, and the lack of affordable public transport to attract residence in remote rural areas to attend support services.(260) The Good Things Foundation guidance for VCSE organisations supporting residence in rural areas recommends carefully considering the venue to host digital support services as this may help overcome travel and connectivity barriers associated with rural areas, for example using village halls, cafes and public houses which offer free Wi-Fi, free car parking and/or good public transport links.(261)

Under-served groups and stakeholders who participated in this PhD project called for more UK government funding to promote the accessibility of educational digital skills support from VCSE organisations, particularly for those living in rural areas and those who are not fluent in English (Chapter

6 and 7). These funds could be used by VCSE organisations to hire staff who speak different languages, support existing staff learn a new language, hire translators, develop picture heavy learning materials, as well as expanding their services to venues in rural areas with free Wi-Fi, free car parking and/or affordable transport links. The UK government's latest 'Digital Inclusion Action Plan' published in February 2025, suggests VCSE organisations will be able to access government funding to support the provision of these educational digital skills services in the coming years through the new Digital Inclusion Innovation Fund.(262) This fund has been designed to support local initiatives to meet the specific and diverse digital related needs of local communities.(262) However, further details of the Digital Inclusion Innovation Fund, such as how much money VCSE organisations can receive, exactly what the funds can or cannot be used for, or the time frame over which the VCSE organisations will receive funding, have yet to be released.

8.2.2 Providing devices and connectivity

Providing devices and connectivity (e.g., pre-paid SIM cards) to support individuals from under-served groups to overcome financial barriers associated with accessing DHTs, was a key digital inclusion strategy discussed in both the systematic review and qualitative studies conducted as part of this PhD programme of work. However, various organisational level challenges made this strategy difficult to implement, such as obtaining enough resources (e.g., staff, devices, SIM cards etc.) through cross-organisational collaboration, and mitigating concerns of the potential unintended consequences of providing access to an internet enabled device (Chapter 7).

8.2.2.1 Cross-organisational collaboration

Stakeholders who participated in the researcher's qualitative study stressed the importance of collaboration between organisations, including healthcare providers, local authorities, community groups and technology companies, to obtain enough compatible hardware (e.g., devices and/or SIM cards) and technical skills to fix broken devices and wipe data from pre-used devices (Chapter 7). Despite cross-organisational collaboration being promoted by both the NHS and the Good Things

Foundation,(52,80,263) they provide no guidance on how to navigate the challenges that may emerge. Challenges often occur when building working relationships with organisations, as successful relationships are dependent upon interactions with individuals working within the organisation,(264) but it can be hard to identify key contacts at big organisations, such as NHS trusts (Chapter 7), and gaining interest and engagement with already over-burdened healthcare staff can be difficult.(264) A second challenge centres around the need to navigate the working practices of different organisations. This includes having to identify different audit times to propose the idea of the organisation donating devices instead of recycling them, and a professional culture of smaller VCSE organisations needing to adhere to bigger organisations (e.g., the NHS) bureaucracy, which in itself was challenging as the VCSE organisation may not have the resources (monetary or staff) to do so (Chapter 7). Such organisational challenges have been shown to hinder collaboration between primary care and Public Health organisations in the US.(265) A qualitative study conducted by Pratt et al.(265) found primary care practitioners (n=12) and key informants from a public health organisation (n=40) were unsure how to initiate or achieve feasible collaboration with each other that was in line with both organisations policies, democracy and resources (e.g., funding) available. A third challenge highlighted in the wider literature centres around financial funding.(264) Short-term funding grants often given to collaborative projects hinder the feasibility of long-term collaborations, as key contacts who have developed relationships with organisations have to be let go when the funding runs out, and the lack of longevity of a project limits the opportunity to evaluate and demonstrate impact to obtain further funding and build trust within communities.(264)

Prior research suggests collaborating organisations should work together to design tailored agreed working practices for each collaborative project which considers the economic context of all organisations involved to foster collaborative relationships.(266,267) This may overcome barriers associated with relationship building as key contacts can be clearly identified for each aspect of a project during the development of working agreements, and mitigate system level challenges as there is a mutual awareness of other organisations practises and resources.(266,267) Further research is needed to assess the impact and feasibility of this approach.

8.2.2.2 Mitigating concerns around potential unintended consequences

Stakeholders often reflected on the concerns raised by decision makers at various organisations around the potential unintended consequences of providing certain groups, for example, those with mental health conditions, with internet enabled devices and connectivity. They felt that unrestricted internet access could negatively impact their well-being by, for example, facilitating access to online gambling websites for an individual who may have been previously addicted to gambling (Chapter 7). The wider literature also highlights the problems that may arise with overuse of the internet, such as higher levels of depressive symptoms, anxiety and loneliness.(268) Furthermore, excessive screen time (spending more than five hours per day on a digital device) has been found to increase suicidal thoughts or actions in young adults and negatively impact sleep, leading to sleep deprivation, exacerbating depression and other mood disorders.(269,270) While these concerns regarding an individual's mental health are valid, restricting access to connectivity and devices for individuals with mental health conditions may reinforce existing digital exclusion amongst individuals from under-served groups, such as those on a low socioeconomic status and homeless individuals, as they are also likely to experience mental health problems.(271,272) A more nuanced approach, that balances safeguarding against potential harms while ensuring equitable access to devices and connectivity, may be necessary to support those at risk of digital exclusion. One solution discussed amongst stakeholders was to limit the use of the internet-enabled device to an intended purpose (e.g., only used to access a health-related app), mitigating the risk of any potential inappropriate use of a device (e.g., to access gambling sites) (Chapter 7). Many stakeholders strongly opposed this idea, suggesting that an individual should also be able to use the device for everyday activities (e.g., using social media to communicate with family and friends) which could have positive outcomes for these individuals (Chapter 7). Previous literature relating to poverty, provides support for this 'use for any purpose' approach, as poverty is often associated with an inability to follow common norms of living.(273) Furthermore, access to social media and other online communication platforms can provide individuals with mental health conditions access to online peer support networks which can increase social connectedness and empowerment during recovery/treatment.(274) To balance this 'use for any purpose' approach with organisations' safety concerns, stakeholders in the researcher's qualitative study discussed how they designed and implemented their own safeguarding procedures (Chapter 7). This included the use of software that enabled an individual's data to be remotely wiped from a device, if the device was reported as lost or stolen. Stakeholders also assessed an individual's request for a replacement device (when a device is reported as damaged) on a case-by-case bases to ensure those who may be accident prone, due to physical disability for example, were not disproportionately excluded from receiving support if the device unintentionally breaks. For example, those with arthritis have reduced grip strength and reduced fine motor skills,(275) increasing the likelihood of accidental device breakage due to difficulties holding handheld devices. Currently, there are no guidelines or standards from the Good Things Foundation, NHS or government organisations that would help guide stakeholders in the development of appropriate risk mitigation plans that support the inclusion of all individuals whilst mitigating potential unintended consequences.

8.2.3 Raising awareness of digital inclusion support in communities

This PhD programme of work revealed that many individuals from under-served groups did not know where to seek digital inclusion support other than their close social network (Chapters 4, 6 and 7), and highlighted how more needs to be done to raise awareness of the digital inclusion support services (e.g., educational digital skills services or services providing devices and/or connectivity) available in local communities. To raise awareness, a combination of approaches need to be implemented, including tailored public facing advertising and signposting from healthcare providers to VCSE organisations offering digital inclusion support. Each approach is described in turn below.

8.2.3.1 Tailored public facing advertising

To design a tailored public facing advertisement of digital inclusion support services available in local communities, the nuances of different social contexts of individuals from under-served digitally excluded communities must be considered. This includes where individuals from these communities are likely to meet, for example, advertising digital inclusion support on public transport, in schools, and/or places of worship (Chapter 6). The wider literature also highlights the need to examine the diversity of people who meet in public places.(276,277,278) For example, homeless women are less likely to attend homeless shelters compared to men, as they may have been previously victimised by men and do not feel comfortable in a shelter with men.(276,277,278) Therefore, to reach these specific individuals, domestic abuse shelters may need to be considered as places of advertising alongside homeless shelters. Furthermore, the content in advertisements (e.g., the information it contains, framing of the message, and imagery) must also be carefully considered. It is important the advert contains real-life examples of the benefits of DHTs that resonate with the community to raise awareness of the benefits DHTs can provide, to inspire and motivate people to engage with digital inclusion support services.(279) The content must also be presented in a way that mitigates any chance of reinforcing stereotypes (e.g., older adults are too old to learn), stigmatisation or racism (Chapter 7). Previous health campaigns addressing various issues, including HIV/AIDS, domestic violence, and obesity, shed light on the importance of avoiding the use of negatively framed messages (emphasising the potential losses or negative consequences of a particular action), as campaigns disseminating negatively framed health messages and feature under-served groups can reinforce racial, ethnic and sexual discrimination and/or stigmatisation.(280) The wider literature also suggests positive message framing is perceived as more informative, especially amongst older adults,(281) and can be more persuasive in generating interest in participating in activities being advertised compared to negatively framed messages.(282) To facilitate the tailoring of advertisements of digital inclusion support (in terms of the content used and places of advertising) to different communities, research conducted with three under-served Bristol-based community organisations exploring inclusive approaches to involve community groups in health research, recommended co-producing the advert with the target population to ensure it meets their needs.(283)

8.2.3.2 Signposting from healthcare providers to VCSE organisations

To be able to signpost digitally excluded individuals to VCSE organisations delivering digital inclusion support, these individuals must first be identified. The CLEARS framework developed in this PhD project (Chapter 3) may prove to be useful here. It could be used by various stakeholders, such as policy-makers, healthcare and VCSE organisations, to conduct population risk stratification to identify geographic areas and/or cohorts of patients most at risk of digital exclusion and inform decision making in regards to digital inclusion support services. The NHS promotes the use of such an approach in their inclusive digital healthcare framework,(52) which describes a case study of a heatmapping tool which identifies areas within the Cheshire and Merseyside region that are likely to be digitally excluded to help identify areas that would benefit the most from digital inclusion support.(52,80,284,285) The heatmapping tool was co-produced by Cheshire and Merseyside Integrated Care Board, Cheshire and Merseyside Health and Care Partnership and Thrive by Design (an organisation supporting healthcare providers co-design digital services with the public).(52,80,284,285) They used publicly available and practise site local data-sets on common factors associated with digital exclusion (e.g., income and older age) to predict the likelihood of digital exclusion within an area in order to develop the heatmapping tool.(52,80,284,285) Similar heatmaps have been replicated by various local authorities for different geographic regions within the UK, such as Lincolnshire County Council who developed a heatmapping tool spanning the Lincolnshire region,(286) and the Greater Manchester Combined Authority developed a heatmap for the whole UK.(287) However, these heatmaps lack standardisation in terms of the metrics used to predict the likelihood of digital exclusion within an area. For example, the Lincolnshire heatmap considers digital engagement (in terms of using technology to communicate (e.g., social media use)) within an area based on Experian Mosaic indicators (data gathered by Expedia to help businesses understand a particular regions' population) to predict the likelihood of digital exclusion,(286,288) whilst the Cheshire and Merseyside heatmap considers rates of health disparity and disability within an area based on healthcare practise site's local data sets.(284,285) Without a standardised method of developing these heatmapping tools, it is difficult for healthcare organisations and government bodies to use them to compare and contrast regional areas at a national level to identify regions most in need of additional resources to support digital inclusion. An alternative solution suggested by stakeholders in this PhD project (Chapter 7) was to explore the patient's desire to use DHTs, confidence in using technologies and their access to compatible devices during their healthcare consultation. This would help identify those who may need additional digital inclusion support. This individual level approach may be useful to use alongside the heatmap approach to identify those at risk and allow decision makers (e.g., ICB) to direct additional resources to those areas and individuals who are most in need.

Another key element of signposting digitally excluded individuals from healthcare providers to VCSE organisations is maintaining an accurate record of the digital inclusion support services provided by local VCSE organisations including relevant contact details for the service. Maintaining an accurate record helps to mitigate referring an individual to a support service which may no longer be running. Social prescribers who work within healthcare organisations, such as GP practices, are typically a non-clinically trained healthcare professional who acts as a communication link between healthcare and local community services, and connects patients to non-clinical social services (e.g., a recommendation to attend local walking groups) to help improve their health and wellbeing.(289) Social prescribers hold local knowledge of available community services and relevant contact information for local VCSE organisations,(289) thus the NHS have suggested them as a possible option to facilitate the signposting of digital excluded individuals to digital support services.(47) However, the Good Things Foundation shared their concerns about using social prescribing to connect healthcare with local VCSE organisations that provide digital inclusion support, including some geographic areas not being very advanced in social prescribing leading to unclear referral routes.(290) Alternatively, or in combination with social prescribing, digital champions could also help connect patients to local digital inclusion support services. Digital champions are dedicated NHS staff and/or volunteers who currently signpost digitally excluded individuals to digital inclusion support, and advise colleagues on how best to use and promote DHTs within their scope of practice.(291,292) Digital champions were first introduced in the NHS in 2013 with the start of the Widening Digital Participation (WDP) programme which aimed to improve digital access and inclusion for all.(293) Since 2019, digital champions are required to complete the digital champions training programme to support the standardising of digital champions within healthcare.(293,294) However, there are currently no estimates available regarding how many digital champions are in place at NHS sites or which regions have them. There has also yet to be an evaluation to assess the impact digital champions are having on NHS patients. Although a recent systematic review exploring the role of digital champions supporting the implementation of new technologies in healthcare systems across different countries (including US, Australia, Canada, Norway, England, Ireland and Malaysia), found champions with experience within a healthcare organisation (e.g., not volunteers or newly graduated health professionals) who were provided with clear mandated, dedicated time, and training could significantly contribute to their colleagues' digital competences with DHTs.(291) There are also similarities between digital champions and carer champions, who are members of staff acting as a key contact for carer information for the team where they work, and ensuring caregivers voices are heard.(292) Carer champions have been implemented across the NHS since the introduction of the Triangle of Care Guide in 2010.(292) They are now considered by the NHS to be "vital" to the successful implementation of, and adherence to care standards, best practice, and carer legislation, and signposting carers to local carer services and events.(292) There is therefore hope that digital champions could advance digital health equity by raising awareness of digital inclusion support amongst under-served groups via signposting, as well as supporting healthcare staff confidently use DHTs.

8.2.4 Involving under-served groups in the design and development of DHT

Involving individuals from under-served digitally excluded groups at the early stages of the design and development of digital healthcare systems and DHTs was highlighted throughout this PhD project as a useful approach to ensuring healthcare systems and DHTs meets their needs. The researcher first describes the importance of involving under-served digitally excluded groups in digital healthcare systems, followed by the importance of involving them in DHTs.

8.2.4.1 Digital healthcare systems

Many individuals from under-served groups in this PhD project provided examples of healthcare services that could only be accessed via digital means. This created barriers for them, including an inability to confirm upcoming hospital appointments (which could only be confirmed via a weblink sent via SMS message) (Chapter 6). The researcher's findings suggest that digital healthcare should be provided as a choice, not instead of more traditional face-to-face in-person services, to support the inclusion of digitally excluded individuals. This finding is echoed in policy documents produced by Healthwatch, an organisation which voices the concerns and experiences of healthcare users to improve healthcare services. In their 2021 report on local experiences of digital health and care services in

Suffolk and North East Essex, they found healthcare users and healthcare professionals expressed the view that digital access to healthcare must remain a choice to support users who lack confidence in using digital technologies, have poor digital literacy skills, prefer face-to-face communication, or do not want to be forced to use digital technology.(295) Furthermore, The Kings Fund, an independent think tank working to improve health and care in England, also produced a policy briefing document in 2023, titled 'Ensuring digitally enabled health care is equitable and effective for all', which called for national policies to ensure both digital and non-digital healthcare services are available to all to reduce inequities.(296) The NHS has recently recognised the importance of delivering digital health services alongside non-digital services to balance the needs of those who are digitally excluded.(52) However, there has yet to be any evaluation regarding which NHS trusts provide both digital and non-digital healthcare services, nor any assessment of the economic impact and feasibility of implementing and maintaining two access routes to healthcare (digital and non-digital).

8.2.4.2 Accessibility of DHTs

This PhD project found various issues with the accessibility of DHTs amongst digitally excluded groups. These challenges ranged from health-related apps (e.g., the NHS app) or websites (e.g., GP practise websites) being hard to navigate, to security features preventing the registration of an online account amongst those without photographic identification (e.g., asylum seekers or those on a low socioeconomic status) (Chapter 4, 6 and 7). Various accessibility legislations and standards regarding public facing websites, software, and security features, do exist in the UK.(174,181,297) For example, there are standards in place which mandates websites and software in the public sector be *'perceivable, operable, understandable and robust'* to ensure that those with visual and hearing impairments, low reading ability (reading age of 9) and/or those who are not fluent in English can access and understand the information provided.(174) The UK government also promote 'secure by design principles' which includes conducting user involvement to mitigate users resorting to unsafe practises (e.g., writing down passwords).(181) Furthermore, the UK Equality Act 2010, states healthcare services cannot directly discriminate against those who cannot afford photographic identification and/or those who are seeking asylum.(297) Despite these legislations and standards being in place, the researcher found they are often not adhered to, resulting in under-served digitally excluded groups experiencing various barriers using and accessing DHTs. A possible reason for the lack of accessibility and consideration for inclusion in DHTs could be due to the working practices of technical security developers.(298,299) The wider literature suggests technical security developers often prioritise mitigating cybersecurity attacks and other breaches of data, without acknowledging how the resulting system will hinder the user's ability to operate the system or website, resulting in systems that do not meet the user's needs (e.g., not allowing a user to see the password they have typed, making it hard to find a typing error). (298,299)

Furthermore, there has been little research exploring the needs of individuals from under-served groups to help identify inclusive user-friendly features to inform the development of secure, inclusive and accessible DHTs. Zhou et al conducted a study to explore user-friendly security features in health-related apps that also reduce security and privacy concerns amongst users.(300) They found 82.1% (n=96) of survey respondents felt user authentication (e.g., multi-authentication systems) would provide confidence their health data will be kept confidential on a health-related app, and 43.6% (n=51) felt regular password updates would provide this confidence.(300) However, this study only included residence in Greater Pittsburgh (Pennsylvania, US) who were native English speakers, were well educated, and had at least 3 years of experience in using a smartphone before the study.(300) In contrast, the perspectives of individuals from under-served digitally excluded groups collected as part of this PhD programme of work described how they often struggled recalling their password (Chapter 6), and stakeholders reflected on the difficulty some under-served groups have when trying to use multi-authentication systems (Chapter 7). The use of biometrics (e.g., recognising facial or fingerprint features) was suggested by a few participants in this PhD programme of work to overcome issues regarding password recall, and provide a method of authentication (Chapter 6 and 7). However, this would exclude those who do not have access to technology with such capabilities (e.g. fingerprint sensors, cameras for facial recognition, or a working microphone for voice recognition). There are also growing concerns of ageist, ethnic and racial bias inbuilt into biometric algorithms due to a lack of inclusion of data from individuals from under-served groups in the development of such algorithms.(301.302,303) For example, a lack of inclusion of older adults in the development of finger pattern recognition software has resulted in questions regarding the effectiveness of such sensors amongst those over 60 years old, as the sensors are less sensitive to dry, wrinkly skin, and holds the potential to exclude older adults from services that use finger biometric authentication.(301) Facial recognition software has been reported to contain racial and ethnic bias in the algorithm, with lower accuracy for East Asian faces compared to Caucasian faces, due to a lack of diverse faces been used during algorithm training.(302) Voice recognition software has also been criticized for containing racial and ethnic bias due to a lack of representation of common phrases spoken by black African American English individuals compared to phrases spoken by White Caucasian English speaking individuals used when training the acoustic models.(303) Recent efforts have been made to improve inclusion of under-served groups within digital health related research, including DHT design and development, with the NIHR now requiring funding applications to detail how diversity, inclusion and equity (EDI) will be implemented across the research project, from acknowledging historical and structural inequities, to dissemination and impact, and providing justifiable costs to support inclusive research.(304) Other funding bodies, such as UK Research and Innovation, have also developed EDI strategies to promote inclusive research.(305)

8.2.5 Demonstrating the benefits of digital inclusion support services.

This PhD programme of work highlighted the importance of demonstrating the benefits of providing digital inclusion support services. This evidence could be used to gain further approvals from healthcare decision makers (e.g., ICBs) and funding bodies to provide resources to digital inclusion support services (e.g., staff time, compatible devices, connectivity etc.) in the future (Chapter 7). However, many stakeholders found it difficult to collect and provide this evidence, as they mentioned how they were unaware of any evaluation tool that could help guide them (Chapter 7). A recent article suggested digital inclusion support services could be assess by measuring different metrics, such as an individual's digital literacy (using The Digital Competence Framework for Citizen (DigComp 2.2)),(306) and digital anxiety (using Generalised Anxiety Disorder 7-item scale (GAD-7)),(307) at baseline and after an individual received support.(255) Both the DigComp 2.2(306) and GAD-7(307) are self-assessment questionnaires composed of closed questions. DigComp 2.2 is a lengthy questionnaire with 5 sections assessing different digital competencies (e.g., ability and confidence to par take in online communication and collaboration) and a total of 257 statements describing a range of digital tasks in which an individual will self-report if they feel confident doing such task.(306) Responses indicate their proficiency level in a particular digital competency.(306) DigComp 2.2 was created by the European Commission to help governments understand their populations digital competency, help policy-makers formulate policies that support digital competence building, and plan educational digital skills initiatives to improve the digital competence of specific target groups.(306) The GAD-7 is a short 7 item Likert scale which individuals indicate how often they experience a particular feeling (e.g., Feeling nervous, anxious, or on edge, or not being able to stop or control worrying) on a scale of 'not at all' to 'nearly every day.(307) The GAD-7 is a valid and efficient tool for screening and assessing severity of anxiety,(308) and commonly used in the NHS to measure self-reported symptoms of anxiety.(307) However, some stakeholders were concerned a questionnaire would be inappropriate to evaluate the benefit of digital inclusion support services as completing multiple and/or lengthy questionnaires may overburden under-served groups (Chapter 7). To provide a more holistic evaluation of a digital inclusion support service, one English NHS Trust (Cheshire and Merseyside) designed a Digital Inclusion Impact Assessment tool in 2023, which provided a step-by-step approach to firstly identify any challenges associated with digital exclusion within a specific healthcare context, and secondly determines if the digital inclusion support is equitable and sufficiently mitigates relevant digital exclusion barriers.(284) The tool contains questions to assess various elements of a digital inclusion support service, such as the involvement and engagement of relevant groups and stakeholders, risks of negative impacts, and accessibility features.(284) The developers of this tool recommended that it should be used alongside an Equality Impact Assessment form, which helps ensure practise and services do not present barriers to participation or disadvantage any protected sociodemographic groups.(284,309) However, as many stakeholders interviewed as part of this PhD project were unaware of any evaluation tool to guide the evaluation of a digital inclusion support service, more needs to be done to raise awareness of the tool and to explore stakeholders perspectives on the usefulness of the tool to evaluate digital inclusion support services.

8.3 Recommendations

8.3.1 Development of the recommendations

Previous recommendations to promote digital health equity in the literature published in the US have centred around guidance for behavioural and social science researchers and/or healthcare providers with limited insight to the facilitators and barriers to implementing digital inclusion strategies into society.(310,311,312) Previous reviews from the US have applied the socioeconomic model (a framework that recognises the intersection of personal, interpersonal, organisational and societal factors that shape behaviour)(313) to inform recommendations to promote digital health equity, such as providing devices (individual level support), education (relationship/interpersonal level support), access to connectivity / infrastructure (community level support), and implementing policies (societal level support).(311,312) The grey literature from the NHS and the Good Things Foundation provided recommendations to advance digital health equity within the UK, such as introducing digital champions into all NHS sites to support signposting to services provided in the community.(52,80,81) However, little consideration has been given to those individuals who belong to two or more under-served groups at risk of digital exclusion, who are likely to face more barriers to digital inclusion due to the intersection of their demographic factors. To develop a set of holistic recommendations to promote digital health equity for these individuals, this PhD programme of work sought the opinions of under-served digitally excluded groups (Chapters 4 and 6), and the facilitators and barriers to adopting digital inclusion strategies into society (Chapters 4 and 7). To ensure the voices of under-served digitally excluded groups were analysed and interpreted in a manner that accurately reflects their opinions, perspectives and views, the researcher validated the findings. The validation involved sending a summary of the findings from the qualitative study with individuals from under-served digitally excluded groups (Chapter 6) and the systematic review (Chapter 4) to a professional artist at an organisation called *More than Minutes*, to help portray these findings through visuals. Four PPI members (on a related project, HEALTH), three under-served participants from this PhD project (Chapter 6), and one gatekeeper provided feedback on a draft image. This feedback was summarised into actionable edits and sent to the professional artist to produce a second draft. The final version of the image depicted tailored recommendations to advance digital health equity in a lay-term friendly manner (as it was also used for public dissemination) (Figure 11). For example, to support the inclusion of culturally diverse groups (e.g., ethnic minority groups, those who have a religious belief and/ or English is their second language), the image highlights how digital inclusion support should be advertised at places of worship and information (about such support and content displayed in DHTs) should be available in different languages. All recommendations shown in the image have been integrated with the rest of the recommendations developed as part of this PhD project (see section 8.3.2, Table 12).

Figure 11: A visualisation produced by More than Minutes depicting tailored recommendations to advance digital health equity based on the perspectives of individuals from under-served groups.

8.3.2 Key recommendations to advance digital health equity amongst individuals from under-served digitally excluded groups

The researcher identified eight key recommendations that could support digital health equity at the population, community and individual level. These recommendations include:

1. Raising awareness amongst professionals of the importance of EDI in digital healthcare.
2. Identifying communities most in need of digital inclusion support.
3. Co-designing DHTs and digital health services with individuals from under-served digitally excluded communities.
4. Embedding cross-organisational collaborations across different sectors.
5. Providing individuals with non-digital options to access healthcare.
6. Providing and/or directing individuals to various digital inclusion support services.
7. Advertising digital inclusion support using various methods to reach individuals from under-served digitally excluded communities.
8. Evaluating digital inclusion support services.

Table 12 provides a detailed description of these recommendations in terms of which stakeholder could help take it forward, how they could practically take action to help implement the recommendation, and how the recommendation will likely advance digital health equity.

Table 12: Eight key practical recommendations for stakeholders to advance digital health equity for individuals from under-served groups experiencing digital exclusion

Recommendation	**Who should act?**	**How should they take action?**	**How will this advance digital health equity?**
Raising awareness amongst professionals of the importance of EDI in digital healthcare.	Technology developers. Researchers, and healthcare decision makers (e.g., NHS trusts Chief Digital and Infrastructure officers/ Integrated Care Boards)	Ensure digital health related research projects and/or the development of new DHTs promote inclusion of individuals from digital exclusion groups. For example, using an inclusive recruitment approach to obtain a diverse digitally excluded participant group to feedback their perspectives throughout the design and development process.	Promotes population level digital inclusion as more inclusive research results in more generalisable and applicable findings across diverse populations. Advances EDI innovation within digital healthcare as researchers and technology developers seek more inclusive approaches to meet funding and ethical requirements.
	Funding bodies	Funding bodies should require all digital health related research funding applications to consider EDI and digital exclusion.	
	Ethical panels	Assess the appropriateness of existing requirements (e.g., use of written information sheets for illegible participants) and ensure research projects have considered inclusive practices and additional support for under-served participants (e.g., translation of DHT interfaces to different languages).	
Identifying communities most in need of digital inclusion support.	Researchers, VCSE organisations, and government bodies.	Use publicly available demographic data at a national or regional level to identify where CLEARS groups are likely to reside. This information could be used by… • **Researchers**: explore how to tailor digital inclusion support to the needs of the community in that area. Develop a standardised method of developing and reporting heatmapping tools identifying areas most likely to be digitally excluded. • **VCSE organisations**: identify areas to provide digital inclusion support. • **Government bodies**: identify areas that require additional funds to support digital inclusion support services, and/or development of infrastructure (e.g., implementing 5G masks in rural areas).	Promotes community level digital inclusion by allowing decision makers to identify key areas that need additional resource (digital inclusion support services/ infrastructure) and researchers to explore the unique needs of those communities.
Co-design DHTs and digital health services with individuals from under-served digitally excluded communities.	Technology developers, researchers, and healthcare decision makers.	Involve individuals from under-served digitally excluded groups in the design and development of DHTs and digital health services to identity and consider the needs of their communities and develop secure user-friendly inclusive design practices. For example, using security features that are easy to use amongst older adults and those without photographic identification, and ensuring a broad range of compatibility with different operating systems and assistive technologies.	Promotes individual level digital inclusion as co-design approaches involving digitally excluded groups are likely to led to more user-friendly, inclusive and accessible DHTs and digital health services. At the population level, policies will help enforce the need to co-design with under-served digitally excluded groups.
	Policy makers	Develop a digital inclusion legislation for DHTs and digital healthcare systems to reinforce the use of secure user-friendly inclusive design practices.	
Embedding cross-organisational collaborations across different sectors.	Technology developers, VCSE organisations, and healthcare decision makers.	Foster collaborative relationships between healthcare providers and third-party organisations (e.g., VCSE organisations, technology companies etc.) to share best practice of how to support different digitally excluded communities, and share resources (e.g., technical skill and hardware) to maximise the	Facilitates the sharing of knowledge amongst stakeholders and maximises the delivery of digital inclusion support services.

		delivery of digital inclusion support to these communities.	
Providing individuals with non-digital options to access healthcare.	Healthcare decision makers	Providing patients with a choice of accessing healthcare digitally or not. Both digital and non-digital services should be as good as each other (e.g., in terms of reliability/ease of use).	Promotes population level digital inclusion by ensuring digitally excluded individuals who cannot access or do not want digital inclusion support are not excluded from healthcare services.
	Policy makers	Implementing a policy which mandates healthcare services need to provide non-digital services alongside digital services.	
Providing and/or directing individuals to various digital inclusion support services.	VCSE organisations	Provide digital skills support, access to devices (e.g., donating re-purposed devices for organisations and the Good Things Foundation National Device Bank) and connectivity (e.g. pre-paid SIM cards from the Good Things Foundation National Data Bank). Educational digital skills services should be delivered in an informal manner, tailored to the individuals' needs and digital abilities, and use plenty of photos to support those with limited English proficiency. Devices should be compatible with the DHT the individual wants to use, and the data plan provided on the pre-paid SIM card should be sufficient for the intended purpose / use. Risk mitigation and safeguarding procedures should be designed in an equitable manner (i.e., a sociodemographic group will not be disadvantaged by the procedure) and shared across VCSE organisations and partnering organisations (e.g., healthcare providers) to promote safe and equitable delivery of hardware (devices/ SIM cards etc.).	Promotes individual level digital inclusion by improving an individual's digital literacy skills and mitigates barriers regarding access to compatible devices and connectivity. Allow individuals from a low socioeconomic status, low educational attainment and/or seeking asylum to access user guides on a website/app to develop their digital literacy skills. Tailored support can be provided to individuals with different needs, such as someone on a low socioeconomic status may have good digital literacy (does not need educational digital skills support) but may not have the financial means to access a compatible device, so they can receive support by accessing devices from VCSE organisations.
	Technology developers and healthcare decision makers	Embed user guides (e.g., printable versions/ video tutorials) that are available in different languages on health-related websites and apps to support those with low digital literacy use the website/ app. Provide mandated digital skills training to healthcare professionals to improve their digital self-efficacy and ability to support patients with digital queries when possible.	
	Policy makers	Implement regulations on the price of technologies and broadband to reduce financial barriers to accessing compatible devices and connectivity. Develop a well-defined national strategy (including funding) to support the delivery of digital skills training to healthcare professionals and members of the public.	
	Government bodies	Provide funding grants with clear details such as how much funding can be given to VCSE organisations and the time frame funds can be access or used within, to support the delivery of digital inclusion support to various under-served digitally excluded communities.	
Advertising digital inclusion support using various methods to reach individuals from	VCSE organisations	Careful consideration should be given to the language used and where this information is advertised. The advertisement should be co-designed with the target population of interest to ensure it meets their needs.	Promotes individual level digital inclusion by improving knowledge of the digital inclusion support available in their local community and how to access it.

under-served digitally excluded communities.	Healthcare professionals	Asking patients during consultations about their ability to use technologies, and if they would like any additional support (e.g., if referring/accessing a digital healthcare service). If a patient would like to receive support, the healthcare professional should signpost them to the Digital Champion, social prescriber, or directly to digital inclusion support services.	Raising awareness of available digital inclusion support using various methods of advertisement is particularly important to reach older adults and homeless individuals who are likely to be socially isolated.
	Healthcare decision makers	Provide healthcare professionals with the time and training on how to identify digitally excluded patients and on what digital inclusion support is available. Explore the use of social prescriber and introduction of a Digital Champion at each healthcare provider site to aid signposting patients to locally available digital inclusion support. Provide training and design clear referral routes to support social prescribers, digital champions and healthcare professionals signpost individuals to digital inclusion support services.	
Evaluating digital inclusion support services.	Researchers, VCSE organisations, and healthcare decision makers	Digital inclusion support services should be evaluated to monitor the different needs of those who accessed the service, opinions and perspectives of users and those running the service to identify areas of improvement and areas that were helpful, and impact on an individual's health and/or digital inclusion. The Equality and Quality Impact Assessment form could be used alongside The Cheshire and Merseyside Digital Inclusion Impact Assessment tool to ensure practise and services do not present barriers to participation or disadvantage any protected sociodemographic groups. A questionnaire could also be used to assess specific metrics e.g., digital anxiety (using Generalised Anxiety Disorder 7-item scale (GAD-7). Further research is needed to verify the usefulness of these additional assessments in evaluating digital inclusion.	Identify the needs of individuals from the local community Reduce any barriers that might prevent / reduce an individual's participation Identify areas for further improvement and help capture the benefits of digital inclusion support services.
	Policy makers	Findings from the evaluation of services can be used to shape policies, standards and legislation to reinforce digital inclusion practises that advance digital health equity amongst all CLEARS groups.	

8.4 Strengths and limitation of this PhD programme of work

8.4.1 Trustworthiness and rigor

Various strategies were used to ensure rigour and trustworthiness was upheld during the two qualitative studies conducted as part of this PhD programme of work. For example, data was collected until thematic saturation was reached and verified in discussions with the supervisory team, and the topic guide used to guide discussions with under-served groups was extensively piloted.(235,236) The topic guide used to interview stakeholders was informed by the findings from earlier interviews with individuals from under-served groups, and tailored to each stakeholder based on their specific role and the details they provided in the professional background questionnaire. The wider context in which under-served participants lived was described allowing readers to explore similarities across comparable contexts, and judge the transferability of these research findings on a case-by-case basis.(237,241) For example, the researcher acknowledged various contextual and societal factors, such as the role intersectionality plays in exacerbating digital health inequities (Chapter 3), and regional health and digital inequities faced by residence within the North East of England (Chapter 5). This important contextual information has previously been omitted in research exploring the implementation of new interventions or strategies into healthcare.(314,315)

8.4.2 Identifying and engaging with individuals from under-served groups

The development of a novel health inequities framework, CLEARS, supported the identification of those most at risk of digital exclusion within healthcare, and helped the researcher understand the unique barriers to access, motivation and/or use of DHTs that different under-served groups are likely to experience (Chapter 3).

With guidance from the CLEARS framework, the researcher developed an inclusive method of recruiting under-served digitally excluded groups into research. The method involved a multi-step process emphasising rapport and relationship building with gatekeepers and potential participants, ensuring the needs of individuals from under-served groups were understood and accommodated (Chapter 5). This method of recruitment yielded high engagement with 29 individuals from CLEARS groups participating across this PhD project. This approach was also used in a separate NIHR Programme Development Grant (the researcher was a co-investigator on (the HEALTH project)), resulting in a further 50 diverse under-served participants being recruited into research.(316) However, some modifications to the recruitment approach will be needed in the future to recruit specific under-served groups. For example, within the **R**esidence group (CLEA**R**S), rural and homeless communities were not represented. The researcher found rural communities particularly hard to recruit from, due to barriers the researcher faced relying on public transport to gain access to these community groups in rural parts of the North East. Homeless communities were hard to recruit as all the organisations supporting homeless individuals that the researcher reached out to, such as The Peoples Kitchen and Crisis, did not respond. This is likely due to the high demand on the organisation's services, such as providing shelter, food and clothing to those who need it, and their limited capacity to support small research projects. Self-integration across rural and homeless communities via volunteering might have helped the researcher further understand these communities' previous experiences of participating in research, build trust and rapport with those who may not initially trust researchers, and identify appropriate additional resources that may have been needed to engage effectively with these groups.(304) However, due to pragmatic time constraints of this PhD project, the researcher was unable to integrate herself across these communities.

Another limitation comes from the reflection of an under-served participant who withdrew without reason at the scheduled time of the interview. She requested the interview to take place over the phone to allow her to fulfil her childcaring responsibilities alongside participating, but she failed to answer the phone when the researcher called her. This individual was recruited from the Angelou centre which supports ethnic minority women experiencing poverty and/or domestic abuse. Her withdrawal questioned the ability of individuals with caring responsibilities to access a safe place to take part in the research. Implementing a co-designed data collection approach with various under-served groups at the very start of the PhD project may have helped the researcher understand how to engage and retain individuals who were not able to attend a public place (e.g., community centre or university campus) to take part in the research.(25,304)

8.4.3 Participant sample

A wide range of different under-served groups (Chapter 6) and stakeholders from different professional sectors (Chapter 7) took part in this PhD programme of work, providing a breadth of different opinions, perspectives and experiences of strategies to promote digital inclusion within healthcare. However, only 29% (n=5) of stakeholders worked outside of the North East and North Cumbria region, and all under-served groups were from the North East. Therefore, insights from this PhD project may not reflect different UK geographic regions due to differences in resources available (e.g., financially),(189) and different rates of health and digital inequities which may affect the feasibility of implementing strategies to promote digital inclusion.(317) Furthermore, one participant who took part in a focus group held at the Angelou centre only represented one CLEARS group, (Cultural factors: ethnicity) which did not meet the eligibility criteria (i.e., two or more required). However, her engagement with the Angelou Centre had indicated that other social factors (e.g., domestic abuse) may have shaped her perspective on the topic, thus her inclusion helped provide a different view of digital exclusion within healthcare.

Finally, there was no objective measure of a participant's digital literacy (i.e., their ability to use technology effectively) used in the researcher's qualitative study with individuals from under-served groups (Chapter 6). Tools that could have been considered to assess participants' digital literacy include the DigComp 2.2,(306) or health literacy (which can overlap in some aspects with digital literacy)(248) using the Newest Vital Sign (NVS).(318) However, evidence from previous studies show that low educational attainment (achieved GCSE level or below), which represented 41.4% (n=12) of under-served participants who took part in this PhD project, has been associated with low health literacy(319) and low digital literacy.(320) Thus, the findings of this PhD project can provide some insights on the challenges faced by those with low digital and health literacy.

8.5 Reflexivity and the role of the researcher

The researcher had experience conducting qualitative research with healthcare professionals and different vulnerable populations (e.g., older adults and those living with different dementia types) before starting this PhD project. The researcher also had experience conducting a scoping review and systematic literature review exploring digital health equity at the very start of this PhD project. This experience of qualitative research, engaging with vulnerable groups and healthcare professionals, and knowledge of digital health equity, helped the researcher successfully recruit a diverse range of under-served individuals and a variety of stakeholders, and construct an understanding and meaning from the qualitative data, which may have differed to a researcher without such experience.

Intersubjective reflection was also considered by the researcher, involving a conscious reflection on ones self-in relation to others.(238) This type of reflection is particularly important when engaging with under-served groups to mitigate power imbalances, such as participants viewing the researcher as a 'professional with authority and influence,'(119) and to build trust with those who may hold negative bias towards research due to historical and social inequities. The literature also suggests researchers who self-identify with participants are better able to build rapport and engage more in conversations due to a shared understanding of a concept or experience.(238) The researcher acknowledged her position within society, as a white British young woman who was well-educated and holds an occupation at a higher educational institution, differs from many of the under-served individuals who participated. The researcher took various actions to improve her understanding of others' experiences and mitigate the chances that participants' perceptions of the researcher would negatively influence data collection. For example, the researcher completed "Cultural Competency Training" delivered by Connected Voice, and "Engagement Training: Embedding Equality, Diversity & Inclusion in Public Engagement" delivered by Newcastle University. These training sessions broadened the researchers' knowledge of cultural differences and understanding of key considerations when engaging with under-served groups to ensure research is delivered in an inclusive, appropriate and respectful manner. To reduce the power imbalance that may stem from participants viewing the researcher as holding authority, the researcher dressed informally during recruitment and data collection, as researchers wearing formal attire exploring healthcare topics can be preconceived as healthcare professionals (who have authority) by members of the public.(119) The researcher also only shared information about herself that was relevant to the study. For example, she disclosed that she grew up in the North East to build a sense of shared understanding of living in the local area and only disclosed she was a PhD student because the study contributed towards the PhD project, but her occupation as a Research Assistant at Newcastle University and previous qualifications (MSc and BSc) were not mentioned to participants. Finally, the researcher adapted the methodology (with ethical approval) to provide under-served individuals the option to take part in a focus group to create an environment consisting of those with a similar background, which could help some individuals feel more comfortable discussing topics of inequities.(132)

8.6 Areas for future research

8.6.1 Beyond the CLEARS framework

Although the CLEARS framework provides a useful guide to identify those most at risk of digital exclusion within healthcare, further research is needed to explore the extent critically under-served groups, such as the LGBTQ+ community, victims of domestic abuse, those with health conditions and informal caregivers, are at risk of digital exclusion within healthcare, and the unique barriers they are likely to experience. There is currently a lack of evidence in the literature around the barriers that members of the LGBTQ+ community face to digital inclusion, hindering the researcher's ability to comprehensively understand their unique circumstances. This is an area that requires further work to advance inclusive digital health equity. Similarly, victims of domestic abuse were not discussed in any articles included in the scoping review conducted to develop the CLEARS framework, but interviews and focus groups with under-served groups highlighted the importance of considering their unique circumstances when developing strategies to ensure they are accessible and inclusive to all. For example, controlling partners may not allow their spouse to attend educational digital skills support from VCSE organisations, and therefore digital inclusion support via VCSE organisations may not be accessible to those in abusive relationships.

Those with health conditions that may be at risk of digital exclusion, such as mild cognitive impairment(155) or mental health conditions,(321) were not explored in this PhD project, but their health condition can make it difficult for an individual to learn how to use new DHTs.(321,322,323) Therefore, the experiences and perspectives of those with mild cognitive impairment and mental health conditions must be further explored to broaden our understanding of how an individual's health and wellbeing can influence barriers to digital inclusion within healthcare, and support the development of strategies to support their inclusion. Finally, the barriers to digital inclusion that are experienced by informal caregivers (e.g., parents/ guardians of children or those providing care to an individual with a disability or health condition(s)) were also not considered in this PhD programme of work, but should be explored further as some literature suggests their caregiving responsibilities can be a practical barrier to attending educational digital skills services.(257) Thus, working with caregivers to develop strategies to support their digital inclusion is vital to ensure support services are accessible to all.

8.6.2 Assessing the recommendations to advance digital health equity

The feasibility of implementing the eight practical recommendations to advance digital health equity proposed in this PhD project in different international, national, or regional settings could be further explored using an established framework, such as the APEASE criteria (Affordability, Practicability, Effectiveness, Acceptability, Size effects/safety, and Equity).(324) This criteria provides guidance on assessing aspects of an intervention, or in this case, a recommendation, and the impact it may have. This could involve conducting an economic evaluation to assess the scalability and sustainability of these recommendations in different context (assessing the affordability aspect of APEASE).(325) This could include a full economic evaluation using a cost-benefit analysis to measure the financial cost in relation to any benefits that a recommendation provides.(324,235,326)

8.7 Conclusion

This PhD programme of work comprised of a scoping review (Chapter 3), a systematic review (Chapter 4) and two qualitative primary data collection studies exploring the perspectives of individuals from under-served groups and stakeholders on their experiences of digital exclusion and strategies to advance digital health equity (Chapters 6 and 7).

This PhD programme of work has great potential to guide future researchers, technology developers, healthcare professionals, policymakers and funding bodies to design and deliver digital health services that promote EDI and digital health equity. For example, the development of a novel health inequalities framework (CLEARS) helps others identify and consider those most at risk of digital exclusion within the design of new DHTs or services. The creation of an inclusive recruitment approach which promotes EDI can be used by other researchers to shape the recruitment strategies of co-design projects and qualitative research to ensure a diverse sample is obtained. Vital insights from under-served groups and stakeholders also provided holistic considerations that could be taken into account when designing, developing and implementing DHTs and/or strategies to promote digital inclusion. Finally, the development of the eight key recommendations holds the potential to advance digital health equity, considering the importance of intersectionality and the wider societal context often omitted from previous research. However, future research is needed to evaluate the feasibility of implementing these recommendations across a variety of different settings, and exploring if additional recommendations are needed to meet the needs of critically under-served groups omitted from the CLEARS framework.

References

1. ITU. Facts and Figures 2021: 2.9 billion people still offline. (published: November 2021). Available from: https://www.itu.int/hub/2021/11/facts-and-figures-2021-2-9-billion-people-still-offline/ [accessed 2025-08-11]
2. Lloyds Bank. Essential Digital Skills Report 2021. Available from: https://charnwood.moderngov.co.uk/documents/s9362/DTSP%2029%20March%202022%20-%20Itm%20XX%20-%20Ann%203%20-%20211109-lloyds-essential-digital-skills-report-2021.pdf [accessed 2025-08-11]
3. Cebr. The economic impact of digital inclusion in the UK. (published: July 2022). Available from: https://www.goodthingsfoundation.org/policy-and-research/research-and-evidence/research-2024/digital-inclusion-uk-economic-impact?gad_source=1&gad_campaignid=22623478783&gbraid=0AAAAAqUqZ8nUDJLKoIEJMfLSB6Huiym5L&gclid=Cj0KCQjwqebEBhD9ARIsAFZMbfyOQf5XZ_l9o_e8715hCaEN5Yr4AMPGNgdSbVF5d902U8NA6_tm4m0aAgMzEALw_wcB [accessed 2025-08-11]
4. CEDEFOP. Digital Exclusion. (published: December 2023). Available from: https://www.cedefop.europa.eu/en/tools/vet-glossary/glossary/digitale-uitsluiting [accessed 2025-08-11]
5. Audit Scotland. Tackling digital exclusion. (published: August 2024). Available from: https://audit.scot/publications/tackling-digital-exclusion [accessed 2025-08-11]
6. Data Rich. Digital Exclusion. Available from: https://www.datarich.info/digital-exclusion/ [accessed 2025-08-11]
7. UK Parliament House of Lord Communications and Digital Committee. Digital exclusion. (published June 2023). Available from: https://committees.parliament.uk/publications/40662/documents/198365/default/ [accessed 2025-08-11]

8. Darzi. Independent Investigation of the National Health Service in England. (published: September 2024). Available from: https://assets.publishing.service.gov.uk/media/66f42ae630536cb92748271f/Lord-Darzi-Independent-Investigation-of-the-National-Health-Service-in-England-Updated-25-September.pdf [accessed 2025-08-11]
9. Honeyman M, Maguire D, Evans H, Davies A. Digital technology and health inequalities: a scoping review. Cardiff: Public Health Wales NHS Trust. Digital technology and health inequalities: a scoping review Cardiff: Public Health Wales NHS Trust. 2020.
10. World Health Organization. Digital Health. Available from: https://www.who.int/health-topics/digital-health#tab=tab_3 [accessed 2025-02-10]
11. Lopez Perales CR, Van Spall HG, Maeda S, Jimenez A, Laţcu DG, Milman A, Kirakoya-Samadoulougou F, Mamas MA, Muser D, Casado Arroyo R. Mobile health applications for the detection of atrial fibrillation: a systematic review. EP Europace. 2021 Jan 1;23(1):11-28.
12. National Institute for Health and Clinical Excellence. Evidence standards framework for digital health technologies. Available from: https://www.nice.org.uk/corporate/ecd7/resources/evidence-standards-framework-for-digital-health-technologies-pdf-1124017447605 [accessed 2025-02-10]
13. Arora S, Venkataraman V, Zhan A, Donohue S, Biglan KM, Dorsey ER, Little MA. Detecting and monitoring the symptoms of Parkinson's disease using smartphones: A pilot study. Parkinsonism & related disorders. 2015 Jun 1;21(6):650-3.
14. Yao R, Zhang W, Evans R, Cao G, Rui T, Shen L. Inequities in health care services caused by the adoption of digital health technologies: scoping review. Journal of medical Internet research. 2022 Mar 21;24(3):e34144.
15. NHS. Remote ECG monitoring to support mental health patients in the North East and Yorkshire. NHS England. Available from: https://transform.england.nhs.uk/covid-19-response/technology-nhs/remote-ecg-monitoring-to-support-mental-health-patients-in-the-north-east-and-yorkshire/#:~:text=The%20project%20aims%20to%3A,process%20quicker%20for%20the%20patient [accessed 2025-02-10]

16. Board E. mHealth: use of appropriate digital technologies for public health: report by the Director-General. World Health Organization. 2017:2020-06.

17. Rahimi K. Digital health and the elusive quest for cost savings. The Lancet Digital Health. 2019 Jul 1;1(3):e108-9.

18. Gentili A, Failla G, Melnyk A, Puleo V, Tanna GL, Ricciardi W, Cascini F. The cost-effectiveness of digital health interventions: a systematic review of the literature. Frontiers in Public Health. 2022 Aug 11;10:787135.

19. Handa T, Onoue T, Kobayashi T, Maeda R, Mizutani K, Yamagami A, Kinoshita T, Yasuda Y, Iwama S, Miyata T, Sugiyama M. Effects of digitization of self-monitoring of blood glucose records using a mobile app and the cloud system on outpatient management of diabetes: Single-armed prospective study. JMIR diabetes. 2024 Jan 19;9(1):e48019.

20. Kletečka-Pulker M, Voelkl-Kernstock S, Fassl A, Klager E, Willschke H, Klomfar S, Wochele-Thoma T, Schaden E, Atanasov AG. Telehealth in times of COVID-19: spotlight on Austria. InHealthcare 2021 Mar 4 (Vol. 9, No. 3, p. 280). MDPI.

21. Petracca F, Ciani O, Cucciniello M, Tarricone R. Harnessing digital health technologies during and after the COVID-19 pandemic: context matters. Journal of medical Internet research. 2020 Dec 30;22(12):e21815.

22. Alhnan MA, Okwuosa TC, Sadia M, Wan KW, Ahmed W, Arafat B. Emergence of 3D printed dosage forms: opportunities and challenges. Pharmaceutical research. 2016 Aug;33:1817-32.

23. Basit AW, Gaisford S, editors. 3D printing of pharmaceuticals. Berlin, Germany:: Springer International Publishing; 2018 Aug 6.

24. Dorociak KE, Mattek N, Ferguson JE, Beattie ZT, Sharma N, Kaye JA, Leese MI, Doane BM, Hughes AM. Subtle changes in medication-taking are associated with incident mild cognitive impairment. Alzheimer Disease & Associated Disorders. 2021 Jul 1;35(3):237-43.

25. NIHR. Improving inclusion of under-served groups in clinical research: Guidance from INCLUDE project (August 2024 v3.0). Available from:

https://www.nihr.ac.uk/documents/improving-inclusion-of-under-served-groups-in-clinical-research-guidance-from-include-project/25435 [accessed 2025-02-11]

26. Global Health Europe. Inequity and Inequality in Health (24 August 2009). Available from: https://globalhealtheurope.org/values/inequity-and-inequality-in-health/ [accessed 2025-02-11]
27. World Health Organization. Health inequities and their causes (22 Feb 2018). Available from: https://www.who.int/news-room/facts-in-pictures/detail/health-inequities-and-their-causes [accessed 2025-02-11]
28. Services Australia. Medicare. Available from: https://www.servicesaustralia.gov.au/medicare [accessed 2025-02-11]
29. Pickett KE, Wilkinson RG. Immorality of inaction on inequality. BMJ. 2017 Feb 8;356.
30. World Health Organization. Social determinants of health. Available from: https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1 [accessed 2025-02-11]
31. UK Parliament House of Commons Library. Health inequalities: Income deprivation and north/south divides (22 January 2019). Available from: https://commonslibrary.parliament.uk/health-inequalities-income-deprivation-and-north-south-divides/ [accessed 2025-02-11]
32. Stronks K, van de Mheen HD, Mackenbach JP. A higher prevalence of health problems in low income groups: does it reflect relative deprivation?. Journal of Epidemiology & Community Health. 1998 Sep 1;52(9):548-57.
33. Blackburn C. Poverty and Health: Working with Families. Open University Press, 1900 Frost Road, Suite 101, Bristol, PA 19007 (paperback: ISBN-0-335-09734-0; clothbound: ISBN-0-335-0-335-09735-9); Open University Press, Celtic Court, 22 Ballmoor, Buckingham, England, United Kingdom MK18 1XW.; 1991.
34. Parson L. Considering positionality: The ethics of conducting research with marginalized groups. Research methods for social justice and equity in education. 2019:15-32.

35. Wallerstein N, Muhammad M, Sanchez-Youngman S, Rodriguez Espinosa P, Avila M, Baker EA, Barnett S, Belone L, Golub M, Lucero J, Mahdi I. Power dynamics in community-based participatory research: A multiple–case study analysis of partnering contexts, histories, and practices. Health Education & Behavior. 2019 Oct;46(1_suppl):19S-32S.
36. Siette J, Meka A, Antoniades J. Breaking the barriers: overcoming dementia-related stigma in minority communities. Frontiers in Psychiatry. 2023 Dec 20;14:1278944.
37. Karamacoska D, Shatnawi E, Ali Y, Leehy M, Woodward J, Sanabria Vasquez F, Morrison N, Siette J, Steiner GZ, DiGiacomo M, Dadich AM. How to co-create a multicultural dementia education initiative. NHMRC Research Translation Long Weekend, 17-21 November 2022, Canberra, Australia. 2022.
38. Purcell DW. Forty years of HIV: the intersection of laws, stigma, and sexual behavior and identity. American Journal of Public Health. 2021 Jul;111(7):1231-3.
39. Allam I, Gresham M, Phillipson L, Brodaty H, Low LF. Beliefs around help-seeking and support for dementia in the Australian Arabic speaking community. Dementia. 2023 Jul;22(5):995-1009.
40. Low LF, Draper B, Cheng A, Cruysmans B, Hayward-Wright N, Jeon YH, LoGiudice D, Wu HZ, Zogalis G, Brodaty H. Future research on dementia relating to culturally and linguistically diverse communities. Australasian Journal on Ageing. 2009 Sep;28(3):144-8.
41. Low LF, Barcenilla-Wong AL, Brijnath B. Including ethnic and cultural diversity in dementia research. Medical journal of Australia. 2019 Oct;211(8):345-6.
42. Low LF, Purwaningrum F. Negative stereotypes, fear and social distance: a systematic review of depictions of dementia in popular culture in the context of stigma. BMC geriatrics. 2020 Dec;20:1-6.
43. Williams DR, Lawrence JA, Davis BA, Vu C. Understanding how discrimination can affect health. Health services research. 2019 Dec;54:1374-88.
44. Gaston GB, Alleyne-Green B. The impact of African Americans' beliefs about HIV medical care on treatment adherence: a systematic review and recommendations for interventions. AIDS and Behavior. 2013 Jan;17:31-40.

45. Ben J, Cormack D, Harris R, Paradies Y. Racism and health service utilisation: A systematic review and meta-analysis. PloS one. 2017 Dec 18;12(12):e0189900.

46. Coe D, Bigirumurame T, Burgess M, Rouse J, Wroe C. Enablers and barriers to engaging under-served groups in research: Survey of the United Kingdom research professional's views. NIHR Open Research. 2023 Dec 18;3:37.

47. NHS England, Digital. Digital inclusion guide for health and social care (7 September 2022). Available from: https://digital.nhs.uk/about-nhs-digital/our-work/digital-inclusion [accessed 2025-02-11]

48. NHS England. Important and urgent–next steps on NHS response to COVID-19 (17 March 2020). Available from: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/urgent-next-steps-on-nhs-response-to-covid-19-letter-simon-stevens.pdf [accessed 2025-02-11]

49. Operario D, King EJ, Gamarel KE. Prioritizing community partners and community HIV workers in the COVID-19 pandemic. AIDS and Behavior. 2020 Oct;24:2748-50.

50. Marhefka SL, Lockhart E, Turner D, Wang W, Dolcini MM, Baldwin JA, Roig-Romero RM, Lescano CM, Glueckauf RL. Social determinants of potential eHealth engagement among people living with HIV receiving Ryan white case management: health equity implications from project TECH. AIDS and Behavior. 2020 May;24:1463-75.

51. Mitchell UA, Chebli PG, Ruggiero L, Muramatsu N. The digital divide in health-related technology use: the significance of race/ethnicity. The Gerontologist. 2019 Jan 9;59(1):6-14.

52. NHS England. Inclusive digital healthcare: a framework for NHS action on digital inclusion (published: 28 September, 2023, last updated: 1 March, 2024). Available from: https://www.england.nhs.uk/long-read/inclusive-digital-healthcare-a-framework-for-nhs-action-on-digital-inclusion/#:~:text=Digital%20exclusion%20can%20compound%20health,to%20lead%20a%20healthy%20life. [accessed 2025-02-11]

53. Gibbons C. Digital access disparities: policy and practice overview. InPanel Discussion, Digital Skills and Connectivity as Social Determinants of Health. Sheon, A Conference Report: Digital

Skills: A Hidden “Super” Social Determinant of Health: Interdisciplinary Association for Population Health Science 2018 Oct 15.

54. Sieck CJ, Sheon A, Ancker JS, Castek J, Callahan B, Siefer A. Digital inclusion as a social determinant of health. NPJ digital medicine. 2021 Mar 17;4(1):52.
55. Bloomer E. Public Health England Local action on health inequalities: Increasing employment opportunities and improving workplace health (September 2014). Available from: https://assets.publishing.service.gov.uk/media/5a7eecf2ed915d74e6227559/Review5_Employment_health_inequalities.pdf [accessed 2025-02-11]
56. Diao JA, Wu GJ, Taylor HA, Tucker JK, Powe NR, Kohane IS, Manrai AK. Clinical implications of removing race from estimates of kidney function. Jama. 2021 Jan 12;325(2):184-6.
57. Saeed SA, Masters RM. Disparities in health care and the digital divide. Current psychiatry reports. 2021 Sep;23:1-6.
58. Levey AS, Titan SM, Powe NR, Coresh J, Inker LA. Kidney disease, race, and GFR estimation. Clinical Journal of the American Society of Nephrology. 2020 Aug 1;15(8):1203-12.
59. Ajmal, Boonya-Ananta T, Rodriguez AJ, Du Le VN, Ramella-Roman JC. Monte Carlo analysis of optical heart rate sensors in commercial wearables: the effect of skin tone and obesity on the photoplethysmography (PPG) signal. Biomedical optics express. 2021 Nov 10;12(12):7445-57.
60. Kaihlanen AM, Virtanen L, Buchert U, Safarov N, Valkonen P, Hietapakka L, Hörhammer I, Kujala S, Kouvonen A, Heponiemi T. Towards digital health equity-a qualitative study of the challenges experienced by vulnerable groups in using digital health services in the COVID-19 era. BMC health services research. 2022 Feb 12;22(1):188.
61. Elena-Bucea A, Cruz-Jesus F, Oliveira T, Coelho PS. Assessing the role of age, education, gender and income on the digital divide: Evidence for the European Union. Information Systems Frontiers. 2021 Aug;23:1007-21.
62. Estacio EV, Whittle R, Protheroe J. The digital divide: examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. Journal of health psychology. 2019 Oct;24(12):1668-75.

63. UK Parliament. The Government has “no credible strategy” to tackle digital exclusion (29 June 2023). Available from: https://committees.parliament.uk/committee/170/communications-and-digital-committee/news/196028/the-government-has-no-credible-strategy-to-tackle-digital-exclusion/ [accessed 2025-02-12]
64. OECD. Regulatory Reform as a Tool for Bridging the Digital Divide. OECD Digital Economy Papers. 2005; No. 90,
65. United Nations. The 17 goals: sustainable development. Available from: https://sdgs.un.org/goals [accessed 2025-02-12]
66. OECD Building better societies through digital policy: Background paper for the CDEP Ministerial meeting. OECD Digital Economy Papers. 2022; No. 338.
67. OECD. Promoting high-quality broadband networks in G20 countries, OECD Publishing. 2021.
68. World Health Organization Guideline. Recommendations on digital interventions for health system strengthening. 2019:2020-10.
69. European Medicines Agency. Questions and answers: qualification of digital technology-based methodologies to support approval of medicinal products (2020). Available from: https://www.ema.europa.eu/en/documents/other/questions-and-answers-qualification-digital-technology-based-methodologies-support-approval-medicinal-products_en.pdf [accessed 2025-02-12]
70. US Food and Drug Administration. Digital health Technologies for Remote Data Acquisition in clinical investigations: guidance for industry, investigators, and other stakeholders. (December 2023). Available from: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/digital-health-technologies-remote-data-acquisition-clinical-investigations [accessed 2025-02-12]
71. UK Parliament House of Lords Library. Digital exclusion in the UK: Communications and Digital Committee report (30 January 2024). Available from: https://lordslibrary.parliament.uk/digital-exclusion-in-the-uk-communications-and-digital-committee-report/#ref-2 [accessed 2025-02-13]

72. LLYODS. UK Consumer Digital Index 2024. Available from: https://www.lloydsbank.com/consumer-digital-index.html [accessed 2025-02-13]

73. Ofcom. Adults' Media Use and Attitudes report (30 March 2022). Available from: https://www.ofcom.org.uk/siteassets/resources/documents/research-and-data/media-literacy-research/adults/adults-media-use-and-attitudes-2022/adults-media-use-and-attitudes-report-2022.pdf?v=327649 [accessed 2025-02-13]

74. UK Parliament Committees. The Government has "no credible strategy" to tackle digital exclusion (29 June 2023). Available from: https://committees.parliament.uk/committee/170/communications-and-digital-committee/news/196028/the-government-has-no-credible-strategy-to-tackle-digital-exclusion/ [accessed 2025-02-13]

75. UK Government Department for Digital, Culture, Media & Sport. Low cost broadband and mobile phone tariffs (25 November 2022). Available from: https://www.gov.uk/government/news/low-cost-broadband-and-mobile-phone-tariffs [accessed 2025-02-13]

76. Ofcom. Social tariffs: Cheaper broadband and phone packages (Published: 6 March 2024Last updated: 7 November 2024). Available from: https://www.ofcom.org.uk/phones-and-broadband/saving-money/social-tariffs [accessed 2025-02-13]

77. UK Government Department for Science, Innovation and Technology. Rural Connectivity Accelerator programme: projects (11 November 2024). Available from: https://www.gov.uk/government/publications/rural-connectivity-accelerator-programme-projects#:~:text=It%20aims%20to%20provide%20tangible,rural%20and%20otherwise%20inaccessible%20areas. [accessed 2025-02-13]

78. UNICEF. Closing the Digital Divide for Good: an end to digital exclusion for children and young people in the UK. Available from: https://www.unicef.org.uk/policy/closing-the-digital-divide-uk/ [accessed 2025-02-13]

79. Good Things Foundation. Our digital inclusion services. Available from: https://www.goodthingsfoundation.org/our-services [accessed 2025-02-13]

80. NHS England. Inclusive digital healthcare: a framework for NHS action on digital inclusion (published: 28 September 2023, last updated: 1 March 2024). Available from: https://www.england.nhs.uk/long-read/inclusive-digital-healthcare-a-framework-for-nhs-action-on-digital-inclusion/#domains-for-action [accessed 2025-02-13]

81. NHS England. Supporting digital inclusion in general practice: 10 top tips. (published: 11 July 2023, last updated: 28 September 2023). Available from: https://www.england.nhs.uk/long-read/supporting-digital-inclusion-in-general-practice-10-top-tips/#:~:text=For%20NHS%20patients%2C%20digital%20inclusion,confidently%20to%20access%20NHS%20services [accessed 2025-02-13]

82. Office for national statistics. Life expectancy for local areas in England, Northern Ireland and Wales: between 2001 to 2003 and 2020 to 2022. (published 26 January 2024). Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/lifeexpectancyforlocalareasoftheuk/between2001to2003and2020to2022 [accessed 2025-02-18]

83. Corris V, Dormer E, Brown A, Whitty P, Collingwood P, Bambra C, Newton JL. Health inequalities are worsening in the North East of England. British Medical Bulletin. 2020 Jun;134(1):63-72.

84. Office for national statistics. Regional gross disposable household income, UK: 1997 to 2018 (published: 4 June 2020). Available from: https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/1997to2018 [accessed 2025-02-18]

85. Good Things Foundation. Homeless and insecurely housed people in Hastings. Available from: https://digital-health-lab.org/hastings [accessed 2025-02-18]

86. Good Things Foundation. A Digital Health Hub on the High Street in Nailsea. Available from: https://digital-health-lab.org/nailsea [accessed 2025-02-18]

87. 100% Digital Leeds. Our approach. Available from: https://digitalinclusionleeds.com/our-work/our-approach [accessed 2025-02-18]

88. Greater Manchester Combined Authority. Digital inclusion: helping residence to live well in the digital age (published 18 October 2024). Available from: https://www.greatermanchester-ca.gov.uk/news/helping-residents-to-live-well-in-the-digital-age-greater-manchester-takes-major-step-towards-closing-the-digital-divide-with-new-digital-champion-volunteer-training-programme [accessed 2025-02-18]
89. North East and North Cumbria Local Maternity and Neonatal System. South Tees midwife improves digital inclusion. Available from: https://northernlms.org/south-tees-midwife-improves-digital-inclusion/ [accessed 2025-02-18]
90. Wilson-Menzfeld G, Erfani G, Charlton MW, De Luca H, Brittain K, Steven A, Young-Murphy L. Understanding Digital Exclusion across North Tyneside (published February 2023). Available from: https://researchportal.northumbria.ac.uk/ws/portalfiles/portal/92647654/Final_report_Understanding_Digital_Exclusion_across_North_Tyneside.pdf [accessed 2025-02-18]
91. Chamberlain K, Cain T, Sheridan J, Dupuis A. Pluralisms in qualitative research: From multiple methods to integrated methods. Qualitative research in psychology. 2011 Apr 1;8(2):151-69.
92. Blaikie N. Approaches to social enquiry: Advancing knowledge. Polity; 2007 Sep 24.
93. Andreas; Hay Gofas, Gofas A, Hay C. The role of ideas in political analysis. London: Routledge; 2010.
94. Aliyu AA, Bello MU, Kasim R, Martin D. Positivist and non-positivist paradigm in social science research: Conflicting paradigms or perfect partners. J. Mgmt. & Sustainability. 2014;4:79.
95. Durkheim E. The Rules of Sociological Method. trans. Sarah A. Solovay and John M. Mueller, ed. George EG Fatlin (1938).
96. Guba EG, Lincoln YS. Competing paradigms in qualitative research. Handbook of qualitative research. 1994 Jun;2(163-194):105.
97. Creswell JW. Research design: Qualitative, quantitavie and mixed methods approaches. Sage publications; 2003.

98. Hay C. Political ontology. The Oxford handbook of contextual political analysis. 2006 Mar 16;5:78-96.
99. Ylönen M, Aven T. A framework for understanding risk based on the concepts of ontology and epistemology. Journal of risk research. 2023 Jun 3;26(6):581-93.
100. Thompson MJ. Toward a critical social ontology. InThe Philosophical Forum 2023 Jun (Vol. 54, No. 1-2, pp. 61-78).
101. O'Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M, Evans T, Pardo JP, Waters E, White H, Tugwell P. Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. Journal of clinical epidemiology. 2014 Jan 1;67(1):56-64.
102. Mays N, Roberts E, Popay J. Synthesising research evidence. InStudying the organisation and delivery of health services 2004 Jun 2 (pp. 200-232). Routledge.
103. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International journal of social research methodology. 2005 Feb 1;8(1):19-32.
104. Munn Z, Peters MD, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC medical research methodology. 2018 Dec;18:1-7.
105. Amir-Behghadami M, Janati A. Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. Emergency Medicine Journal. 2020 Apr 6.
106. Belbasis L, Bellou V, Ioannidis JP. Conducting umbrella reviews. BMJ medicine. 2022 Nov 22;1(1):e000071
107. Berman Y. INFUSE [Information Uses in Social Welfare]—Delineation of a grey document. Eurosocial Newsletter. 1992;59:39-43.
108. Mays N, Pope C, Popay J. Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. Journal of health services research & policy. 2005 Jul;10(1_suppl):6-20.

109. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review-a new method of systematic review designed for complex policy interventions. Journal of health services research & policy. 2005 Jul;10(1_suppl):21-34.
110. Sukhera J. Narrative reviews: flexible, rigorous, and practical. Journal of graduate medical education. 2022 Aug 1;14(4):414-7.
111. Khalil H, Tricco AC. Differentiating between mapping reviews and scoping reviews in the evidence synthesis ecosystem. Journal of Clinical Epidemiology. 2022 Sep 1;149:175-82.
112. Wong G. Realist reviews in health policy and systems research. InEvidence synthesis for health policy and systems: A methods guide 2018 Oct 8. World Health Organization.
113. Duddy C, Wong G. Grand rounds in methodology: when are realist reviews useful, and what does a 'good'realist review look like?. BMJ Quality & Safety. 2023 Mar 1;32(3):173-80.
114. University Libraries. Evidence Synthesis and Systematic Reviews. (last updated February 2025). Available from: https://guides.temple.edu/c.php?g=78618&p=9548660#:~:text=Definition:%20A%20systematic%20review%20is,Reporting%20the%20review [accessed 2025-08-11]
115. Patton MQ. Alternative Evaluation Research Paradigm. 1975 Grand Forks, ND: University of North Dakota.
116. Sofaer S. Qualitative methods: what are they and why use them?. Health services research. 1999 Dec;34(5 Pt 2):1101.
117. University of South Florida. Systematic Reviews for Social Sciences. (last updated June 2025). Available from: https://guides.lib.usf.edu/systematicreviews/mapping [accessed 2025-08-11]
118. Christou E, Parmaxi A, Zaphiris P. A systematic exploration of scoping and mapping literature reviews. Universal access in the information society. 2025 Mar;24(1):941-51.
119. Ballinger C, Payne S. Falling from grace or into expert hands? Alternative accounts about falling in older people. British Journal of Occupational Therapy. 2000 Dec;63(12):573-9.
120. Ayrton R. The micro-dynamics of power and performance in focus groups: an example from discussions on national identity with the South Sudanese diaspora in the UK. Qualitative Research. 2019 Jun;19(3):323-39.

121. McGrath C, Palmgren PJ, Liljedahl M. Twelve tips for conducting qualitative research interviews. Medical teacher. 2019 Sep 2;41(9):1002-6.
122. Lingard L, Kennedy TJ. Qualitative research methods in medical education. Understanding medical education: evidence, theory and practice. 2010 Jul 30:323-35.
123. Segal DL, Coolidge FL, O'Riley A, Heinz BA. Structured and semistructured interviews. InClinician's handbook of adult behavioral assessment 2006 Jan 1 (pp. 121-144). Academic Press.
124. Adeoye-Olatunde OA, Olenik NL. Research and scholarly methods: Semi-structured interviews. Journal of the american college of clinical pharmacy. 2021 Oct;4(10):1358-67.
125. Legard R, Keegan J, Ward K. In-depth interviews. Qualitative research practice: A guide for social science students and researchers. 2003 Feb 18;6(1):138-69.
126. DiCicco-Bloom B, Crabtree BF. The qualitative research interview. Medical education. 2006 Apr;40(4):314-21.
127. Brinkmann, S., & Kvale, S. (2015). InterViews: Learning the craft of qualitative research interviewing (3rd ed.). London: SAGE.
128. Seidman I. Interviewing as qualitative research: A guide for researchers in education and the social sciences. Teachers college press; 2006.
129. Namey E, Guest G, McKenna K, Chen M. Evaluating bang for the buck: a cost-effectiveness comparison between individual interviews and focus groups based on thematic saturation levels. American Journal of Evaluation. 2016 Sep;37(3):425-40.
130. Gibbs A. Focus groups. Social research update. 1997 Mar 8;19(8):1-8.
131. Kitzinger J. Qualitative research: introducing focus groups. Bmj. 1995 Jul 29;311(7000):299-302.
132. Reisner SL, Randazzo RK, White Hughto JM, Peitzmeier S, DuBois LZ, Pardee DJ, Marrow E, McLean S, Potter J. Sensitive health topics with underserved patient populations: Methodological considerations for online focus group discussions. Qualitative health research. 2018 Aug;28(10):1658-73.
133. Powell RA. HM Single. Focus groups IJ Qual Health Care. 1996;8:499-504.

134. Smithson J. Using and analysing focus groups: limitations and possibilities. International journal of social research methodology. 2000 Jan 1;3(2):103-19.
135. Mahood Q, Van Eerd D, Irvin E. Searching for grey literature for systematic reviews: challenges and benefits. Research synthesis methods. 2014 Sep;5(3):221-34.
136. Google Search. Automatically generating and ranking results. Available from: https://www.google.com/intl/en_us/search/howsearchworks/how-search-works/ranking-results/#:~:text=After%20identifying%20relevant%20content%2C%20our,expertise%2C%20authoritativeness%2C%20and%20trustworthiness. [accessed 2025-02-24]
137. Pope C, Mays N. Qualitative research: reaching the parts other methods cannot reach: an introduction to qualitative methods in health and health services research. bmj. 1995 Jul 1;311(6996):42-5.
138. Popay J, Roberts H, Sowden A, Petticrew M, Arai L, Rodgers M, Britten N, Roen K, Duffy S. Guidance on the conduct of narrative synthesis in systematic reviews. A product from the ESRC methods programme Version. 2006 Apr 1;1(1):b92.
139. Asgary R, Sckell B, Alcabes A, Naderi R, Adongo P, Ogedegbe G. Perceptions, attitudes, and experience regarding mHealth among homeless persons in New York City shelters. Journal of health communication. 2015 Dec 2;20(12):1473-80.
140. Holgersson J, Söderström E. Bridging the gap: Exploring elderly citizens' perceptions of digital exclusion. In27th European Conference on Information Systems (ECIS), Stockholm & Uppsala, Sweden, June 8-14, 2019 2019. Association for Information Systems.
141. Jamil S. From digital divide to digital inclusion: Challenges for wide-ranging digitalization in Pakistan. Telecommunications Policy. 2021 Sep 1;45(8):102206.
142. Alvarez-Galvez J, Salinas-Perez JA, Montagni I, Salvador-Carulla L. The persistence of digital divides in the use of health information: A comparative study in 28 European countries. International Journal of Public Health. 2020 Apr;65:325-33.
143. Dilmaghani M. Religiosity and the digital divide in Canada. The Communication Review. 2018 Jul 3;21(3):181-211.

144. Rhoades H, Wenzel SL, Rice E, Winetrobe H, Henwood B. No digital divide? Technology use among homeless adults. Journal of Social Distress and the Homeless. 2017 Jan 2;26(1):73-7.
145. Harris J. The use, role and application of advanced technology in the lives of disabled people in the UK. InDisability and Technology 2017 Oct 2 (pp. 80-127). Routledge.
146. Bix AS. 'Remember the Sabbath': a history of technological decisions and innovation in Orthodox Jewish communities. History and Technology. 2020 Apr 2;36(2):205-39.
147. Yao Y, Zhang H, Liu X, Liu X, Chu T, Zeng Y. Bridging the digital divide between old and young people in China: challenges and opportunities. The Lancet Healthy Longevity. 2021 Mar 1;2(3):e125-6.
148. Husain L, Greenhalgh T, Hughes G, Finlay T, Wherton J. Desperately seeking intersectionality in digital health disparity research: narrative review to inform a richer theorization of multiple disadvantage. Journal of Medical Internet Research. 2022 Dec 7;24(12):e42358.
149. Reiners F, Sturm J, Bouw LJ, Wouters EJ. Sociodemographic factors influencing the use of eHealth in people with chronic diseases. International journal of environmental research and public health. 2019 Feb;16(4):645.
150. Gov.uk. People in low income households. Available from: https://www.ethnicity-facts-figures.service.gov.uk/work-pay-and-benefits/pay-and-income/people-in-low-income-households/latest [accessed 2025-02-25].
151. Ofcom. Digital exclusion: A review of Ofcom's research on digital exclusion among adults in the UK (Published: 30 March 2022). Available from: https://www.ofcom.org.uk/siteassets/resources/documents/research-and-data/media-literacy-research/adults/adults-media-use-and-attitudes-2022/digital-exclusion-review-2022.pdf?v=327651 [accessed 2025-02-25].
152. Islam.org. Rules related to socializing. Available from: https://al-islam.org/code-ethics-muslim-men-and-women/rules-related-socializing#:~:text=B)-,Women%20Talking%20To%20Non%2DMahram%20Men,and%20seeking%20(sexual)%20pleasure. [accessed 2025-02-25].

153. Lee J, Trudel R. Man up! The mental health-feminine stereotype and its effect on the adoption of mental health apps. Journal of Consumer Psychology. 2024 Jan 8.

154. Addis ME, Mahalik JR. Men, masculinity, and the contexts of help seeking. American psychologist. 2003 Jan;58(1):5.

155. Liu X, Wang X, Zhang H, Pei M, Li N. Relationship between digital exclusion and cognitive impairment in Chinese adults. Frontiers in Aging Neuroscience. 2023 Jul 3;15:1194348.

156. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MD, Horsley T, Weeks L, Hempel S. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Annals of internal medicine. 2018 Oct 2;169(7):467-73.

157. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021 Mar 29;372.

158. Budhwani S, Fujioka J, Thomas-Jacques T, De Vera K, Challa P, De Silva R, Fuller K, Shahid S, Hogeveen S, Chandra S, Bhatia RS. Challenges and strategies for promoting health equity in virtual care: findings and policy directions from a scoping review of reviews. Journal of the American Medical Informatics Association. 2022 May 1;29(5):990-9.

159. Chandler J, Cumpston M, Li T, Page MJ, Welch VJ. Cochrane handbook for systematic reviews of interventions. Hoboken: Wiley. 2019;4.

160. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. Health affairs. 2008 May;27(3):759-69.

161. Rayyan. AI powered tool for Systematic Literature Reviews. Available from: https://www.rayyan.ai/ [accessed 2025-02-28].

162. Critical Appraisal Skills Programme (2018). CASP Checklist: CASP Qualitative Studies Checklist (2018). Available at: https://casp-uk.net/casp-tools-checklists/qualitative-studies-checklist/ . [accessed: 2023-04-30]

163. Lucas PJ, Baird J, Arai L, Law C, Roberts HM. Worked examples of alternative methods for the synthesis of qualitative and quantitative research in systematic reviews. BMC medical research methodology. 2007 Dec;7:1-7.

164. Wertz FJ. Five ways of doing qualitative analysis: Phenomenological psychology, grounded theory, discourse analysis, narrative research, and intuitive inquiry. Guilford Press; 2011 Mar 29.

165. Alkureishi MA, Choo ZY, Rahman A, Ho K, Benning-Shorb J, Lenti G, Velázquez Sánchez I, Zhu M, Shah SD, Lee WW. Digitally disconnected: qualitative study of patient perspectives on the digital divide and potential solutions. JMIR human factors. 2021 Dec 15;8(4):e33364.

166. Choxi H, VanDerSchaaf H, Li Y, Morgan E. Telehealth and the digital divide: identifying potential care gaps in video visit use. Journal of medical systems. 2022 Jul 30;46(9):58.

167. Kim H, Zhang Y. Health information seeking of low socioeconomic status Hispanic adults using smartphones. Aslib Journal of Information Management. 2015 Sep 21;67(5):542-61.

168. Kramer J, Yinusa-Nyahkoon L, Olafsson S, Penti B, Woodhams E, Bickmore T, Jack BW. Black men's experiences with health care: individuals' accounts of challenges, suggestions for change, and the potential utility of virtual agent technology to assist black men with health management. Qualitative Health Research. 2021 Aug;31(10):1772-85.

169. Howells K, Amp M, Burrows M, Brown J, Brennan R, Dickinson J, Jackson S, Yeung WL, Ashcroft D, Campbell S, Blakeman T. Remote primary care during the COVID-19 pandemic for people experiencing homelessness: a qualitative study. British Journal of General Practice. 2022 Jul 1;72(720):e492-500.

170. Maidment DW, Heyes R, Gomez R, Coulson NS, Wharrad H, Ferguson MA. Evaluating a theoretically informed and cocreated mobile health educational intervention for first-time hearing aid users: qualitative interview study. JMIR mHealth and uHealth. 2020 Aug 5;8(8):e17193.

171. Mizrachi Y, Shahrabani S, Nachmani M, Hornik A. Obstacles to using online health services among adults age 50 and up and the role of family support in overcoming them. Israel Journal of Health Policy Research. 2020 Dec;9:1-0.

172. Wikaire E, Harwood M, Wikaire-Mackey K, Crengle S, Brown R, Anderson A, Jansen RM, Keenan R. Reducing healthcare inequities for Māori using Telehealth during COVID-19. NZ Med J. 2022 Apr 1;135(1552):112-7.

173. Yeong JL, Thomas P, Buller J, Moosajee M. A newly developed web-based resource on genetic eye disorders for users with visual impairment (Gene. Vision): usability study. Journal of medical Internet research. 2021 Jan 20;23(1):e19151.

174. Legislation.gov.uk. The Public Sector Bodies (Websites and Mobile Applications) (No. 2) Accessibility Regulations 2018. Available from: https://www.legislation.gov.uk/uksi/2018/952/contents [accessed 2025-03-03]

175. Digital.gov. Checklist of requirements for federal websites and digital services: A self-assessment tool to review and evaluate product maturity. Available from: https://digital.gov/resources/checklist-of-requirements-for-federal-digital-services/ [accessed 2025-03-03]

176. Alajarmeh N. Evaluating the accessibility of public health websites: an exploratory cross-country study. Universal access in the information society. 2022 Aug;21(3):771-89.

177. Brach C, Fraserirector I. Can cultural competency reduce racial and ethnic health disparities? A review and conceptual model. Medical care research and review. 2000 Nov;57(1_suppl):181-217.

178. U.S. Department of Health and Human Services, Office of Minority Health. National Standards for Culturally and Linguistically Appropriate Services in Health and Health Care: Compendium of State-Sponsored National CLAS Standards Implementation Activities. Washington, DC: U.S. Department of Health and Human Services (2016).

179. Slattery P, Saeri AK, Bragge P. Research co-design in health: a rapid overview of reviews. Health research policy and systems. 2020 Dec;18:1-3.

180. Government Security Central Digital and Data Office (CDDO), Cabinet Office. Understanding business objectives and user needs. Available from: https://www.security.gov.uk/policy-and-guidance/secure-by-design/activities/understanding-business-objectives-and-user-needs/ [accessed 2025-03-03]

181. Government Security Central Digital and Data Office (CDDO), Cabinet Office. Secure by Design Principles. Available from: https://www.security.gov.uk/policy-and-guidance/secure-by-design/principles/#4-design-usable-security-controls [accessed 2025-03-03]

182. Verhagen LM, De Groot R, Lawrence CA, Taljaard J, Cotton MF, Rabie H. COVID-19 response in low-and middle-income countries: Don't overlook the role of mobile phone communication. International Journal of Infectious Diseases. 2020 Oct 1;99:334-7.
183. IJsselsteijn W, Tummers-Heemels A, Brankaert R. Warm technology: A novel perspective on design for and with people living with dementia. HCI and Design in the Context of Dementia. 2020:33-47.
184. Shull JG. Digital health and the state of interoperable electronic health records. JMIR medical informatics. 2019 Nov 1;7(4):e12712.
185. Landeiro F, Barrows P, Musson EN, Gray AM, Leal J. Reducing social isolation and loneliness in older people: a systematic review protocol. BMJ open. 2017 May 1;7(5):e013778.
186. Ige J, Gibbons L, Bray I, Gray S. Methods of identifying and recruiting older people at risk of social isolation and loneliness: a mixed methods review. BMC medical research methodology. 2019 Dec;19:1-1.
187. Tate S, Greatbatch D. Review of evidence on education in the north of England. London: Department for Education; 2016 Nov.
188. North East Combined Authority Evidence Hub. Qualification levels in the North East (Published: 11th April 2022, Last updated: 6th May 2024). Available from: https://evidencehub.northeast-ca.gov.uk/report/qualifications [accessed 2025-03-04].
189. Office for National Statistics. What are the regional differences in income and productivity? (Published 17th May 2021). Available from: https://www.ons.gov.uk/visualisations/dvc1370/ [accessed 2025-03-04].
190. Joseph Rowntree Foundation. UK Poverty 2024 (Published 23 January 2024). Available from: https://www.jrf.org.uk/uk-poverty-2024-the-essential-guide-to-understanding-poverty-in-the-uk#:~:text=Between%202019%2F20%20and%202021%2F22%2C%20the%20West%20Midlands,North%20West%20(all%2023%25) [accessed 2025-03-04]
191. North East Combined Authority Evidence Hub. Strategic Evidence Base: People (Published: 6th May 2024, last updated: 7th Nov 2024). Available from: https://evidencehub.northeast-ca.gov.uk/strategic-evidence-base-

people#:~:text=The%20North%20East%20has%20a,Sunderland%20built%20up%20areas)%E2%80%8B. [accessed 2025-03-04].

192. LLYODS bank. 2023 Consumer Digital Index: The UK's largest study of digital and financial lives. (Published November 2023). Available from: https://www.lloydsbank.com/assets/media/pdfs/banking_with_us/whats-happening/231122-lloyds-consumer-digital-index-2023-report.pdf [accessed 2025-03-04]
193. Wilson S, Tolley C, Mcardle R, Slight R, Slight S. Who is most at risk of digital exclusion within healthcare?. International Journal of Pharmacy Practice. 2024 Apr 1;32(Supplement_1):i3-4.
194. Hoogesteyn K, Verigin BL, Finnick D, Meijer EH. Rapport-building: Chat versus in-person witness interviews. Journal of Investigative Psychology and Offender Profiling. 2023 Jun;20(2):162-78.
195. Weller S. Using internet video calls in qualitative (longitudinal) interviews: Some implications for rapport. International journal of social research methodology. 2017 Nov 2;20(6):613-25.
196. Wilkinson O. Re-framing Common Themes in Religions and Development Research. The Review of Faith & International Affairs. 2022 Oct 2;20(4):91-106.
197. Taylor M. Research governance framework for health and social care. Health & social care in the community. 2002 Jan 1;10(1):6-9.
198. Matsuda Y, Brooks JL, Beeber LS. Guidelines for research recruitment of underserved populations (EERC). Applied Nursing Research. 2016 Nov 1;32:164-70.
199. Morse EV, Simon PM, Besch CL, Walker J. Issues of recruitment, retention, and compliance in community-based clinical trials with traditionally underserved populations. Applied Nursing Research. 1995 Feb 1;8(1):8-14.
200. Public Health England. Guidance: Inclusion Health: applying All Our Health (Published Updated 10 May 2021). Available from: https://www.gov.uk/government/publications/inclusion-health-applying-all-our-health/inclusion-health-applying-all-our-health [accessed 2025-03-04]
201. UK Parliament House of Lords Library. Health care in rural areas (Published 17 February, 2023). Available from: https://lordslibrary.parliament.uk/health-care-in-rural-areas/#heading-1 [accessed 2025-03-04].

202. Watt IS, Franks AJ, Sheldon TA. Health and health care of rural populations in the UK: is it better or worse?. Journal of Epidemiology & Community Health. 1994 Feb 1;48(1):16-21.

203. Kadambari S, Vanderslott S. Lessons about COVID-19 vaccine hesitancy among minority ethnic people in the UK. The Lancet Infectious Diseases. 2021 Sep 1;21(9):1204-6.

204. Salimi Y, Shahandeh K, Malekafzali H, Loori N, Kheiltash A, Jamshidi E, Frouzan AS, Majdzadeh R. Is community-based participatory research (CBPR) useful? A systematic review on papers in a decade. International journal of preventive medicine. 2012 Jun;3(6):386.

205. Tapp H, White L, Steuerwald M, Dulin M. Use of community-based participatory research in primary care to improve healthcare outcomes and disparities in care. Journal of Comparative Effectiveness Research. 2013 Jul;2(4):405-19.

206. Jamshidi E, Morasae EK, Shahandeh K, Majdzadeh R, Seydali E, Aramesh K, Abknar NL. Ethical considerations of community-based participatory research: Contextual underpinnings for developing countries. International journal of preventive medicine. 2014 Oct;5(10):1328.

207. Wilson E, Kenny A, Dickson-Swift V. Ethical challenges in community-based participatory research: A scoping review. Qualitative health research. 2018 Jan;28(2):189-99.

208. Löfman P, Pelkonen M, Pietilä AM. Ethical issues in participatory action research. Scandinavian journal of caring sciences. 2004 Sep;18(3):333-40.

209. Naderifar M, Goli H, Ghaljaie F. Snowball sampling: A purposeful method of sampling in qualitative research. Strides in development of medical education. 2017 Sep 30;14(3).

210. Gürbüz S. Survey as a quantitative research method. Research methods and techniques in public relations and advertising. 2017;2017:141-62.

211. Wilson S, Tolley C, Mc Ardle R, Lawson L, Beswick E, Hassan N, Slight R, Slight S. Recommendations to advance digital health equity: a systematic review of qualitative studies. NPJ digital medicine. 2024 Jun 29;7(1):173.

212. Green J and Thorogood N (2004) Qualitative Methods for Health Research. London: Sage.

213. Francis JJ, Johnston M, Robertson C, Glidewell L, Entwistle V, Eccles MP, Grimshaw JM. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. Psychology and health. 2010 Dec 1;25(10):1229-45.

214. Marshall MN. Sampling for qualitative research. Family practice. 1996 Jan 1;13(6):522-6.

215. Onwuegbuzie AJ, Leech NL. Taking the "Q" out of research: Teaching research methodology courses without the divide between quantitative and qualitative paradigms. Quality and Quantity. 2005 Jun;39:267-95.

216. Hennink M, Kaiser BN. Sample sizes for saturation in qualitative research: A systematic review of empirical tests. Social science & medicine. 2022 Jan 1;292:114523.

217. Malterud K, Siersma VD, Guassora AD. Sample size in qualitative interview studies: guided by information power. Qualitative health research. 2016 Nov;26(13):1753-60.

218. UK Government, Ministry of Housing, Communities & Local Government. English indices of deprivation 2019. Available from: https://imd-by-postcode.opendatacommunities.org/imd/2019 [accessed 2025-03-13].

219. Cooper HE, Camic PM, Long DL, Panter AT, Rindskopf DE, Sher KJ. APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological. American Psychological Association; 2012.

220. Byrne D. A worked example of Braun and Clarke's approach to reflexive thematic analysis. Quality & quantity. 2022 Jun;56(3):1391-412.

221. Braun V, Clarke V. Reflecting on reflexive thematic analysis. Qualitative research in sport, exercise and health. 2019 Aug 8;11(4):589-97.

222. Braun V, Clarke V, Hayfield N, Terry G. Answers to frequently asked questions about thematic analysis (Published: Oct 2019). Available from: https://cdn.auckland.ac.nz/assets/psych/about/our-research/documents/Answers%20to%20frequently%20asked%20questions%20about%20thematic%20analysis%20April%202019.pdf [accessed: 2025-03-14].

223. Ritchie J, Ormston R, McNaughton Nicholls C, Lewis J. Qualitative research practice: A guide for social science students and researchers. 2003, London: Sage.

224. Glaser B, Strauss A. Discovery of grounded theory: Strategies for qualitative research. Routledge; 2017 Jul 5.

225. Walker D, Myrick F. Grounded theory: An exploration of process and procedure. Qualitative health research. 2006 Apr;16(4):547-59.
226. Wilson S, Tolley C, Mc Ardle R, Beswick E, Slight SP. Key considerations when developing and implementing digital technology for early detection of dementia-causing diseases among health care professionals: qualitative study. Journal of Medical Internet Research. 2023 Aug 22;25:e46711.
227. Wilson S, Beswick E, Morrell R, Bhogal S, Tolley C, Whitfield T, Wing K, Ardle RM, Walker Z, Slight S. Acceptance of wearable technology for the early detection of dementia-causing diseases: perspectives from the CODEC II cohort. Alzheimer's & Dementia. 2024 Dec;20:e094258.
228. Neubauer BE, Witkop CT, Varpio L. How phenomenology can help us learn from the experiences of others. Perspectives on medical education. 2019 Apr;8:90-7.
229. Braun V, Clarke V. Successful qualitative research: A practical guide for beginners. 2013. Sage Publications, Thousand Oaks.
230. Patton MQ. Qualitative evaluation and research methods. SAGE Publications, inc; 1990.
231. Braun V, Clarke V. One size fits all? What counts as quality practice in (reflexive) thematic analysis?. Qualitative Research in Psychology. 2020; 18: 328–52
232. Ziebland S, McPherson A. Making sense of qualitative data analysis: an introduction with illustrations from DIPEx (personal experiences of health and illness). Medical education. 2006 May;40(5):405-14.
233. O’Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. Academic medicine. 2014 Sep 1;89(9):1245-51.
234. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International journal for quality in health care. 2007 Dec 1;19(6):349-57, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. Academic medicine. 2014 Sep 1;89(9):1245-51.

235. Lincoln YS, Guba EG. But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. New directions for program evaluation. 1986 Jun;1986(30):73-84.

236. Nowell LS, Norris JM, White DE, Moules NJ. Thematic analysis: Striving to meet the trustworthiness criteria. International journal of qualitative methods. 2017 Sep 28;16(1):1609406917733847.

237. Ahmed SK. The pillars of trustworthiness in qualitative research. Journal of Medicine, Surgery, and Public Health. 2024 Apr 1;2:100051.

238. Finlay L. Negotiating the swamp: the opportunity and challenge of reflexivity in research practice. Qualitative research. 2002 Aug;2(2):209-30.

239. Birt L, Scott S, Cavers D, Campbell C, Walter F. Member checking: a tool to enhance trustworthiness or merely a nod to validation?. Qualitative health research. 2016 Nov;26(13):1802-11.

240. Tobin GA, Begley CM. Methodological rigour within a qualitative framework. Journal of advanced nursing. 2004 Nov;48(4):388-96.

241. Lincoln YS, Guba EG. Naturalistic inquiry. Sage, Newberry Park; 1985.

242. Halpren ES. Auditing naturalistic inquiries: The development and application of a model (Unpublished doctoral dissertation). Indiana University, Bloomington. 1983.

243. Guba EG, Lincoln YS. Fourth generation evaluation. Sage; 1989

244. Leanza Y, Miklavcic A, Boivin I, Rosenberg E. Working with interpreters. InCultural consultation: Encountering the other in mental health care 2013 Jul 16 (pp. 89-114). New York, NY: Springer New York.

245. Magsamen-Conrad K, Dillon JM, Billotte Verhoff C, Faulkner SL. Online health-information seeking among older populations: family influences and the role of the medical professional. Health communication. 2019 Jul 3;34(8):859-71.

246. Hafkin N. Gender issues in ICT policy in developing countries: An overview. InUN division for the advancement of women expert group meeting on Information and communication technologies and their impact on and use as an instrument for the advancement and empowerment of women, Seoul, Republic of Korea 2002 Nov 11 (pp. 11-14).

247. Henry N, Vasil S, Flynn A, Kellard K, Mortreux C. Technology-facilitated domestic violence against immigrant and refugee women: A qualitative study. Journal of interpersonal violence. 2022 Jul;37(13-14):NP12634-60.

248. Good Things Foundation. Mitigating risks of digital exclusion in health systems (Published July 30th 2024). Available from: https://www.goodthingsfoundation.org/policy-and-research/research-and-evidence/research-2024/health-inequalities-digital-exclusion [accessed 2025-04-23].

249. Pierce P, Whitten M, Hillman S. The impact of digital healthcare on vulnerable pregnant women: A review of the use of the MyCare app in the maternity department at a central London tertiary unit. Frontiers in Digital Health. 2023 Apr 21;5:1155708.

250. Borges do Nascimento IJ, Abdulazeem H, Vasanthan LT, Martinez EZ, Zucoloto ML, Østengaard L, Azzopardi-Muscat N, Zapata T, Novillo-Ortiz D. Barriers and facilitators to utilizing digital health technologies by healthcare professionals. NPJ digital medicine. 2023 Sep 18;6(1):161.

251. Navarro-Martínez O, Igual-García J, Traver-Salcedo V. Bridging the educational gap in terms of digital competences between healthcare institutions' demands and professionals' needs. BMC nursing. 2023 Apr 27;22(1):144.

252. Kaihlanen AM, Virtanen L, Kainiemi E, Sulosaari V, Heponiemi T. Continuing education in digital skills for healthcare professionals—mapping of the current situation in EU Member States. International Journal of Health Policy and Management. 2024 Jun 24;13:8309.

253. NHS. GP surgery appointments. Available from: https://www.nhs.uk/nhs-app/nhs-app-help-and-support/appointments-and-online-consultations-in-the-nhs-app/gp-surgery-appointments/ [accessed 2025-04-23].

254. Good Things Foundation. Health inequalities and mitigating risks of digital exclusion (2nd edition, published: May 2024). Available from: https://www.goodthingsfoundation.org/dam/jcr:43bc6a26-98ae-4304-bc4e-

fcbcfa010d60/GoodThings_HealthInequalitiesAndMitigatingRisksOfDigitalExclusion_2024.pdf [accessed 2025-04-23].

255. Poduval S, Arnold L, Carta E, Nimmons D, Stratton I, Shaw M, Bradbury K, Stevenson F. Do community-based digital health inclusion programmes contribute to tackling health inequalities in disadvantaged population groups?: a qualitative study of experiences of a city-wide programme in the North of England. BMC Public Health. 2025 Jan 22;25(1):275.
256. Good Things Foundation. Basic Digital Skills: Expert Overview (published: January 23rd 2025). Available from: https://www.goodthingsfoundation.org/policy-and-research/what-works-colab/basic-digital-skills-briefing#routes [accessed 2025-04-23].
257. Good Things Foundation. Supporting digital inclusion for adults with low English language skills (published: March 17th 2020). Available from: https://www.goodthingsfoundation.org/policy-and-research/research-and-evidence/research-2024/supporting-digital-inclusion-adults-with-low-english-language-skills [accessed 2025-04-23].
258. Medhi I, Sagar A, Toyama K. Text-free user interfaces for illiterate and semi-literate users. In2006 international conference on information and communication technologies and development 2006 May 25 (pp. 72-82). IEEE.
259. Good Things Foundation. Find local digital inclusion support. Available from: https://www.goodthingsfoundation.org/find-support/map [accessed 2025-04-23].
260. OneDigitial. Developing digital skills in rural communities. Available from: https://www.onedigitaluk.com/knowledge-hub/developing-a-digital-champion-project/developing-digital-skills-in-rural-communities/ [accessed 2025-04-23].
261. Good Things Foundation. Digital Skills in rural settings using Learn My Way. Available from: https://www.goodthingsfoundation.org/discover/digital-inclusion-resources/learning-and-skills/using-learn-my-way-with-rural-learners [accessed 2025-04-23].
262. UK Government. Digital Inclusion Action Plan: First Steps (published: February 26th 2025). Available from: https://www.gov.uk/government/publications/digital-inclusion-action-plan-first-steps/digital-inclusion-action-plan-first-steps [accessed 2025-04-23].

263. Good Things Foundation. What Works? Co-Lab: What works for digital inclusion in the UK. Available from: https://www.goodthingsfoundation.org/policy-and-research/what-works-colab#:~:text=Good%20Things%20Foundation%20is%20launching,and%20aim%20for%20systemic%20change [accessed 2025-04-23].
264. Thomson LJ, Waterson H, Chatterjee HJ. Successes and challenges of partnership working to tackle health inequalities using collaborative approaches to community-based research: mixed methods analysis of focus group evidence. International Journal for Equity in Health. 2024 Jul 4;23(1):135.
265. Pratt R, Gyllstrom B, Gearin K, Lange C, Hahn D, Baldwin LM, VanRaemdonck L, Nease D, Zahner S. Identifying barriers to collaboration between primary care and public health: experiences at the local level. Public Health Reports. 2018 May;133(3):311-7.
266. Alderwick H, Hutchings A, Briggs A, Mays N. The impacts of collaboration between local health care and non-health care organizations and factors shaping how they work: a systematic review of reviews. BMC public health. 2021 Dec;21:1-6.
267. Steihaug S, Johannessen AK, Ådnanes M, Paulsen B, Mannion R. Challenges in achieving collaboration in clinical practice: the case of Norwegian health care. International journal of integrated care. 2016 Jul 18;16(3):3.
268. Cai Z, Mao P, Wang Z, Wang D, He J, Fan X. Associations between problematic internet use and mental health outcomes of students: a meta-analytic review. Adolescent research review. 2023 Mar;8(1):45-62.
269. Twenge JM, Joiner TE, Rogers ML, Martin GN. Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. Clinical psychological science. 2018 Jan;6(1):3-17.
270. Devi KA, Singh SK. The hazards of excessive screen time: Impacts on physical health, mental health, and overall well-being. Journal of Education and Health Promotion. 2023 Nov 1;12(1):413.

271. Gutman LM, Joshi H, Parsonage M, Schoon I. Children of the new century: Mental health findings from the Millennium Cohort Study. Centre for Mental Health Report. London, UK: Centre for Mental Health. 2015.
272. Housing LIN. The Unhealthy State of Homelessness: health audit results 2014 (published: May 1st 2014). Available from: https://www.housinglin.org.uk/Topics/type/The-Unhealthy-State-of-Homelessness-health-audit-results-2014/#:~:text=Research%20published%20Homeless%20Link%20shows,not%20getting%20the%20right%20help [accessed 2025-04-23].
273. Smith A. An Inquiry into the Nature and Causes of the Wealth of Nations. Readings in economic sociology. 2002 Jan 1:6-17.
274. Naslund JA, Bondre A, Torous J, Aschbrenner KA. Social media and mental health: benefits, risks, and opportunities for research and practice. Journal of technology in behavioral science. 2020 Sep;5(3):245-57.
275. Liphardt AM, Manger E, Liehr S, Bieniek L, Kleyer A, Simon D, Tascilar K, Sticherling M, Rech J, Schett G, Hueber AJ. Similar impact of psoriatic arthritis and rheumatoid arthritis on objective and subjective parameters of hand function. ACR open rheumatology. 2020 Dec;2(12):734-40.
276. de Vet R, Beijersbergen MD, Lako DA, van Hemert AM, Herman DB, Wolf JR. Differences between homeless women and men before and after the transition from shelter to community living: A longitudinal analysis. Health & Social Care in the Community. 2019 Sep;27(5):1193-203.
277. Springs Rescue Mission. A Hidden Side of Homelessness: Why Women Avoid Homeless Shelters. Available from: https://www.springsrescuemission.org/articles/a-hidden-side-of-homelessness-why-women-avoid-homeless-shelters#:~:text=Homeless%20women%20avoid%20staying%20in%20shelters&text=Some%20studies%20have%20found%20that,in%20a%20shelter%20with%20men [accessed 2025-04-23].

278. Crystal S. Homeless men and homeless women: The gender gap. Urban and social change review. 1984 Jan 1;17(2):2-6.
279. Age UK. Helping older people get online. Available from: https://www.ageuk.org.uk/our-impact/programmes/digital-skills/ [accessed 2025-04-23].
280. Bigman CA. Health campaigns: underserved/vulnerable populations. The International Encyclopedia of Health Communication. 2022:1-9.
281. Shamaskin AM, Mikels JA, Reed AE. Getting the message across: age differences in the positive and negative framing of health care messages. Psychology and aging. 2010 Sep;25(3):746.
282. Murayama H, Sasaki S, Takahashi Y, Takase M, Taguchi A. Message framing effects on attitude and intention toward social participation in old age. BMC public health. 2023 Sep 4;23(1):1713.
283. Jameson C, Haq Z, Musse S, Kosar Z, Watson G, Wylde V. Inclusive approaches to involvement of community groups in health research: the co-produced CHICO guidance. Research Involvement and Engagement. 2023 Sep 7;9(1):76.
284. NHS Cheshire and Merseyside. Supporting digital inclusion in Cheshire and Merseyside: Our toolkit and approach (published: June 2023). Available from: https://www.cheshireandmerseyside.nhs.uk/media/twihfeda/supporting-digital-inclusion-in-cheshire-merseyside-toolkit-and-approach.pdf [accessed 2025-04-23].
285. NHS Cheshire and Merseyside. Digital Inclusion in Cheshire and Merseyside. Available from: https://www.cheshireandmerseyside.nhs.uk/about/digital-and-data-strategy/digital-inclusion-in-cheshire-and-merseyside [accessed 2025-04-23].
286. Lincolnshire health intelligence hub. Lincolnshire Digital Health Toolkit. Available from: https://lhih.org.uk/lincolnshire-digital-health-toolkit/ [accessed 2025-04-23].
287. Greater Manchester Combined Authority. Digital Exclusion Risk Index (DERI) (published October 2021). Available from: https://www.greatermanchester-ca.gov.uk/what-we-do/digital/get-online-greater-manchester/greater-manchester-wide-support/digital-exclusion-risk-index-deri/ [accessed 2025-04-23].

288. Expedia. Mosaic segmentation groups and types. Available from: https://www.experian.co.uk/business/platforms/mosaic/segmentation-groups [accessed 2025-04-23].

289. University of Westminster. Making sense of Social Prescribing. Available from: https://westminsterresearch.westminster.ac.uk/download/f3cf4b949511304f762bdec137844251031072697ae511a462eac9150d6ba8e0/1340196/Making-sense-of-social-prescribing%202017.pdf [accessed 2025-04-23].

290. Good Things Foundation. Digital Health Hubs: An evaluation for the NHS Widening Digital Participation Programme (published June 2020). Available from: https://www.goodthingsfoundation.org/policy-and-research/research-and-evidence/research-2024/digital-health-hubs-evaluation [accessed 2025-04-23].

291. Pettersen S, Eide H, Berg A. The role of champions in the implementation of technology in healthcare services: a systematic mixed studies review. BMC Health Services Research. 2024 Apr 11;24(1):456.

292. Cumbria, Northumberland, Tyne and Wear NHS Foundation trust. Triangle of Care: Annual Report 2020-2021. Available from: https://www.cntw.nhs.uk/wp-content/uploads/2020/08/Traingle-of-Care-Annual-Report-2021.pdf [accessed 2025-04-23].

293. NHS England. How we can support digital inclusion. Available from: https://digital.nhs.uk/about-nhs-digital/corporate-information-and-documents/digital-inclusion/supporting-digital-inclusion-locally#:~:text=The%20Widening%20Digital%20Participation%20(WDP,through%20the%20Good%20Things%20Foundation.&text=You%20can%20read%20more%20about,locally%2C%20such%20as%20the%20following [accessed 2025-04-23].

294. Digital Unite. Digital Health Champions Assemble! – A new Digital Champion training hub in health is launched (published: February 6th 2020). Available from: https://www.digitalunite.com/news-and-views/digital-health-champions-assemble-new-digital-champion-training-hub-health-launched#:~:text=In%20July%202019%2C%20Digital%20Unite%20was%20commissioned,he

althcare%20organisations%20and%20Digital%20Champions.%20Most%20recent [accessed 2025-04-23].

295. Healthwatch. Digital health and Care: A report on local experiences in Suffolk and North East Essex (published May 2021). Available from: https://healthwatchsuffolk.co.uk/wp-content/uploads/2021/05/Digital-Health-and-Care-Final-Copy-1.pdf [accessed 2025-04-23].
296. Kings Fund. Policy brief: Ensuring digitally enabled health care is equitable and effective for all (published March 7th 2023). Available from: https://www.kingsfund.org.uk/insight-and-analysis/evidence-and-consultations/ensuring-digitally-enabled-health-care-equitable-effective-for-all [accessed 2025-04-23].
297. UK Government. Equality Act 2010. Available from: https://www.legislation.gov.uk/ukpga/2010/15/contents [accessed 2025-04-23].
298. Bures, V., Comparative analysis of system dynamics software packages, (2015) International Review on Modelling and Simulations (IREMOS), 8 (2), pp. 245-256.
299. Al-Sarayreh KT, Hasan LA, Almakadmeh K. A trade-off model of software requirements for balancing between security and usability issues. Int. Rev. Comput. Software. 2015;10(12):1157-68.
300. Zhou L, Bao J, Watzlaf V, Parmanto B. Barriers to and facilitators of the use of mobile health apps from a security perspective: mixed-methods study. JMIR mHealth and uHealth. 2019 Apr 16;7(4):e11223.
301. Hall JL, John J, Liebig J, Skariah A. Age Bias in Finger Vein Biometric Research. InICISSP 2022 (pp. 472-477).
302. Phillips PJ, Jiang F, Narvekar A, Ayyad J, O'Toole AJ. An other-race effect for face recognition algorithms. ACM Transactions on Applied Perception (TAP). 2011 Feb 2;8(2):1-1.
303. Koenecke A, Nam A, Lake E, Nudell J, Quartey M, Mengesha Z, Toups C, Rickford JR, Jurafsky D, Goel S. Racial disparities in automated speech recognition. Proceedings of the national academy of sciences. 2020 Apr 7;117(14):7684-9.

304. NIHR Research Support Service. Equality, Diversity and Inclusion Toolkit (published: January 2022, updated: June 2024). Available from: https://www.rssleicesterresources.org.uk/edi-toolkit [accessed 2025-04-23].

305. UK Research and Innovation. EDI strategy and action plans (published: 15 May 15th 2023). Available from: https://www.ukri.org/what-we-do/supporting-healthy-research-and-innovation-culture/equality-diversity-and-inclusion/edi-strategy/ [accessed 2025-04-23].

306. Vuorikari R, Kluzer S, Punie Y. DigComp 2.2: The Digital Competence Framework for Citizens-With new examples of knowledge, skills and attitudes. 2022 Mar 17.

307. Mind. Tools for measuring changes in mental health and wellbeing. Available from: https://www.mind.org.uk/media/9007/tools-for-measuring-changes-in-mental-health.pdf [accessed 2025-04-24].

308. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of internal medicine. 2006 May 22;166(10):1092-7.

309. Assessment EI. Equality Impact Assessment. Dementia. 2012 Jan 23;1:2-135

310. Jaworski BK, Webb Hooper M, Aklin WM, Jean-Francois B, Elwood WN, Belis D, Riley WT, Hunter CM. Advancing digital health equity: directions for behavioral and social science research. Translational Behavioral Medicine. 2023 Mar 1;13(3):132-9.

311. McCall T, Asuzu K, Oladele CR, Leung TI, Wang KH. A socio-ecological approach to addressing digital redlining in the United States: a call to action for health equity. Frontiers in Digital Health. 2022 Jul 18;4:897250.

312. Richardson S, Lawrence K, Schoenthaler AM, Mann D. A framework for digital health equity. NPJ digital medicine. 2022 Aug 18;5(1):119.

313. Good Things Foundation. Digital inclusion in health and care: lessons learned from the NHS Widening Digital Participation Programme (published: September 2020). Available from: https://www.goodthingsfoundation.org/policy-and-research/research-and-evidence/research-2024/health-and-care-digital-inclusion [accessed 2025-04-24].

314. Waters E, Hall BJ, Armstrong R, Doyle J, Pettman TL, de Silva-Sanigorski A. Essential components of public health evidence reviews: capturing intervention complexity, implementation, economics and equity. Journal of public health. 2011 Sep 1;33(3):462-5.

315. Pfadenhauer LM, Gerhardus A, Mozygemba K, Lysdahl KB, Booth A, Hofmann B, Wahlster P, Polus S, Burns J, Brereton L, Rehfuess E. Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework. Implementation science. 2017 Dec;12:1-7.

316. Tolley C, Wilson S, Hassan N, de Nazelle AJ, Slight R, Slight S. Development of an air quality communication strategy with underserved groups. European Journal of Public Health. 2024 Nov;34(Supplement_3):ckae144-1426.

317. NIHR. North and South: Regional Health Inequalities in England. Available from: https://arc-nenc.nihr.ac.uk/projects/north-and-south-regional-health-inequalities-in-england/ [accessed 2025-04-25].

318. Weiss BD, Mays MZ, Martz W, Castro KM, DeWalt DA, Pignone MP, Mockbee J, Hale FA. Quick assessment of literacy in primary care: the newest vital sign. The Annals of Family Medicine. 2005 Nov 1;3(6):514-22.

319. Shahid R, Shoker M, Chu LM, Frehlick R, Ward H, Pahwa P. Impact of low health literacy on patients' health outcomes: a multicenter cohort study. BMC health services research. 2022 Sep 12;22(1):1148.

320. Hussain N, Phulpoto S. Digital literacy: Empowering individuals in the Digital Age. Assyfa Learning Journal. 2024 Jul 21;2(2):70-83.

321. Greer B, Robotham D, Simblett S, Curtis H, Griffiths H, Wykes T. Digital exclusion among mental health service users: qualitative investigation. Journal of medical Internet research. 2019 Jan 9;21(1):e11696.

322. Anderberg P, Barnestein-Fonseca P, Guzman-Parra J, Garolera M, Quintana M, Mayoral-Cleries F, Lemmens E, Berglund JS. The effects of the digital platform support monitoring and reminder technology for mild dementia (SMART4MD) for people with mild cognitive impairment and

their informal carers: protocol for a pilot randomized controlled trial. JMIR research protocols. 2019 Jun 21;8(6):e13711.

323. Gerritzen EV, Kohl G, Orrell M, McDermott O. Peer support through video meetings: Experiences of people with young onset dementia. Dementia. 2023 Jan;22(1):218-34.
324. Rabarison KM, Bish CL, Massoudi MS, Giles WH. Economic evaluation enhances public health decision making. Frontiers in public health. 2015 Jun 24;3:164.
325. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. Oxford university press; 2015 Sep 25.
326. Haddix AC, Teutsch SM, Corso PS, editors. Prevention effectiveness: a guide to decision analysis and economic evaluation. Oxford University Press; 2003.

Appendix

Appendix 1: Search strategies used to systematically explore the literature on digital inclusion strategies to improve inclusion amongst under-served groups

Appendix 1 Table 1: Search strategy used in Embase

Category	**Search string**
CLEARS groups	exp ancestry group/ or exp ethnicity/ or exp "ethnic or racial aspects"/ or exp ethnic group/ or BAME.mp./ or exp cultural factor/ or exp religion/ or exp English as a second language/ or language.mp./ or exp visual impairment/ or exp hearing impairment/ or exp educational status/ or exp adult/ or exp residence characteristics/ or exp rural population/ or exp rural area/ or exp homeless person/ or exp developing country/ or exp rural health care/ or medically underserved area.mp./ or exp socioeconomics/ or exp income/ or exp health insurance/ or exp sociodemographics/ or exp minority group/ or exp vulnerable population/ AND
Inequities	exp health care disparity/ or exp racial disparities/ or exp health care access/ or health inequities.mp./ or exp health disparity/ or exp digital divide/ or digital inequities.mp./ or digital exclusion.mp./ or digital gap.mp/ or exp urban rural difference/ or underserved.mp. or exp medically underserved/ or underrepresented.mp./ or exp computer literacy/ or exp internet access/ AND
Digital technology	exp Internet/ or exp "internet use"/ or exp digital technology/ or exp telehealth/ or ehealth.mp./ or exp algorithm/ or exp mobile application/ or exp smartphone/ or "technology use".mp./ or exp remote sensing/or exp wireless communication/ or exp wearable computer/ or wearable technology.mp./ or smart home.mp./ or exp telemedicine/ or digital health technologies .mp./ or patient portal.mp./ or mhealth.mp./ or exp "internet of things"/ or apps.mp.

Key: exp = exploded mesh term, .mp. = key word search. A limit was placed on the search to only include papers indexed as the publication type “article”, published between 2012- 2022 and are in the English language. This search was conduced 25/11/2022.

Appendix 1 Table 2: Search strategy used in PsycInfo

Category	**Search string**
CLEARS groups	exp "Racial and Ethnic Groups"/ OR exp Ethnic Identity/ OR BAME.mp./ OR exp Sociocultural Factors/ OR exp Religion/ OR language/ OR exp language proficiency/ OR exp Hearing Disorders/ OR exp Vision Disorders/ OR exp Educational Attainment Level/ OR adult.mp./ OR exp Rural Environments/ OR exp Homeless/ OR exp Developing Countries/ OR exp Rural Health/ OR exp Socioeconomic Factors/ OR exp Deprivation/ OR exp Poverty Areas/ or exp Poverty/ OR exp Middle Income Level/ or exp Lower Income Level/ OR exp Health Insurance/ OR exp Demographic Characteristics/ OR exp Minority Groups/AND
Inequities	exp "Race and Ethnic Discrimination"/ OR exp Health Disparities/ OR exp Cultural Sensitivity/ OR exp "Racial and Ethnic Differences"/ OR exp Racial Disparities/ OR exp Health Care Access/ OR health inequities.mp./ OR exp Digital Divide/ OR digital inequities.mp./ OR digital exclusion.mp./ OR digital gap.mp./ OR urban rural divide.mp./ OR exp Disadvantaged/ OR underserved.mp./ OR underrepresented.mp./ OR exp Digital Literacy/ OR internet access.mp./ AND

Digital technology	exp Digital Technology/ OR exp Wireless Technologies/ OR exp Wearable Devices/ OR exp Smartphones/ OR remote sensing technology.mp./ OR exp/ OR Algorithms/ OR smart home.mp./ OR telehealth.mp./ OR exp Telemedicine/ OR digital health technology.mp./ OR exp Electronic Health Services/ OR ehealth.mp./ OR exp Mobile Applications/ OR exp Computer Usage/ OR technology usage.mp./ OR internet of things.mp./ OR exp Electronic Health Records/ or patient portal.mp./ OR mhealth.mp. OR exp Mobile Health/ OR apps.mp./

Key: exp = exploded mesh term, .mp. = key word search. A limit was placed on the search to only include papers indexed as the publication type "article", published between 2012- 2022 and are in the English language. This search was conduced 25/11/2022.

Appendix 1 Table 3: Search strategy used in Medline

Category	Search string
CLEARS groups	exp racial groups/ OR exp ethnicity/ OR exp "Ethnic and Racial Minorities"/ OR BAME.mp./ OR exp cross-cultural comparison/ or exp cultural characteristics/ OR exp Religion/ OR exp Language/ OR exp limited english proficiency/ OR exp persons with hearing impairments/ or exp visually impaired persons/ OR exp Educational Status/ exp Adult/ OR exp Residence Characteristics/ OR exp Rural Population/ OR exp Homeless Persons/ OR developing contries.mp./ OR exp Rural Health Services/ OR exp Medically Underserved Area/ OR exp Socioeconomic Factors/ OR exp Income/ OR exp health benefit plans, employee/ or exp insurance, medigap/ or exp medicare/ OR exp sociodemographic factors/ OR exp Minority Groups/ OR exp "health disparity, minority and vulnerable populations"/ AND
Inequities	exp Healthcare Disparities/ OR exp Health Services Accessibility/ OR exp Health Inequities/ OR exp Digital Divide/ OR digital exclusion.mp./ OR digital inequities.mp./ OR digital gap.mp./ OR urban-rural divide.mp. / OR underserved.mp./ OR underrepresented.mp./ OR exp Computer Literacy/ OR exp Digital Technology/ OR exp Remote Sensing Technology/ AND
Digital technology	Wireless Technology/ OR wearable technology.mp. or exp Wearable Electronic Devices/ OR exp Telemedicine/ or smart home.mp./ OR digital health technology.mp. or Mobile Applications/ OR exp Smartphone/ OR ehealth.mp./ OR telehealth.mp./ OR exp algorithms/ OR racial disparities.mp./ OR exp Internet Access/ OR exp "Internet Use"/ or exp Internet/ or exp "Internet of Things"/ OR exp Internet-Based Intervention/ OR apps.mp./ OR mhealth.mp./ OR exp Patient Portals/

Key: exp = exploded mesh term, .mp. = key word search. A limit was placed on the search to only include papers indexed as the publication type "article", published between 2012- 2022 and are in the English language. This search was conduced 25/11/2022.

Appendix 1 Table 4: Search strategy used in Scopus

Category	Search string
CLEARS groups	ethnicity OR "racial groups" OR "ethnic identity" OR bame OR religion OR language OR "sociocultural factors" OR "hearing impairments" OR "visual impairments" OR "educational attainment" OR adult OR "residence characteristics" OR rural OR homeless OR "developing contr*" OR "rural health" OR "medically underserved area" OR socioeconomic OR deprivation OR poverty OR income OR "health insurance" OR "sociodemographic factors" OR "minority groups" OR "vulnerable populations" AND
Inequities	"healthcare disparit*" OR "race and ethnic discrimination" OR "racial disparit*" OR "healthcare access" OR "health inequit*" OR "digital divide" OR "digital inequit*" OR "digital exclu*" OR "digital gap" OR "urban rural divide" OR disadvantage OR underserved OR "digital literacy" OR "internet access" OR underrepresented AND
Digital technology	internet OR "internet use" OR "digital technolog*" OR "wireless technolog*" OR "wearable technolog*" OR smartphone OR "mobile app*" OR "remote sensing technolog*" OR algorithm OR "smart home" OR telehealth OR telemedicine OR "digital health technolog*" OR ehealth OR "technology use" OR "internet of things" OR "digital health technolog*" OR "patient portal" OR mhealth OR apps AND

Key: exp = exploded mesh term, .mp. = key word search. A limit was placed on the search to only include papers indexed as the publication type "article", published between 2012- 2022 and are in the English language. This search was conduced 25/11/2022.

Appendix 2: Data extraction form

Appendix 2: Table 1: Data extraction form.

Authors	Year	Aim	Method	CLEARS	Other demographic factors	Sample size	Location (i.e. Country)
Alkureishi, M.A., Choo, Z.-Y., Rahman, A., Ho, K., Benning-Shorb, J., Lenti, G., SÃ¡nchez, I.V., Zhu, M., Shah, S.D., Lee, W.W.	2021	Interview patients to understand their perspectives on (1) the definition, causes, and impact of the digital divide; (2) whose responsibility it is to address the digital divide; and (3) potential solutions to mitigate the digital divide.	Interviews	Hispanic (2), black/ African American (23), white (8), other (2). Private medical insurance (10), Medicare (25). High school or less (14). All reported English as their primary language	Adult primary care patients (35/54), and 19 were parents of paediatric patients who had a phone, video or both types of visits at a Chicago medical centre. Adult sample: Hispanic (2), black/ African American (23), white (8), other (2). Female (27), male (8). Private medical insurance (10), Medicare (25). High school or less (14). All reported English as their primary language	54 (35 participants adult & of focus to the aims, the other 19 were parents of patients)	Centres for Medicare and Medicaid Services (CMS) - Chicago (USA)
Asgary, R. And Sckell, B. And Alcabes, A. And Naderi, R. And Adongo, P. And Ogedegbe, G.	2015	To evaluate homeless individuals perceptions, attitudes and experiences regarding mobile health	Interview	Homeless	Average Age (SD; Range): 51.66 (±11.34; 25 to 79), Female: 29 (58%), Age above 50: 33 (66%), Average years of homelessness (SD): 2.03 yrs (SD±3.10), max 14 yrs, History of Chronic Dis. 30 (60%), Active mental illness 10 (20%)	50	New York City (USA)
Kim, H., Zhang, Y.	2015	Exploring the context in which smartphones were used for health information.	Interview	Hispanic, low education, low income	20 low-SES adults self-identified as Hispanics in Texas: Females (12), males (8), 18 had an annual income of less than $25,000, 15 had only high school or less than high school education, age ranged from 20 to 60 (Mean¼34.6; SD¼ 13.8), 15 participants spoke both English and Spanish, with the majority (13 out of 15) speaking Spanish as the first language, 11 reported having some kind of health-related concerns.	20	Texas (USA)
Kramer, Justin and Yinusa-Nyahkoon, Leanne and Olafsson, Stefan and Penti, Brian and Woodhams, Elisabeth and Bickmore, Timothy and Jack, Brian W.	2021	Black men's experiences with, and suggestions for, health care systems, while also exploring the acceptability of ECA technology (embodied conversational agent (ECA) that simulates face-to-face conversation with a health counsellor) to address some of these concerns	Focus groups and interviews	Ethic diverse men, some spoke Spanish, some low education, some unemployed	Focus groups: perceptions & experiences of healthcare, factors affecting health behaviour change, acceptability of ECA model. Boston (3 groups, 8 ppt): • mean age: 23.4 • Ethnicity: black African American (5), black other (3) • Education: high school (4), uni (4) • Employment: full time (2), part time (4), unemployed (1), student (1) Providence (1 group and 7 ppt excluded as minors, include 3 groups and 19 ppt): • mean age: 21.6 • Ethnicity: black African American (14), black other (5) • Spanish speaking at home (3) • Education: no high school (4) less than high school (6), high school (4) uni (5) • Employment: full time (2), part time (3), unemployed (1), student (3) New Haven (1 group and 12 ppt excluded as minors, include 1 groups and 12 ppt): • mean age: 24 • Ethnicity: black African American (11), black other (1) • Spanish speaking at home (3) • Education: no high school (1) less than high school (3), high school (4) uni (4) • Employment: full time (3), part time (9), unemployed (0), student (0) Philadelphia (2 groups, 9 ppt): • mean age: 19.8 • Ethnicity: black African American (8), black other (1) • Education: less than high school (4), high school (2) uni (3) • Employment: full time (0), part time (1), unemployed (3), student (5) Interviewees (N = 5) were recruited from the sample of 30 men who used ECA for 2 weeks. • ages of 18 and 27 years, mean age of 19.4.	67 in focus group and 5 in interviews (12 key informant interviews excluded, Remove 19 as minors (under 18)).	Boston (MA), New Haven (CT), Providence (RI), and Philadelphia (PA) with programs serving young Black and African American men. (USA)
Maidment, D.W., Heyes, R., Gomez, R., Coulson, N.S., Wharrad, H., Ferguson, M.A.	2020	Compare barriers and facilitators between m2Hear and C2Hear	Interviews	(1) adults aged ≥18 years, (2) adults who had never worn hearing aids, (3) adults who were familiar with smartphone technologies, and (4) adults who had a good understanding of the English language to understand the content. Exclusion criteria included those who were unable to use m2Hear unassisted due to cognitive decline or dementia, determined via a self- or familial report. (Limiting condition - hearing & Age - most over 65)	1st time hearing aid users recruited through a medical centre in Nottingham • Female (6) male (10) • Age range: 39-85 mean: 68.81 • 2 self-reported as a beginner in digital tech competency and 14 as fully competent	16	Nottingham (UK)
Mizrachi, Y. And Shahrabani, S. And Nachmani, M. And Hornik, A.	2020	Provide a qualitative picture of these invisible obstacles and to profile their main features, with special attention to the role of family members in supporting OHS use among this population group.	Interviews	The proportions of Jews and non-Jews were similar. Moreover, non-users and users were also represented in proportion to the survey findings, as were age and gender and other relevant demographic variables. In terms of age, 12 respondents were between the ages of 50 and 54, six respondents were between the ages of 55 and 60, seven respondents	People picked from the sample the authors used in a quantitative survey in a different study • proportions of Jews (82% reported in questionnaire) and other religion (18%) • 21 users – 9 men and 12 women; 10 non-users – 4 men and 6 women • ages between 50 and 54 (n=12), 55 and 60 (n=6), 61 and 69 (n=7), 70 and above (n=6)	31	Israel

				were between 61 and 69, and six respondents were 70 years old and above.			
Wikaire, E. And Harwood, M. And Wikaire-Mackey, K. And Crengle, S. And Brown, R. And Anderson, A. And Jansen, R. M. And Keenan, R.	2022	Investigated Māori experiences of Telehealth consultations during the March 2020 COVID-19 lockdown. Participants were asked about what worked, what did not work, and for suggestions to improve future Telehealth provision to Māori whānau	Interviews - A Māori interviewer employed te reo (Māori language), tikanga (Māori protocols) and whanaungatanga (Māori customary engagement rituals) to facilitate the interview process.	Native new Zealand people	Little info given	14 ppt: 5 Māori health professionals (will exclude), 6 Māori telehealth consultation patients, and 6 Māori in-clinic consultation patients.	New Zealand
Yeong, J. L. And Thomas, P. And Buller, J. And Moosajee, M.	2021	Identify key web-based accessibility features for internet users with vision impairment and to explore whether the contents provided in website were relevent and comprehensible.	Observation & focus group	1 above 65 (Ages 25-70), , Visually impaired (n=6), controls(n=3) based in London, 1 unemployed, 2 retired;	4 females, 5 male, 1= 25, 1= 37, 3= 40-50, 2= 50-60, 1= 62, all use internet, all at least somewhat confident in using tech . Some clinicians also texted but it doesn't give much info on them.	9	Moorfields Eye Hospital NHS Foundation Trust, London (UK)
Howells, K. And Amp, M. And Burrows, M. And Brown, J. And Brennan, R. And Dickinson, J. And Jackson, S. And Yeung, W. L. And Ashcroft, D. And Campbell, S. And Blakeman, T. And Sanders, C.	2022	Explore the experience and impact of organisational and technology changes in response to COVID-19 on access to health care for people experiencing homelessness.	Interviews	Homeless , Ethnicity: white British (18), mixed race (2), eastern European (1), Education: no qualifications (11), GCSE (8), degree (1), missing (1)	• 3 females; 18 males • Age ranges: 25-34 (n=5), 35-44 (n=6), 45-54 (n=8), 55-64 (n=2) • Ethnicity: white British (18), mixed race (2), eastern European (1) • Education: no qualifications (11), GCSE (8), degree (1), missing (1) • All have at least one chronic condition • All reported anxiety & depression and/ or alcohol & drug related issues	21 (22 excluded as they are social workers/ clinicians)	North West England (UK)
Choix et al	2022	Identify the barriers of video visits for patients who rely on telephone visits for ambulatory care.	Interviews	Ethnicity: Majority were Black, Indigenous, and People of Colour (BIPOC) (n=6), Average age: was 68, and a majority (n=5) were 70 or older, Socioeconomic status: Majority had Medicaid or Medicare (n=7).	The average age of the randomly sampled patient participants was 68, and a majority (n = 5, 56%) were 70 or older. A majority were Black, Indigenous, and People of Colour (BIPOC) (n = 6, 67%), and a majority had Medicaid or Medicare (n = 7, 78%). Staff participants included a Care Coordinator (n = 1, 25%), a Medical Assistant Supervisor (n = 1, 25%), a Patient Access Specialist (n = 1, 25%), and a Behavioural Health Resource Specialist (n = 1, 25%).	9 (4 excluded as they were clinical support staff)	Portland, Oregon (USA)

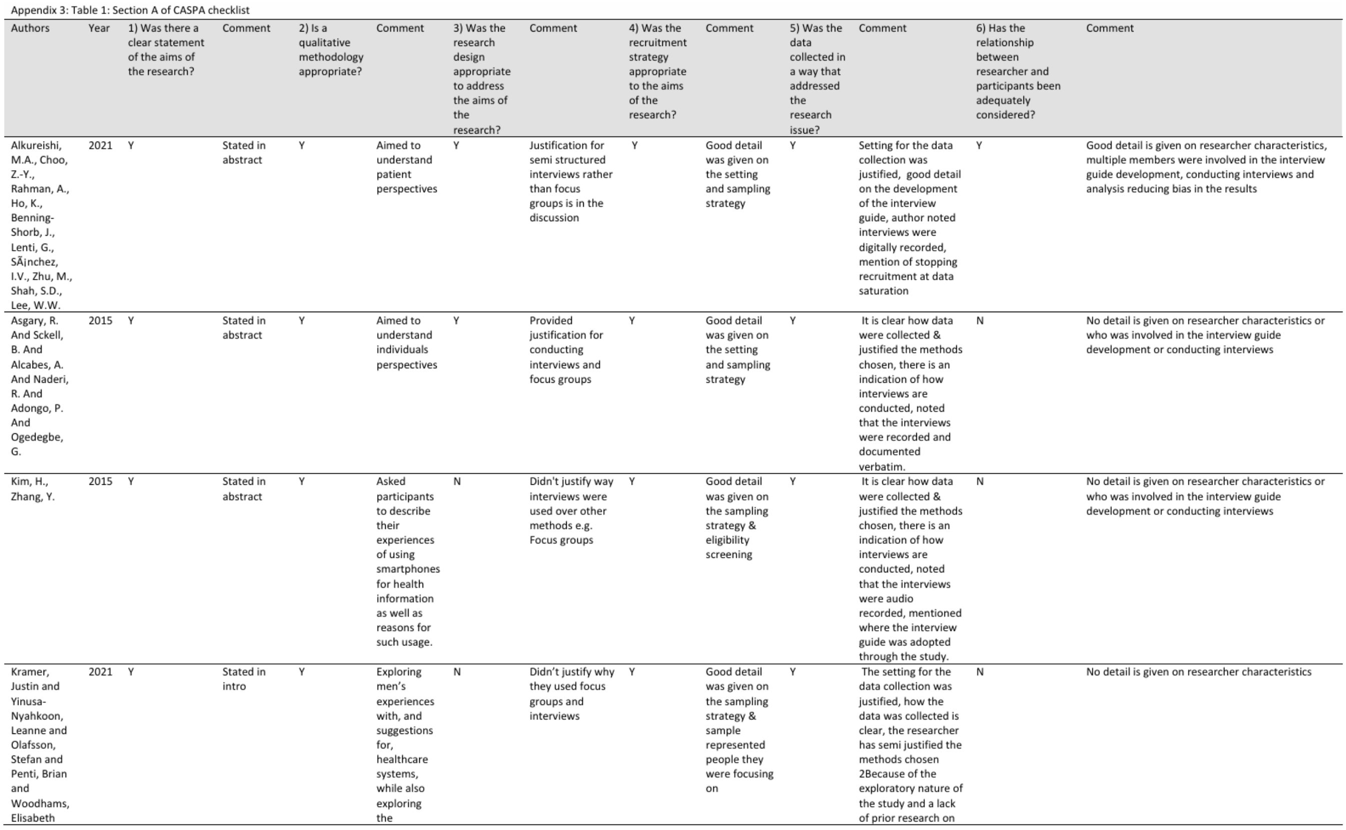
Appendix 2: Table 2: Data extraction form (continuation).

Authors	Factors causing inequities / barrier the strategy is trying to overcome	Inclusive strategy used	Benefits and Challenges		Key findings / notes
Alkureishi, M.A., Choo, Z.-Y., Rahman, A., Ho, K., Benning-Shorb, J., Lenti, G., SÃ¡nchez, I.V., Zhu, M., Shah, S.D., Lee, W.W.	Telemedicine utilization increased during the COVID-19 pandemic, divergent usage patterns for video and audio-only telephone visits emerged. Older, low-income, minority, and non-English speaking Medicaid patients are at highest risk of experiencing technology access and digital literacy barriers. This raises concern for disparities in health care access and widening of the "digital divide," While studies demonstrate correlation between racial and socioeconomic demographics and technological access and ability, individual patients' perspectives of the divide and its impacts remain unclear.	Co-design: Understanding patient views on the digital divide and how they think it could be mitigated.	Providing free resources/wifi - financial burden on healthcare system / gov but relieve financial burden on underserved populations . Provision through libraries / clinics - availability of services and opening times/ lack of knowledge of available resources but allows individuals to access wifi/ tech which they don't have at home. Low tech modalities - phone/post - interoperability problems but will reach individuals who have no access to wifi/ tech at home/ older generation who don't want to use tech. Education / tech champions in community - financial burden on community/ gov to pay individuals for the serve		1)understand tech needs: survey to assess resources people need, 2)access to tech: "Free access to Wi-Fi and providing something to access that, like a computer or a tablet. 3) Providing the resource for these people to be able to access. Even libraries are not enough or some small things like that are difficult. [Patient 53]", patient friendly portals that can be integrated with families accounts, use for libraries to provide tech/ wifi. 4) Education - provide educational/ skill building classes, tech support e.g. Tech champions for the community. 5) low tech approaches running parallel i.e. Landline phones, postal mail, home visits to access those who don't have tech/ wifi at home or can't travel to libraries etc. To get access to resources.
Asgary, R. And Sckell, B. And Alcabes, A. And Naderi, R. And Adongo, P. And Ogedegbe, G.	Little information exists regarding strategies that use mhealth (i.e., mobile technology for providing health information or services) to mitigate barriers to healthcare access among the homeless. Exploring perceptions, attitudes and experiences of the homeless regarding potential mhealth methods may help design programs to mitigate some of these barriers and address health disparities among homeless individuals.	Co-design: previous experiences text messaging healthcare info including appointment reminders, health education, or management of diseases.	Small phones are hard for older generation to type on/ theft can occur / changing no's - longest a person is quoted to keep the same no. Is 3 years, question the possibility of leaving someone out of the loop if they change their no. And don't tell healthcare/ state provided phone 'Obama phone' was used by most and well liked although the plan didn't provide unlimited minutes leading to some running out - some had distrust in the government to provide a phone plan with more minutes on of free		Phones to provide reminders for appointments were well liked and Obama phones were used by most - unlimited data/ minute plans should be provided to encourage more use of phones for health info. Most liked simple texts with only relevant information rather than lengthy motivational messages. Some prefer phone calls but most preferred a text as they can "can save or store" [F43] it.
Kim, h., zhang, y.	A recent study showed that Hispanics (a group more at risk of health inequities)have the highest smartphone ownership among ethnic groups, and are more likely to look up health information using their phones than blacks and whites (Fox and Duggan, 2013). However, little is known about the users, particularly those of low-socioeconomic status, health information-seeking behaviour using smartphones.	Co-design:	Improve access e.g. Call dr, text, apps, location, bus times, set up dr appointment, quicker to access internet vs computer (log on etc), can access in free time (convenient). Cheaper vs computer. More private than shared computer (e.g. Library).	Tech ownership, particularly computers/ UpToDate models, wifi access, limited data plans, small screen hard to read and navigate, some documents not compatible with phone, limited skills (how to use apps, internet and search engines), miss understanding of language (medical jargon, comprehending English if not 1st language, evaluating	Phones are accessible amongst underserved populations but wifi/ data plan could be provided to improve access. Bigger screen phones could be provided or taught how to increase letter size in classes (covering using apps/ internet/ understanding or evaluating health info)

				health i.e. Dr vs google)	
Kramer, Justin and Yinusa-Nyahkoon, Leanne and Olafsson, Stefan and Penti, Brian and Woodhams, Elisabeth and Bickmore, Timothy and Jack, Brian W.	Black individuals are more likely to live in medically underserved areas, which are characterized by an insufficient number of primary care providers, elevated poverty, and poor population health (Molina et al., 2017). Technology may offer an opportunity to address health disparities. The "Gabe System" (hereafter called "Gabe") is an embodied conversational agent (ECA) that simulates face-to-face conversation with a health counsellor - predicted that it could help improve trust of docs if it is culturally sensitive and representative (culturally informed health care, and strategies to promote sustained participant engagement in health care)	Co-design: interviews were with people who had used GABE (interactive avatar)	Focus groups = challenges to underserved communities getting health info - culturally appropriate representation in images and clinicians. A lot of experienced bias / judgment over treatment e.g. Where told they were dumb for fighting and they just wanted their hand fixed / the clinician didn't know the context. Some suggested training clinicians to be culturally sensitive and aware of the issues in their area. With GABE (the cartoon) people were likely to engage with certain content or not was their perception as to how that material may have specific relevance to them (e.g. Student was drawn to sections on alcohol/ drugs) - preference was shared for this to be compatible with phone and get notifications/ set up appointments / get info		ECR are an accepted approach if culturally sensitive and provide relevant info. If compatible with a phone, it was suggested to make it more accessible and could have more features to make it more useful.
Maidment, d.w., heyes, r., gomez, r., coulson, n.s., wharrad, h., ferguson, m.a.	First-time users, for instance, experience difficulties using their hearing aids because they struggle to remember all of the information given to them by their audiologist at the time of fitting [7,8]. Similarly, hearing aid handling skills in existing hearing aid users are highly variable, ranging from poor to excellent [9]. As a result, hearing aids are often used sub optimally or not at all, with estimates of non use varying from 3% to 24% [10]. Unmanaged hearing loss results in persistent psychosocial difficulties that can lead to social withdrawal and isolation for both individuals and their frequent communication partners [11,12]. Although audiological counselling post hearing aid fitting aims to address suboptimal use and non use of hearing aids, information in clinical settings is typically delivered verbally. Consequently, most of the information provided to patients is forgotten or retained incorrectly	Co-design: used an app to help use hearing aid	If someone didn't have a phone they cant use it but people found it was easy to navigate and use. The use of short info chunks and ease navigation met people could find the info they wanted quick and easy. Having the info in an accessible place (on phone) meant people would go back to some info if they had forgot it but would still go to the dr if they thought their hearing had changed or the hearing aid had a fault.		Ease to navigate apps with short chunks of information to allow personalisation was liked. Phone app was perceived as more accessible than computer / using YouTube for info. Falls down in terms of still need a phone & good digital literacy skills to be able to use the tech.
Mizrachi, Y. And Shahrabani, S. And Nachmani, M. And Hornik, A.	Low adoption of OHS amongst +65s. In Israel, people age 65 and above make extensive use of health services (e.g., an average of 11.2 annual visits to general and family physicians compared to an average of only 3.2 annual visits among the general population age 20 and above [3]). Yet according to the 2018 Statistical Abstract of Israel, only 51% of Israelis over the age of 65 use computers, compared to 72% of all adults over the age of 20. Among the population of older adults who do use computers, the primary uses are information searches (91%), e-mail (72%) and social networks (72%)[4].	Outreach: role of family members/ younger generation to support tech use	Forgetting password/ security issues e.g. Multi authentication still an issue, most don't have privacy concerns so happy to get family to help and most have family as 1st point of contact if they have a tech issue/ need assistance. Some didn't want family help "i don't need that kind of help" attitude so pride might get in the way / family relations may not be positive to get help. Incentive programs to encourage use were suggested. Font of text needs to increase, reduce or make multi authentication easier, reduce the no. Of times someone needs to change their password & provide language settings to change to the one they prefer. Increase advertising of available services and what is out there/ how easy it is to use it. Increase functionality i.e. What services are available to increase usefulness.		Reduced use in old people related to: unawareness of benefit for them personally/ service and not liking looking at screens due to decreased eye sight. Incentive programs to encourage use were suggested. Font of text needs to increase, reduce or make multi authentication easier, reduce the no. Of times someone needs to change their password & provide language settings to change to the one they prefer. Increase advertising of available services and what is out there/ how easy it is to use it. Increase functionality i.e. What services are available to increase usefulness.
Wikaire, E. And Harwood, M. And Wikaire-Mackey, K. And Crengle, S. And Brown, R. And Anderson, A. And Jansen, R. M. And Keenan, R.	Māori experience barriers to accessing timely, quality healthcare. The March 2020 COVID-19 lockdown in New Zealand required provision of Telehealth consultation options in primary care. This scoping project investigated Māori experiences of Telehealth consultations during the March 2020 COVID-19 lockdown.	Co-design: experiences of Telehealth consultations	Time and economic saving (less time waiting to be seen, less time taken off work, no transport costs, easier to look after kids). Made ppt feel in charge of their healthcare (could see times available and pick which suits them, could pick their doctor) Increased flexibility of service and access (improved access to a dr with same cultural background as them & access in remote areas)	Resources (internet access, data, software, tech, info on access to resources was limited) Unmet needs (physical assessments are hard, not all symptoms are acknowledged leading to self-medicating at home, hard to assess some basic symptoms e.g. Temperature if ppt doesn't have thermometer at home) Something new to learn Healthcare systems weren't aiding with financial cost of resources Language (medical terms hard to follow)	Suggestions for improvements: More user-friendly with language options & audio Providing an option of in clinic, over the phone or online Ensuring clinicians are culturally competent & can communicate in a lay term way over telehealth Providing resources needed to use telehealth including education Sense of connection with health care provider – clinicians build an 'online repour' with patient
Yeong, J. L. And Thomas, P. And Buller, J. And Moosajee, M.	Health websites for genetic eye disorders are typically poorly accessible to users with visual impairment	Co-design: usability testing session on a prototype of a accessible website with patients to identify website features that would increase accessibility for users with visual impairment.	Features of the prototype that improve accessibility: Consistent layout (colour theme, size, left aligned); Structured information hierarchy with a clear description of links & use of bullet points; Adaptability to different assistive software & high magnification; Simple home page with easy navigation; Readable content (low reading level / not too detailed)	Features that reduce accessibility • Poor contrast: navigation and search bar were fait and hard to see. • Dynamic content: slides with info that rotate automatically didn't give enough time to read. • Large white spaces: easy to get lost if people use magnifying setting. • Miss understanding how to search (expected google set up but it split the results into 'page title match' and 'page text match'	To make a website accessible to users with visual impairment, attention should be focused on making simple, well-designed pages with consistent layout and information structure, good contrast, and simple navigation, all of which will directly improve the overall user experience. All ppt had basic digital skills - unsure if accessible/ usable amongst those with low digital literacy skills. Sample didn't include anyone using braille keyboard - might affect navigation/ usability.
Howells, K. And Amp, M. And Burrows, M. And Brown, J. And Brennan, R. And Dickinson, J. And Jackson, S. And Yeung, W. L. And Ashcroft, D. And Campbell, S. And Blakeman, T. And Sanders, C.	COVID-19 pandemic has caused unprecedented disruption and change to the organisation of primary care, including for people experiencing homelessness who may not have access to a phone. Little is known about whether the recent changes required to deliver services to people experiencing	Outreach: explore barriers with natural change to remote telephone consultations & community	Improved awareness of help e.g. Individuals right to be registered with a GP. Access increased by community workers helping to make appointments/medical queries on behalf of people experiencing homelessness, supplying pre-paid phones and digital devices to hostels	If worker misses a call if the dr rings back late then this can delay access to patients treatment. The nurses interviewed often went above and beyond their expected	The findings have emphasised the importance of addressing practical and technology barriers as well as supporting communication and choice for mode of consultation. The authors argue that consultations should not be remote 'by default' and instead take into consideration both the clinical and social factors underpinning health. Consultations should not be

	homelessness will help to address or compound inequality in accessing care. Remote access was perceived as time efficient and helped those with anxiety but it did lead to long waiting times to get appointments/ reduced chance of same day / late & missed callbacks delayed access to treatment, reduced access if you don't have funds or access to a phone or computer (covid reduced access to shared computers), tech issues & poor signal reduced quality of communication, makes it harder for the dr to see stuff so ppt felt this reduced good quality diagnosing, reduced personal interaction & empathy.	support workers and clinicians to provide access to primary health care through the pandemic - support works & outreach workers being key facilitators of care.	(such as ipads), to enable easier and timely access, engaging with people to raise awareness of organisational changes, facilitating GP registration, and discussing specific patients as part of a multidisciplinary team meeting within the primary care network. Some facilitating appointments by allowing their patients to use their smartphones.	role and working hours to secure appointments for their patients - adds more workload & pressure to community nurses/ workers involved.	remote 'by default' and instead take into consideration both the clinical and social factors underpinning health.
Choix et al	Due to covid, video visits increased to allow physical examination and aid diagnostic decision making but require video capable technology, reliable internet access and greater digital literacy than phone visits contributing towards inequities.	Co-design: experiences of video consultations to explore how to better support their use of this technology	Video consultation benefits included avoiding unreliable medical transportation and reduced time to complete an appointment. Participants who do not own internet-capable technology are interested in getting assistance to obtain and use it (showing motivation to be more engaged). Highlights the need for supportive infrastructure and educational support.	Some participants reported needing information from providers about why video consultations are better than telephone consultations. Though many have access to technology and use it for tasks such as email, they want in-person help specific to their personal technology to build confidence. Some participants did not have devices compatible for video consultations.	Majority of participants were interested in using video consultations but lacked the confidence to use it or have access to compatible equipment. In-person help was suggested to be the best approach to help individuals.

Appendix 3: Critical Appraisal Skills Programme (CASP) Qualitative Review Checklist



Appendix 3: Table 1: Section A of CASPA checklist

Authors	Year	1) Was there a clear statement of the aims of the research?	Comment	2) Is a qualitative methodology appropriate?	Comment	3) Was the research design appropriate to address the aims of the research?	Comment	4) Was the recruitment strategy appropriate to the aims of the research?	Comment	5) Was the data collected in a way that addressed the research issue?	Comment	6) Has the relationship between researcher and participants been adequately considered?	Comment
Alkureishi, M.A., Choo, Z.-Y., Rahman, A., Ho, K., Benning-Shorb, J., Lenti, G., SÃ¡nchez, I.V., Zhu, M., Shah, S.D., Lee, W.W.	2021	Y	Stated in abstract	Y	Aimed to understand patient perspectives	Y	Justification for semi structured interviews rather than focus groups is in the discussion	Y	Good detail was given on the setting and sampling strategy	Y	Setting for the data collection was justified, good detail on the development of the interview guide, author noted interviews were digitally recorded, mention of stopping recruitment at data saturation	Y	Good detail is given on researcher characteristics, multiple members were involved in the interview guide development, conducting interviews and analysis reducing bias in the results
Asgary, R. And Sckell, B. And Alcabes, A. And Naderi, R. And Adongo, P. And Ogedegbe, G.	2015	Y	Stated in abstract	Y	Aimed to understand individuals perspectives	Y	Provided justification for conducting interviews and focus groups	Y	Good detail was given on the setting and sampling strategy	Y	It is clear how data were collected & justified the methods chosen, there is an indication of how interviews are conducted, noted that the interviews were recorded and documented verbatim.	N	No detail is given on researcher characteristics or who was involved in the interview guide development or conducting interviews
Kim, H., Zhang, Y.	2015	Y	Stated in abstract	Y	Asked participants to describe their experiences of using smartphones for health information as well as reasons for such usage.	N	Didn't justify way interviews were used over other methods e.g. Focus groups	Y	Good detail was given on the sampling strategy & eligibility screening	Y	It is clear how data were collected & justified the methods chosen, there is an indication of how interviews are conducted, noted that the interviews were audio recorded, mentioned where the interview guide was adopted through the study.	N	No detail is given on researcher characteristics or who was involved in the interview guide development or conducting interviews
Kramer, Justin and Yinusa-Nyahkoon, Leanne and Olafsson, Stefan and Penti, Brian and Woodhams, Elisabeth	2021	Y	Stated in intro	Y	Exploring men's experiences with, and suggestions for, healthcare systems, while also exploring the	N	Didn't justify why they used focus groups and interviews	Y	Good detail was given on the sampling strategy & sample represented people they were focusing on	Y	The setting for the data collection was justified, how the data was collected is clear, the researcher has semi justified the methods chosen 2Because of the exploratory nature of the study and a lack of prior research on	N	No detail is given on researcher characteristics

and Bickmore, Timothy and Jack, Brian W.					acceptability of ECA technology to address some of these concerns						this subject, the semi-structured interview method was adopted", the researcher has made the methods explicit (e.g. Indication of how interviews were conducted, and their topic guide), information was provided about where further questions were asked to get more detail,		
Maidment, D.W., Heyes, R., Gomez, R., Coulson, N.S., Wharrad, H., Ferguson, M.A.	2020	Y	Stated in abstract	Y	Aimed to gain an in-depth insight into the views of the barriers and facilitators	N	Didn't justify way interviews were used over other methods e.g. Focus groups	Y	Good detail was given on the sampling strategy & exclusion criterial to ensure sample represented people they were focusing on	Y	The setting for the data collection was justified, it is clear how data were collected, the researcher has made the methods explicit (e.g. For interview method, is there an indication of how interviews are conducted and topic guide in appendix), the form of data is clear	N	No detail is given on researcher characteristics
Mizrachi, Y. And Shahrabani, S. And Nachmani, M. And Hornik, A.	2020	Y	Stated in abstract	Y	To gain insights regarding the central barriers associated with OHS adoption among older adults in Israel	N	Didn't justify way interviews were used over other methods e.g. Focus groups	Y	Mentions sample was picked from a sample previously used in a connected study & proportionally representative of the original sample	Y	If the setting for the data collection was justified, it is clear how data were collected, the researcher has made the methods explicit (e.g. For interview method, is there an indication of how interviews are conducted, and info on their topic guide)	N	No detail is given on researcher characteristics
Wikaire, E. And Harwood, M. And Wikaire-Mackey, K. And Crengle, S. And Brown, R. And Anderson, A. And Jansen, R. M. And Keenan, R.	2022	Y	Stated in intro	Y	Aim to understand peoples personal experiences	Y	Provided justification for the method	Y	Good detail was given on the sampling strategy & sample represented people they were focusing on	Y	If the setting for the data collection was justified, it is clear how data were collected, the researcher has justified the methods chosen, the researcher has made the methods explicit (e.g. There is an indication of how interviews are conducted), the form of data is clear	Y	The research is led and carried out by Māori health researchers (same ethnicity as participants)
Yeong, J. L. And Thomas, P. And Buller, J. And Moosajee, M.	2021	Y	Stated in abstract	Y	Identify website features that would increase accessibility for users with visual impairment.	Y	Further discussions were prompted by asking participants to expand their answers and seek opinions or counter-opinions from the rest of the group --> good justification for why interviews weren't used.	N	Details on setting but didn't mention how they recruited	Y	The setting for the data collection was justified, it is clear how data were collected, the researcher has justified the methods chosen, the researcher has made the methods explicit (e.g. For interview method, is there an indication of how interviews are conducted), the form of data is clear	N	No detail is given on researcher characteristics
Howells, K. And Amp, M. And Burrows, M. And Brown, J. And Brennan, R. And Dickinson, J. And Jackson, S. And Yeung, W. L. And Ashcroft, D. And Campbell, S. And Blakeman, T. And Sanders, C.	2022	Y	Stated in abstract	Y	Explore the experience and personal impact	Y	Provided justification for the method	Y	Good detail was given on the sampling strategy & sample represented people they were focusing on	Y	The setting for the data collection was justified, it is clear how data were collected, the researcher has justified the methods chosen, the researcher has made the methods explicit (e.g. For interview method, is there an indication of how interviews are conducted, the form of data is clear (e.g. Audi recordings)	Y	The interviews with people experiencing homelessness were led by a researcher employed by Groundswell (a homeless charity) following a peer-research approach. Researchers with lived experience of homelessness receive research skills training (via Groundswell) to enable them to engage with the target research population more easily.
Choix et al	2022	Y	Stated in intro	Y	Explored people's perceived on barriers to video visits	N	Didn't justify why they didn't use focus groups instead	Y	Good detail was given on the sampling strategy & sample represented people they were focusing on	Y	It is clear how data were collected & , there is an indication of how interviews are conducted, mentioned where the interview guide w	N	No detail is given on researcher characteristics

Appendix 3: Table 2: Section B of CASPA checklist

Authors	7) Have ethical issues been taken into consideration?	Comment	8) Was the data analysis sufficiently rigorous?	Comment	9) Is there a clear statement of findings?	Comment
Alkureishi, M.A., Choo, Z.-Y., Rahman, A., Ho, K., Benning-Shorb, J., Lenti, G., SÃ¡nchez, I.V., Zhu, M., Shah, S.D., Lee, W.W.	Y	Oral consent was gained before the interview and ppt received $20 voucher for their time. The project conforms with the Standards for Reporting Qualitative Research , and was approved as a quality improvement project by the University of Chicago. As such, it was deemed not human subjects research and was not reviewed by the Institutional Review Board.	Y	In-depth description of the analysis process, sufficient data are presented to support the findings, multiple people helped with the analysis reducing personal bias	Y	The researcher has discussed the credibility of their findings (triangulation, more than one analyst). The findings are discussed in relation to the original research question
Asgary, R. And Sckell, B. And Alcabes, A. And Naderi, R. And Adongo, P. And Ogedegbe, G.	Y	This study received IRB approval from the Lutheran Family Health Centres, New York City.	Y	There is an in-depth description of the analysis process, thematic analysis was used with clear info on how the categories/themes were derived from the data, 2 authors conducted the analysis reducing bias	Y	Adequate discussion of the evidence both for and against the researcher's arguments, the researcher has discussed the credibility of their findings (more than one analyst), the findings are discussed in relation to the original research question
Kim, H., Zhang, Y.	Y	Approved by the Human Subjects and Institutional Review Board at the University of Texas at Austin.	Y	There is an in-depth description of the analysis process, its clear how the categories/themes were derived from the data, the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation by testing inter-coder reliability.	Y	There is adequate discussion of the evidence both for and against the researcher's argument, the researcher has discussed the credibility of their findings (e.g. More than one analyst), the findings are discussed in relation to the original research question
Kramer, Justin and Yinusa-Nyahkoon, Leanne and Olafsson, Stefan and Penti, Brian and Woodhams, Elisabeth and Bickmore, Timothy and Jack, Brian W.	Y	All study protocols were approved by the BUSM Institutional Review Board and informed consent was obtained from all adult participants, with parental consent and participant assent having been obtained for those under the age of 18 years.	N	Lacks a lot of detail and doesn't say which method of analysis was used. But the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, contradictory data are taken into account, Whether the researcher reduced, potential bias and influence during analysis and selection of data for presentation by having 2 analysists.	Y	If there is adequate discussion of the evidence both for and against the researcher's arguments, the researcher has discussed the credibility of their findings (e.g. Triangulation more than one analyst), the findings are discussed in relation to the original research question
Maidment, D.W., Heyes, R., Gomez, R., Coulson, N.S., Wharrad, H., Ferguson, M.A.	Y	The study was approved by the NHS Health Research Authority, East of England Cambridgeshire and Hertfordshire Research Ethics Committee, and Nottingham University Hospitals NHS Trust Research and Innovation Department.	Y	There is an in-depth description of the analysis process, thematic analysis is used and is it clear how the categories/themes were derived from the data, the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, contradictory data are taken into account during teh analysis process, the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation by having a 2nd author work on the analysis as well	Y	There is adequate discussion of the evidence both for and against the researcher's arguments, the researcher has discussed the credibility of their findings (e.g. More than one analyst), the findings are discussed in relation to the original research question
Mizrachi, Y. And Shahrabani, S. And Nachmani, M. And Hornik, A.	Y	The ethics committee of the Max Stern Yezreel Valley College in Israel approved the current research (Emek no. 2012–17).	Y	Doesn't say what theory or process was used but there is an in-depth description of the analysis process, the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, sufficient data are presented to support the findings, the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation	Y	There is adequate discussion of the evidence both for and against the researcher's arguments, the researcher has discussed the credibility of their findings (e.g. More than one analyst), the findings are discussed in relation to the original research question
Wikaire, E. And Harwood, M. And Wikaire-Mackey, K. And Crengle, S. And Brown, R. And Anderson, A. And Jansen, R. M. And Keenan, R.	Y	This study was categorised as low-risk (ie did not require full approval) by the New Zealand Health and Disability Ethics Committee review process. Additional ethical review was then completed and granted by the New Zealand Ethics Committee (NZEC)18 on 20 November 2020.	Y	Lacks a detail but does mention thematic analysis is used and is it clear how the categories/themes were derived from the data, the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation	Y	There is adequate discussion of the evidence both for and against the researcher's arguments, the findings are discussed in relation to the original research question
Yeong, J. L. And Thomas, P. And Buller, J. And Moosajee, M.	N	Only mentioned informed consent was provided by ppt, not mention of an ethics committee giving approval	N	Lacks detail and doesn't say which theory used to analyse. But the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process	Y	There is adequate discussion of the evidence both for and against the researcher's arguments, the findings are discussed in relation to the original research question
Howells, K. And Amp, M. And Burrows, M. And Brown, J. And Brennan, R. And Dickinson, J. And Jackson, S. And Yeung, W. L. And Ashcroft, D. And Campbell, S. And Blakeman, T. And Sanders, C.	Y	Ethical approval was obtained from an NHS Research Ethics Committee (REC) committee.	Y	There is an in-depth description of the analysis process, thematic analysis was used and it is clear how the categories/themes were derived from the data, the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process, sufficient data are presented to support the findings, the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation	Y	There is adequate discussion of the evidence both for and against the researcher's arguments, the researcher has discussed the credibility of their findings (e.g. More than one analyst), the findings are discussed in relation to the original research question
Choix et al	Y	Mentions participants provided verbal informed consent. This study was IRB exempt.	N	Lacks details and uses minimal quotes	Y	Discussion of the evidence both for and against the researcher's arguments, the findings are discussed in relation to the original research question

Appendix 3: Table 3: Section C of CASPA checklist

Authors	10) How valuable is the research?	Comment	Frequency of Y
Alkureishi, M.A., Choo, Z.-Y., Rahman, A., Ho, K., Benning-Shorb, J., Lenti, G., SÃ¡nchez, I.V., Zhu, M., Shah, S.D., Lee, W.W.	Y	The researcher discusses the contribution the study makes to existing knowledge or understanding, discussed whether or how the findings can be transferred to other populations or considered other ways the research may be used	10
Asgary, R. And Sckell, B. And Alcabes, A. And Naderi, R. And Adongo, P. And Ogedegbe, G.	Y	The researcher discusses the contribution the study makes to existing knowledge or understanding, they identify new areas where research that is necessary	9
Kim, H., Zhang, Y.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research is necessary, discussed whether / how the findings can be applied to other populations	8
Kramer, Justin and Yinusa-Nyahkoon, Leanne and Olafsson, Stefan and Penti, Brian and Woodhams, Elisabeth and Bickmore, Timothy and Jack, Brian W.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	7
Maidment, D.W., Heyes, R., Gomez, R., Coulson, N.S., Wharrad, H., Ferguson, M.A.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	8
Mizrachi, Y. And Shahrabani, S. And Nachmani, M. And Hornik, A.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	8
Wikaire, E. And Harwood, M. And Wikaire-Mackey, K. And Crengle, S. And Brown, R. And Anderson, A. And Jansen, R. M. And Keenan, R.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	10
Yeong, J. L. And Thomas, P. And Buller, J. And Moosajee, M.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	6
Howells, K. And Amp, M. And Burrows, M. And Brown, J. And Brennan, R. And Dickinson, J. And Jackson, S. And Yeung, W. L. And Ashcroft, D. And Campbell, S. And Blakeman, T. And Sanders, C.	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary, identifies where findings can be applied to other groups	10
Choix et al	Y	The researcher discusses the contribution the study makes to existing knowledge and understanding, they identify new areas where research that is necessary	7

Appendix 4: Included studies participant demographics

Authors	**CLEARS representation**	**Additional demographic details**	**Country**
Alkureishi, et al. (165)	35 participants: • **Culture (ethnicity):** Hispanic (n=2), Black/ African American (n=23), white (n= 8), other (n=2). • **Educational attainment:** High school or less (n=14). • **Socioeconomic status:** Medicare (n=25).	• 35 Adult primary care patients (27 female, 8 males) and 19 parents of paediatric patients who had a phone, video or both types of visits at a Chicago medical centre. Only the sample of 35 adult primary care patients were included in the analysis to avoid analysing paediatric perspectives. • All reported English as their primary language. • 10 in the analysed sample had higher economic status using medical plan as proxy (private medical insurance). • 21 individuals has higher educational attainment (college/associate degree (n=7), Bachelor's degree (n=6), Graduate or professional degree (n=8)	Chicago (USA)
Asgary, et al. (139	50 participants: • **Residence (homeless):** Average years of homelessness: 2.03 yrs (max 14 yrs)	• 50 homeless individuals, of which 29 were female. • 30 participants had a history of chronic diseases and 10 had an active mental illness. • Sample had an average age: 51.66 and 33 were above the age of 50 but it is unclear how many were above 65.	New York City (USA)
Choxi et al. (166)	9 participants: • **Culture (ethnicity):** Majority were Black, Indigenous, and People of Colour (BIPOC) (n=6) • **Age:** Average age was 68, and a majority (n=5) were 70 or older. • **Socioeconomic status (health insurance):** Majority had Medicaid or Medicare (n=7).	• 14 participants in total including older patients (n=9) and clinical support staff (n=4). Clinical support staff were excluded from analysis.	Portland, Oregon (USA)
Howells et al. (169)	21 participants: • **Culture (ethnicity)**: mixed race (n=2), eastern European (n=1), white British (n=18) • **Educational attainment:** no qualifications (n=11), GCSE (n=8), degree (n=1), missing (n=1) • **Residence:** Homeless	• 43 participants of which 21 were homeless (including 3 females and 18 males) and 22 were healthcare professionals. Healthcare professionals were excluded from the analysis. • All homeless individuals had at least one chronic condition and reported anxiety & depression and/ or alcohol & drug related issues. • Homeless individuals age ranges included :25-34 (n=5), 35-44 (n=6), 45-54 (n=8), 55-64 (n=2)	Manchester (UK)
Kim, et al. (167)	20 articipants: • **Culture (ethnicity and language):** All identified as Hispanic and 13 has spanish as their first language (n=13). • **Educational attainment:** High school or less than high school education (n=15) • **Socioeconomic status (income):** All low SES with 18 on an annual income of less than $25,000.	• A total of 20 participants of which 12 were female and 8 males. • All reported having some kind of health-related concerns. • Age of the sample ranged from 20 to 60.	Texas (USA)
Kramer et al. (168)	Boston (3 groups, 8 participants): • **Culture (ethnicity):** black African American (n=5), black other (n=3) • **Educational attainment**: high school (n=4), university (n=4) • **Socioeconomic status (employment)**: unemployed (n=1), part time (n=4), full time (n=2), student (n=1) Providence (3 groups and 19 participants): •**Culture (ethnicity and language)**: black African American (n= 14), black other (n=5) and 3 prefer speaking Spanish at home. •**Educational attainment**: no high school (n=4) less than high school (n=6), high school (n=4), university (n=5) •**Socioeconomic status (employment):** unemployed (n=1), part time (n=3), full time (n=2), student (n=3)	• 67 in focus group and 5 in interviews (12 key informant interviews excluded and 19 minors (under 18) excluded from analysis). • Interviewees were recruited from the sample of 30 men who used Embodied conversational agent for 2 weeks. • Mean ages of recruitment sites: o Boston: 23.4yrs o Providence: 21.6yrs o New Haven: 24yrs o Philadelphia: 19.8yrs	Boston, New Haven, Providence, & Philadelphia (USA)

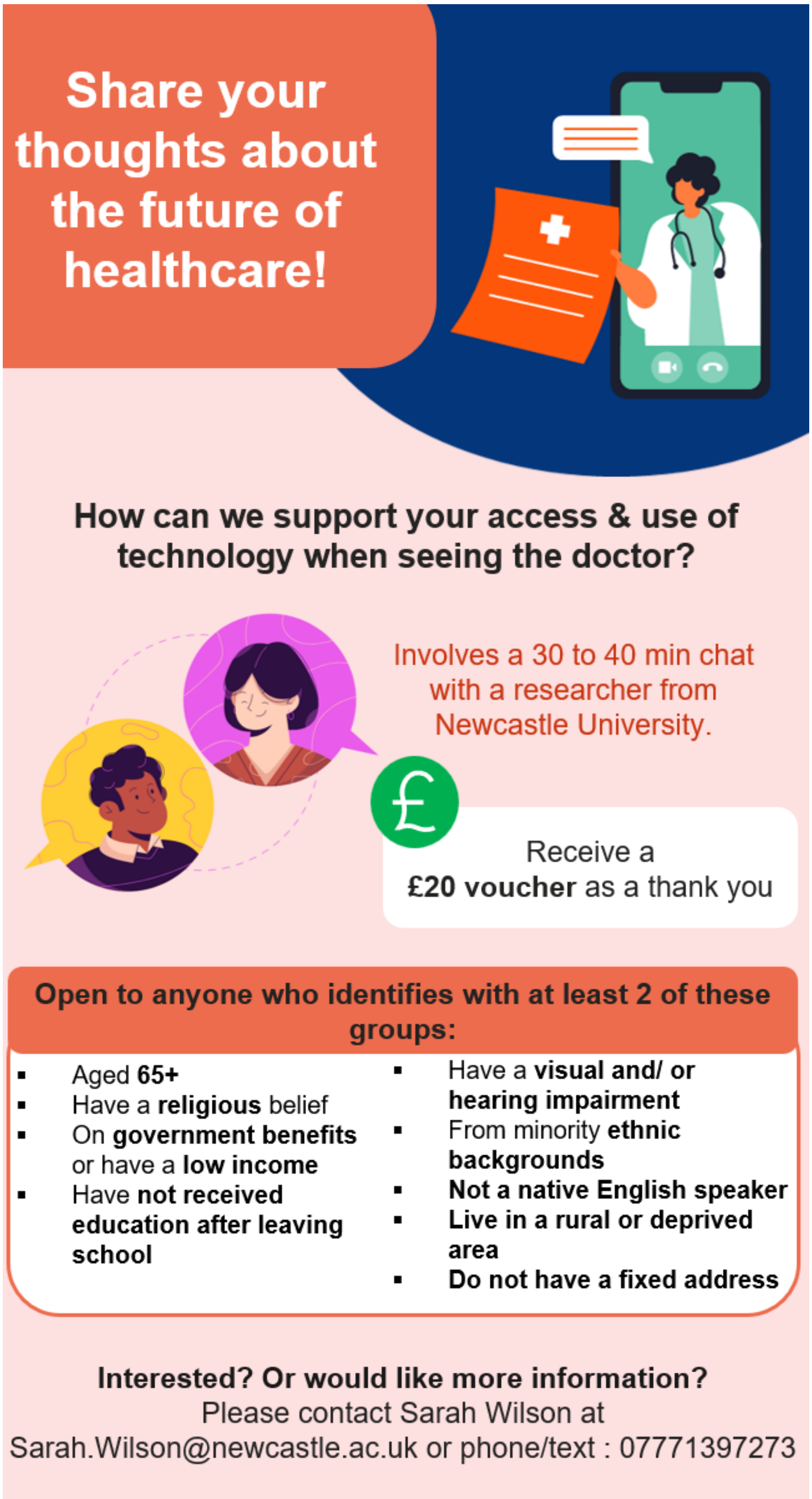
	New Haven (1 group and 12 participants): •**Culture (ethnicity and language):** black African American (n=11), black other (n=1), and 3 prefer speaking Spanish at home. •**Educational attainment:** no high school (n=1) less than high school (n=3), high school (n=4), university (n=4) •**Socioeconomic status (employment):** Employment: part time (n=9), full time (n=3), Philadelphia (2 groups, 9 participants): •**Culture (ethnicity):** black African American (n=8), black other (n=1) •**Educational attainment**: less than high school (n=4), high school (n=2) uni (n=3) •**Socioeconomic status (employment):** unemployed (n=3), part time (n=1), full time (n=0), student (n=5)		
Maidment et al. (170)	16 participants: • **Limiting conditions**: All had a hearing impairment. **Age range**: 39-85 (mean: 68.81)	• 16 first time hearing aid users recruited through a medical centre in Nottingham. • 6 were female and 10 were males. • 2 self-reported as a beginner in digital tech competency and 14 as fully competent. • All participants had a good understanding of the English language.	Nottingham (UK)
Mizrachi, et al. (171)	31 participants: • **Culture (religion):** Jewish (n= 25), other religion (n=6) • **Age:** 61 and 69 (n=7), 70 and above (n=6).	• 31 people picked from the sample the authors used in a quantitative survey in a different study. • 21 users of online health services (9 men and 12 women) and 10 non-users (4 men and 6 women). • Other ages included between 50 and 54 (n=12), 55 and 60 (n=6),	Israel
Wikaire, et al. (172)	12 participants: • **Culture (ethnicity):** native New Zealand individuals	• 6 Māori telehealth consultation patients and 6 Māori in-clinic consultation patients. (5 Māori health professionals were excluded from analysis).	New Zealand
Yeong, et al. (173)	9 participants: • **Limiting conditions**: Visually impaired (n=6), • **Age:** above 65 (n=1) • **Socioeconomic status:** Unemployed (n=1)	• 4 females and 5 males who all used the internet and all reported to be at least somewhat confident in using tech. Some healthcare professionals were interviewed but are excluded from analysis.	London (UK)

Appendix 5: Included study details

Author	**Aim**	**Method**	**Inclusive digital health strategy**	**Factor(s) causing inequities**	**Overarching theme covered**
Alkureishi, et al. (165)	To understand patients' perspectives on (1) the definition, causes, and impact of the digital divide; (2) whose responsibility it is to address the digital divide; and (3) potential solutions to mitigate the digital divide.	Interviews	Co-designing general digital health services	Older, low-income, minority, and non-English speaking Medicaid patients are at highest risk of experiencing technology access and digital literacy barriers.	• Infrastructure • Educational support
Asgary, et al. (139)	To evaluate homeless individuals' perceptions, attitudes and experiences regarding mobile health.	Interviews	Co-designing mHealth	Little information exists regarding strategies that use mHealth to mitigate barriers to healthcare access among the homeless.	• Infrastructure • User-friendly design
Choxi et al. (166)	Identify the barriers of video visits for patients who rely on telephone visits for ambulatory care.	Interviews	Co-designing video consultation health services	Due to covid, video visits increased to allow physical examination and aid diagnostic decision making but require video capable technology, reliable internet access and greater digital literacy than phone visits contributing towards inequities.	• Educational support • User-friendly design
Howells et al. (169)	Explore the experience and impact of organisational and technology changes in response to COVID-19 on access to health care for people experiencing homelessness.	Interviews	Outreach	Little is known about whether the recent changes required during COVID-19 to deliver services to people during experiencing homelessness will help to address or compound inequality in accessing care.	• Infrastructure • Educational support
Kim, et al. (167)	Exploring the context in which smartphones were used for health information.	Interviews	Co-designing mHealth	Little is known about the users, particularly those of low-socioeconomic status, health information-seeking behaviour using smartphones.	• Infrastructure • User-friendly design
Kramer et al. (168)	Black men's experiences with, and suggestions for, health care systems, while also exploring the acceptability of ECA technology (embodied conversational agent (ECA) that simulates face-to-face conversation with a health counsellor).	Interviews & focus groups	Co-designing Embodied conversational agent (ECA)	Black individuals are more likely to live in medically underserved areas, technology may offer an opportunity to address health disparities by improving trust & cultural sensitivity.	• User-friendly design
Maidment et al. (170)	Compare barriers and facilitators between m2Hear (app which provides information on how to use a hearing aid) and	Interviews	Co-designing mHealth	First-time users experience difficulties using their hearing aids because they struggle to remember all of the information given to them by their audiologist at the time of	• Educational support • User-friendly design

	C2Hear (YouTube videos delivering similar information as m2Hear).			fitting. An app could provide easily accessible information to promote proper use.	
Mizrachi, et al. (171)	Explore the role of family members in supporting online health services usage amongst older groups.	Interviews	Outreach	Low adoption of online health services amongst over 65s.	• Educational support • User-friendly design
Wikaire, et al. (172)	Investigate Māori (New Zealand natives) experiences of Telehealth consultations during the March 2020 COVID-19 lockdown.	Interviews	Co-designing General digital health services	Telehealth may present additional barriers to) that contribute to inequities.	• Infrastructure
Yeong, et al. (173)	Identify key web-based accessibility features for internet users with vision impairment and to explore whether the contents provided in website were relevant and comprehensible.	Interviews & focus groups	Co-designing Health websites	Health websites for genetic eye disorders are typically poorly accessible to users with visual impairment.	• User-friendly design

Appendix 6: Study 1 Advert



Share your thoughts about the future of healthcare!

How can we support your access & use of technology when seeing the doctor?

Involves a 30 to 40 min chat with a researcher from Newcastle University.

Receive a
£20 voucher as a thank you

Open to anyone who identifies with at least 2 of these groups:

- Aged **65+**
- Have a **religious** belief
- On **government benefits** or have a **low income**
- Have **not received education after leaving school**
- Have a **visual and/ or hearing impairment**
- From minority **ethnic backgrounds**
- **Not a native English speaker**
- **Live in a rural or deprived area**
- **Do not have a fixed address**

Interested? Or would like more information?
Please contact Sarah Wilson at
Sarah.Wilson@newcastle.ac.uk or phone/text : 07771397273

Appendix 7: Study 1 Participant Information Sheet

Participant Information Sheet

Finding ways to help you access & use technology for your health.

Project background and aim:

In the last few years, doctors and nurses have started using computers, technology and gadgets more and more in hospitals and your local doctors' clinic. For example, you might have noticed people using the NHS app, or you might have also been offered a video or phone call with your doctor or nurse instead of visiting them in person.

These technologies can help healthcare professionals care for you, and help you take care of yourself. But not everyone has them, knows how to use them, or even wants to use them. To make sure no one is left behind as these technologies become more common in healthcare, we need to find ways to help people access and feel happy to use them, if they want to.

We have found some different ways that have been used to help people use health technology, but we would like to know what you think of them, how they can be improved and what else could be done.

Is this project right for you?

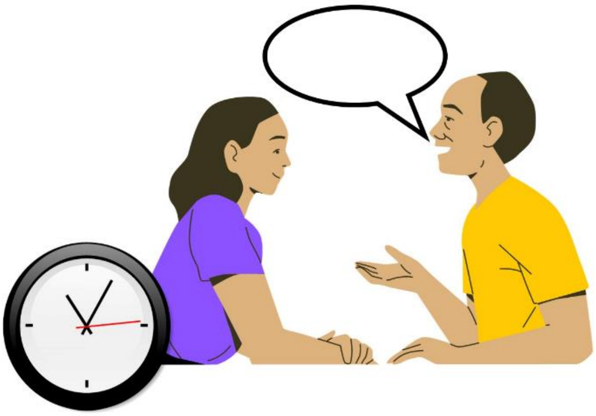
We would like to talk to you if you are aged over 18, and feel like you belong to at least 2 of these groups:

- Aged 65+
- Have a religious belief
- On government benefits or have a low income
- Have not received education after leaving school
- Have a visual and / or hearing impairment
- From an ethnic background which is not white British
- Not a native English speaker
- Live in a rural or deprived area or do not have a fixed address

If you would like to have a chat about the project, you can reach out to our research team. You will find their contact information at the end of this paper. We can also get someone to help translate or write in different languages.

What does the activity involve?

A one-to-one chat with someone from our research team to hear what you think about ways that could help people use and access computers, technology and gadgets for health purposes, how we can improve these, and talk about any ideas that you might have. This will take 30 to 40 minutes, and you can choose when and where it happens from a range of options given by a member of our research team. After the chat, you'll be asked to answer a short set of questions about yourself, which will take about 5 minutes.



30-40 minutes

If you would prefer to have a group discussion, with 4-6 other people in the room, that is no problem. Please see the image below to read about the pros and cons of having a one to one chat vs a group discussion.

	Focus groups	**Interviews**
Pros ✓	• Brainstorm new ideas with others • Hearing other's thoughts can help develop your own ideas • Receive group support for your opinions • Opportunity to socialise and meet new people	• More privacy • More flexibility in time & location • More time to talk about what matters to you • Fewer distractions
Cons ✗	• Less flexibility in time & location • Less privacy	• Can't develop group ideas • Lacks the opportunity to meet new people

Interested? Just contact Sarah Wilson, a member of our research team, by emailing her (email address: Sarah.Wilson@newcastle.ac.uk) or calling or texting her (phone number: 07771397273) and she will help you plan a time, date and place to have a chat.

What are the benefits and disadvantages of taking part in this activity?

Benefits

You'll get a £20 supermarket voucher or Amazon voucher as a thank you (or we can donate it to a charity or local community group if you prefer). You can choose between an Aldi, Lidl, Asda, Morrisons or a Tesco voucher. Just let us know which voucher you prefer before we have a chat. We'll also pay for your travel to meet us.

By joining in this activity, you will help us learn how to make it easer for people to access and use technology for health purposes. We will also share a summary of our results with you.

If you would like to take part, but we cannot include you right now, we'll ask you to join a group where we talk about our research and tell you about other chances to help in the future.

Potential disadvantages

Taking part in this activity will take some of your time. We will talk about how you feel about using technology for your health so if you find talking about this hard or difficult in any way, we will stop the discussion and give you some options to get support. Helplines can also be found at the end of this document.

What will happen to the results?

We will use what we learn from this project to help improve peoples' access and use of technology for health purposes. The responses you provide in the questionnaire will help us understand a bit about your background and the community you are apart of. This will help us make sure we gather a wide range of views from different people of different backgrounds.
We will tell others about what we find in meetings, presentations, and published papers. When we are telling others about what we find, we will **not** mention your name or any other information that could be used to identify you. If you change your mind and don't want to be a part of this activity anymore, that's okay. But the things you told us up until that point may still be used.

Other stuff we need to tell you about...

Will people be able to find out that I took part ?

No, if you decide to take part, your answers to the questionnaire and what you say in our chat will be confidential and saved in a way that no one will be able to know it was you.

The chat will be recorded to make sure we don't miss anything and written out using some computer software, or an approved third-party (e.g., UK Transcription https://www.uktranscription.com/). This will then be checked over by a member of the research team to make sure everything is correct.

Will I be contacted by other researchers?

No, we will not share your contact details with anyone without your permission. We will also not expect you to take part in any of our future activities. If you would like to take part in future activities, just let us know and we will safely keep your contact details.

Who is responsible for making sure my data is used properly?

Newcastle University is legally responsible for looking after your information and making sure it is used properly. If you would like to read more about this, get in touch with a member of our research team and we can give you more information.

Who can I contact?

If you have any questions, would like to receive this information in a different format or language, or would like to reschedule please contact:

- Sarah Wilson
  Email : Sarah.Wilson@newcastle.ac.uk
  Phone : 07771397273

To report any formal complaints relating to this study, contact:

- Sarah Slight
  Email: Sarah.Slight@newcastle.ac.uk
  Phone : +44 (191) 208 2358

Helplines:

- For mental health support:
  Call: 0300 123 3393

  Email: info@mind.org.uk

  Post: Mind Infoline, PO Box 75225, London, E15 9FS
  Or visit https://www.nhs.uk/nhs-services/hospitals/what-is-pals-patient-advice-and-liaison-service/

- Would you like to share your experience of the NHS with a professional? Contact Health Watch by calling 03000 683 000 between the hours of 08:30 – 17:30 Monday to Friday, email: enquiries@healthwatch.co.uk or visit https://www.healthwatch.co.uk/have-your-say

This study was approved by the Faculty of Medical Sciences Research Ethics Committee, part of Newcastle University's Research Ethics Committee. This Committee includes members who are internal to the Faculty. This study was reviewed by members of the Committee, who must provide impartial advice and avoid significant conflicts of interests.

Appendix 8: Study 1 Expression of Interest form

Expression of interest form

1. What gender do you identify as?
   - ☐ Female (same as my sex assigned at birth)
   - ☐ Male (same as my sex assigned at birth)
   - ☐ Transgender female
   - ☐ Transgender male
   - ☐ Genderfluid
   - ☐ Non-binary
   - ☐ Other, please specify
   - ☐ Prefer not to say.

2. How old are you?
   - ☐ Under 18
   - ☐ 18- 20
   - ☐ 21-30
   - ☐ 31-40
   - ☐ 41-50
   - ☐ 51-60
   - ☐ 61-70
   - ☐ 71-80
   - ☐ 81-90
   - ☐ Over 91
   - ☐ Prefer not to say.

3. Please specify your ethnicity.
   - ☐ White
   - ☐ Mixed / Multiple ethnic groups
   - ☐ Asian / Asian British
   - ☐ Black / African / Caribbean / Black British
   - ☐ Other ethnic group, please specify
   - ☐ Prefer not to say.

4. What is your preferred language to communicate in?
   - ☐ English
   - ☐ British sign language
   - ☐ Arabic
   - ☐ Polish
   - ☐ Romanian
   - ☐ Panjabi
   - ☐ Urdu
   - ☐ Other, please specify
   - ☐ Prefer not to say.

5. Do you have a religious faith?
   - ☐ Christian (Catholic, Protestant or any other Christian denominations)
   - ☐ Hindu
   - ☐ Jewish
   - ☐ Muslim
   - ☐ Other, (please specify)
   - ☐ I am not religious
   - ☐ Prefer not to say.

6. What is your highest educational attainment?
   - ☐ No qualifications
   - ☐ GCSE (or equivalent)
   - ☐ A level (or equivalent)
   - ☐ First degree (e.g. BA, BSc)
   - ☐ Postgraduate degree or professional qualification (e.g., qualified teacher)
   - ☐ Other, please specify
   - ☐ Prefer not to say.

7. Do you have any visual or hearing impairments ?
   - ☐ No
   - ☐ Yes (visual)
   - ☐ Yes (hearing)
   - ☐ Yes (both)

If you feel comfortable providing further details e.g. the name of your condition, please specify.

☐ Prefer not to say.

8. What is your postcode? We will only use this information to gather publicly available consensus data on your local area.

☐ Prefer not to say.

9. Do you identify as having a low income? (The government classifies a low income as an annual income below £20,000).
   - ☐ Yes
   - ☐ No
   - ☐ Prefer not to say

10. Do you own or have access to any of the following digital tools below? Please tick as many that apply to you.
    - ☐ Landline
    - ☐ Mobile phone (without internet)
    - ☐ Smartphone (a phone with internet connection)
    - ☐ Broadband
    - ☐ iPad or smart tablet
    - ☐ Laptop
    - ☐ Computer
    - ☐ Smart TV
    - ☐ Smart speaker (e.g. an Alexa)
    - ☐ Smart home technology (e.g. Hive)
    - ☐ Other
    - ☐ None of the above
    - ☐ Prefer not to say.

11. If you have selected any digital tools in question 10, how do you have access?
    - ☐ I own it and do not share with someone in my household.
    - ☐ I share it with someone in my household.
    - ☐ Via a family or friend.
    - ☐ Via public places e.g. libraries.

12. If you selected mobile phone or smartphone, what type of plan are you on?
    - ☐ Pay as you go
    - ☐ Contract
    - ☐ Prefer not to say.

13. What is your main reason for using technology? Please tick all the options that apply to you.

☐ Work
☐ Volunteering
☐ To study
☐ For entertainment
☐ To socialise with others
☐ Gaming
☐ For online shopping/banking
☐ Other
☐ I very rarely use technology, so this question does not apply to me.
☐ Prefer not to say

14. Do you feel confident when using technology?

☐ Not at all
☐ Slightly
☐ Somewhat
☐ Only if someone is helping me.
☐ Only with technology I am familiar with
☐ Fairly
☐ Completely

15. Please provide your name and contact details below so I can get back in touch with you to organise a chat.

Name

Contact details:

Voucher preference:

Appendix 9: Study 1 Consent form

CONSENT FORM

Strategies to promote digital health equity.

Thank you for your interest in taking part in this research study. Please read the information sheet carefully and take this opportunity to ask any questions that you might have. If you would like any information in a non-written/accessible format, or different language please ask. If you are happy that you understand fully what you are being asked to do and would like to take part, **please initial each of the boxes below that you agree with and then sign the form at the bottom.** You will be asked to sign two copies and one is to keep for your records.

I confirm that I have read and understood the information sheet dated (version 1) for the above study; I have had the opportunity to consider the information, ask questions and I have had any questions answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. I understand that if I decide to withdraw, any data that I have provided up to that point will be included.	
I consent to the processing of my personal information [ethnicity, gender identity, preferred language, religion, limiting condition, health conditions, educational attainment, age, place of residence (full postcode),] for the purposes of this research study, as described in the information sheet. I understand that all personal information will be anonymised with a random participant code and I consent to my anonymised research data being stored and included in analysis and publications.	
I understand that my anonymised research data may be published as a report.	
I consent to the retention of my personal information name, email and telephone number for 1-year, for the purpose of being re-contacted and I consent to being contacted for participation in future studies.	
I consent to being audio and/or video recorded and understand that the recordings will be destroyed immediately after transcription. Anonymised transcriptions will be stored on a password-protected computer and used for research purposes only.	
I agree to take part in this research study.	

Participant name:

Signature:

Date:

Researcher name:

Signature:

Date:

Appendix 10: Study 1 Follow up questionnaire

Follow up questionnaire

10. Is this your first-time taking part in research?
    - ☐ Yes
    - ☐ No
    - ☐ Prefer not to say

11. Have you ever used technology for health purposes? This can include video calls with a doctor or other healthcare provider, phone apps (e.g. NHS app) or wearable technology your doctor has asked you to use.
    - ☐ Yes. Please provide further details below e.g., the technology you used, and/or the purpose of using it.
    - ☐ No
    - ☐ Prefer not to say

If you answered yes to question 10 please complete questions a,b and c. If you selected no please continue to question 11.

a) What motivated you to start using the technology?
   - ☐ Family and/or friend recommended it
   - ☐ Doctor recommended it
   - ☐ Read about it online
   - ☐ Other. Please provide details below
   - ☐ Prefer not to say

b) What did you like about using the technology?

☐ Prefer not to say

c) What did you find challenging about using the technology? Please tick all that apply to you.

☐ Finding information about the technology (to solve and issue or to learn how to use it)
☐ Accessing the technology or a device to use the service (e.g. a computer with a video camera for video calls, or a phone that is suitable for an app)
☐ Financial reasons
☐ Using the technology due to the complexity of the technology
☐ Using the technology due to small fount size or features
☐ Limited language translation
☐ Having the time to use it
☐ Accessing support from a family, friend or healthcare professional
☐ Seeing how using the technology benefits me
☐ None of the above – I really enjoyed using the technology
☐ Other. Please provide more details

☐ Prefer not to say

12. Would you be interested in hearing about other opportunities to take part in research?

☐ Yes
☐ No

If yes, please enter your email or phone number below

Appendix 11: Study 2 Advert

Strategies to advance digital health equity

Share your professional experiences to help improve digital health equity!

Take part in

One to one chat
(~ 30 to 40 min)

OR

A group discussion
(~60-90mins)

We are particularly interested in hearing from you if you are a…

- Healthcare professional
- Commissioner
- Integrated care board (ICB) professional
- Work for a policy or regulatory body
- Community or charity worker supporting underserved groups
- Or involved in implementing digital health technologies in a professional capacity

Interested?
Scan the QR code & complete the form

Would like more information?
Please contact:
Sarah.Wilson@newcastle.ac.uk

NIHR | National Institute for Health Research | Newcastle University | ALZHEIMER'S RESEARCH UK FOR A CURE

Appendix 12: Study 2 Professional background questionnaire

Stakeholder participant questionnaire

This short questionnaire is made up of questions relating to your background, where you work, and the demographic group you typically work with or for. It will take you approximately 2 minutes to complete. Please answer all the questions as accurately as you can. If you do not feel comfortable answering a question, please just tick 'Prefer not to say' and move on to the next question. All your answers will be kept confidential and only used for the purpose of this study.

1. What is your job title?

   ☐ Prefer not to say

2. Which sector best describes where you work?
   - ☐ Healthcare professional
   - ☐ Commissioner
   - ☐ Integrated care system (ICS) professional
   - ☐ Policy
   - ☐ Regulations
   - ☐ Community work
   - ☐ Charity worker
   - ☐ Other third party sectors/ organisations
   - ☐ Other
     Please specify

   - ☐ Prefer not to say

3. What is the postcode for your current place of work?

   ☐ Prefer not to say

4. What demographic group do you typically work with or for? Please tick all groups that apply.
    - ☐ Diverse ethnic and/or racial groups
    - ☐ Individuals whose first language is **not** English
    - ☐ Individuals with religious beliefs. Please provide the religion(s) below

    - ☐ Hearing impairments/ wear hearing aids/ hearing loss/ deaf/ Deaf
    - ☐ Visual impairment/ vision loss/ partly blind/ blind
    - ☐ Low educational attainment
    - ☐ Over the age of 65
    - ☐ Live in deprived areas
    - ☐ Live in rural areas
    - ☐ Homeless
    - ☐ Low socio-economic income
    - ☐ Prefer not to say

5. How many years have you been working with or for these groups?
    - ☐ Less than 1 year
    - ☐ 1-3 years
    - ☐ 4-6 years
    - ☐ 6-10 years
    - ☐ +10 years
    - ☐ Prefer not to say

6. Do you have any experience of the following; tick all that apply.
    - ☐ Implementing digital technology into healthcare
    - ☐ Helping others use technology for health purposes
    - ☐ Helping others access technology for health purposes
    - ☐ No
    - ☐ Prefer not to say

7. Please provide more information about your answer to question 7. For example, the technologies you have implemented or aided others to use. If you respond No to question 7 please tick ‘does not apply to me’.

    - ☐ Does not apply to me
    - ☐ Prefer not to say

Appendix 13: Study 1 Topic guide

Interview guide

I would like to start by thanking you for taking the time to talk to me today. I am interested in hearing your experiences of accessing your doctor and opinions on using technology to help you access them. Do you have any questions before we begin?

Before we start, is it ok if I record our conversation? Everything you say will be kept confidential.

1) Can you tell me about any challenges you have experienced when trying to access your doctor or any type of healthcare?

2) Have you ever used or heard of any technology, such as an app or video call, that could help you access your doctor or other health information?

3) Have you got any thoughts about how can we improve technology that is been used for a health purposes?

I've been reading about different ways to support people like yourself in accessing and using technology for health purposes, as well as helping people feel more motivated to use them.

4) The first way is about making the technology easy to use. So, what makes some technology easy for you to use?

5) The second is about being provided with equipment. What would you like to be provided with to help you access and use technology for a health purpose and why?

6) The last one is about technical support. Can you tell me if this is something you would like and what this support should look like?

7) Are there any other things you would like to see in place to help you use, access or feel more motivated to use technology for health purposes?

    - How would you like to hear about any new changes to support that is available?

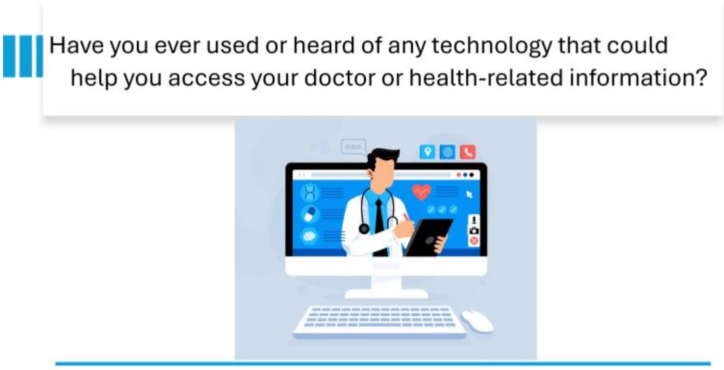
Appendix 14: Study 1 Focus group slides

Slide 1

Have you faced any challenges when trying to access healthcare?

Doctors, nurses, pharmacists, services e.g. health checks/ screening

Slide 2



Have you ever used or heard of any technology that could help you access your doctor or health-related information?

Slide 3

Any thoughts about how can we improve technology designed to be used for healthcare purposes?

Slide 4

Strategies to support use, access & motivation

User-friendly design

Providing devices

Tech support

Any other suggestions?

Slide 5

Who should be involved in delivering new support services?

Slide 6

How would you like to hear about new changes to services or support available?

Appendix 15: Study 2 Topic guide

Stakeholder topic guide

I would like to start by thanking you for taking the time to talk to me today. I'm interested in hearing about your experiences of improving digital inclusivity within healthcare and your thoughts on how things can be done better. Is there anything you would like to ask me before we start?

Are you happy for this conversation to be recorded?

1) Can you tell me about your experience involved in [insert name of project(s) to improve inclusivity or the DHT(s) the stakeholder is known to be involved in]?
   - Any major challenges and/or facilitators?
   - How did you overcome these challenges?
   - Any reflections or findings from this work that you feel are key to improving digital inclusivity?

As part of my PhD project, I've been reading about different strategies to improve digital inclusivity within healthcare and just finished a study exploring the opinions of underserved groups on ways to improve digital inclusion. From this work there seems to be 3 key elements to supporting digital inclusivity that I would like to get your thoughts on.

2) The first one is to do with the technology itself. Have you had any thoughts or reflections about how we make the technology used for healthcare purposes more inclusive?
   - e.g., translation options, content in different formats (videos or infographics), simplistic design, easy login/registering process
   - Any concerns about the feasibility of implementing these changes?
   - What would reduce these concerns?

3) The second one is about supportive infrastructure, such as access to decent Wi-Fi signal, provision of devices and non-digital routes to healthcare. What do you think should be provided to improve inclusivity?
   - E.g., devices, sim cards, vouchers, assistive technology, broadband/ phone deals, low or non-digital routes (e.g., physical leaflets for information)
   - Any concerns about the feasibility of implementing these changes? E.g. securing funding/ who should provide funding? Security of devices in terms of loss/ theft or hacking?
   - What would reduce these concerns?

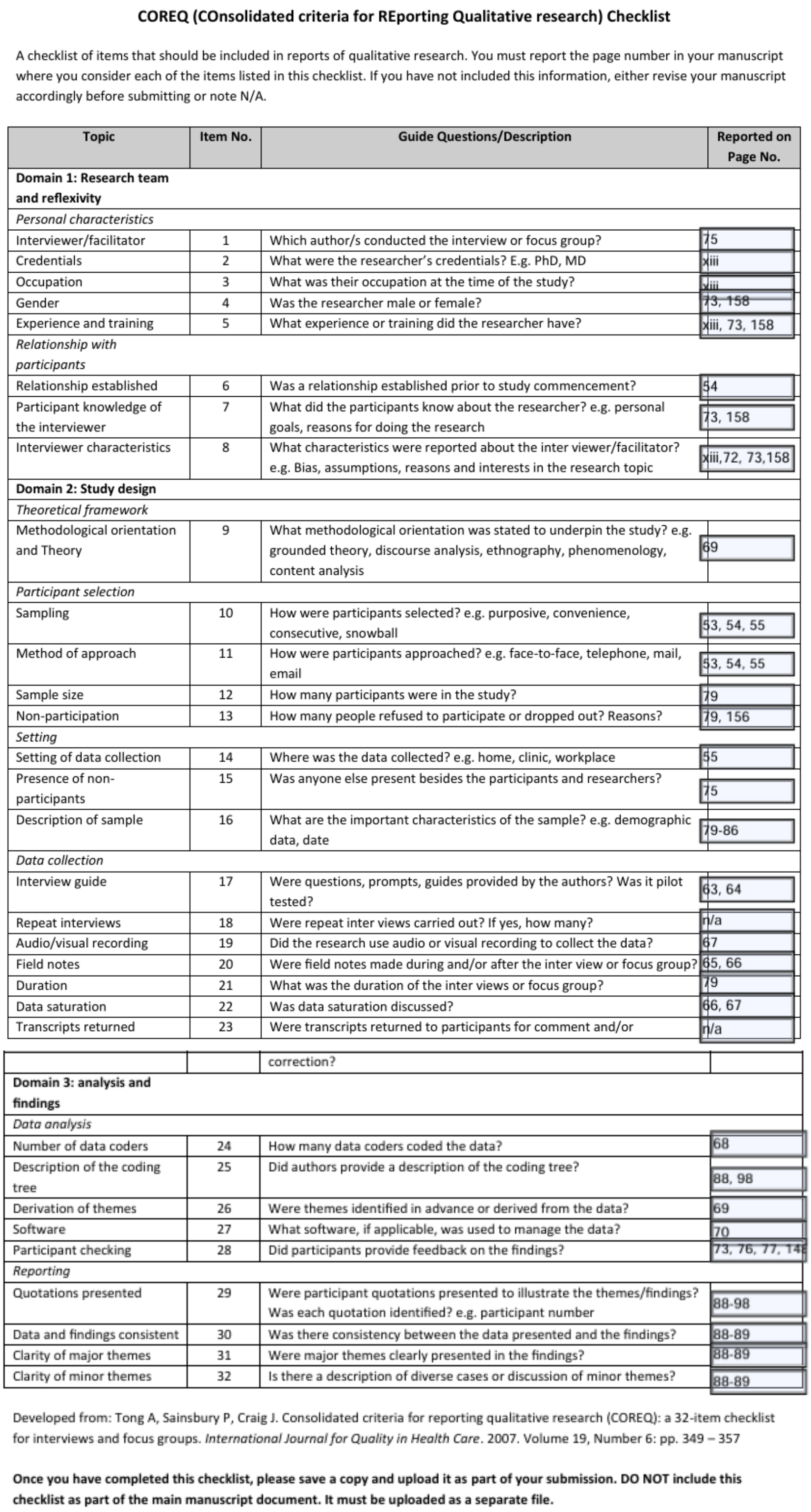
4) The last one is about providing educational support. Based on your experiences, how might it be best to deliver educational support and who should be involved?

- E.g., community centres with technology champions and peer teaching/ healthcare sites with healthcare professionals, medical students, or IT team delivering the training.
- Any concerns about the feasibility of implementing these changes? E.g. funding/ advertisement.
- What would reduce these concerns?

5) Is there anything else that you would like to see in place to improve digitally inclusivity within healthcare?
    - How would implementing this idea help reduce digital exclusion? E.g. what barrier would it overcome? Is there a particular demographic group it would help?
    - Any concerns about the feasibility of implementing these changes?
    - What would reduce these concerns?
    - Support from a different angle e.g., directly impacting the public/ additional support for organisations helping others/ policies.

6) Do you know of any colleagues or groups involved in implementing digitally inclusive strategies within healthcare, e.g., someone with a similar role to you in a different region, that I could contact and might be happy to talk to me?

Appendix 16: Study 1 COREQ checklist



COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

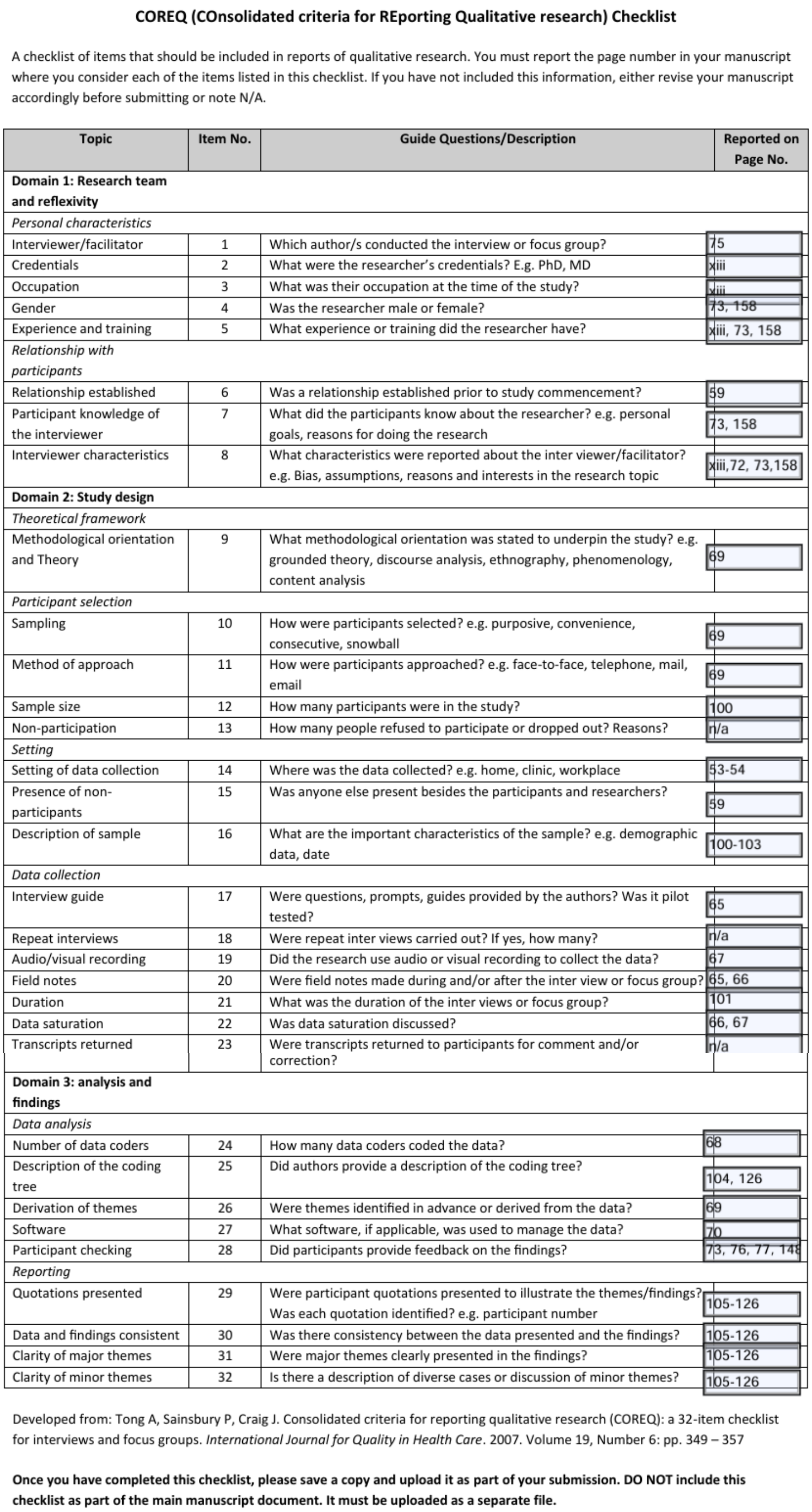
A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	75
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	xiii
Occupation	3	What was their occupation at the time of the study?	xiii
Gender	4	Was the researcher male or female?	73, 158
Experience and training	5	What experience or training did the researcher have?	xiii, 73, 158
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	54
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	73, 158
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	xiii,72, 73,158
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	69
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	53, 54, 55
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	53, 54, 55
Sample size	12	How many participants were in the study?	79
Non-participation	13	How many people refused to participate or dropped out? Reasons?	79, 156
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	55
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	75
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	79-86
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	63, 64
Repeat interviews	18	Were repeat inter views carried out? If yes, how many?	n/a
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	67
Field notes	20	Were field notes made during and/or after the inter view or focus group?	65, 66
Duration	21	What was the duration of the inter views or focus group?	79
Data saturation	22	Was data saturation discussed?	66, 67
Transcripts returned	23	Were transcripts returned to participants for comment and/or correction?	n/a
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	68
Description of the coding tree	25	Did authors provide a description of the coding tree?	88, 98
Derivation of themes	26	Were themes identified in advance or derived from the data?	69
Software	27	What software, if applicable, was used to manage the data?	70
Participant checking	28	Did participants provide feedback on the findings?	73, 76, 77, 14
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	88-98
Data and findings consistent	30	Was there consistency between the data presented and the findings?	88-89
Clarity of major themes	31	Were major themes clearly presented in the findings?	88-89
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	88-89

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Appendix 17: Study 2 COREQ checklist



COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	75
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	xiii
Occupation	3	What was their occupation at the time of the study?	xiii
Gender	4	Was the researcher male or female?	73, 158
Experience and training	5	What experience or training did the researcher have?	xiii, 73, 158
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	59
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	73, 158
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	xiii,72, 73,158
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	69
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	69
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	69
Sample size	12	How many participants were in the study?	100
Non-participation	13	How many people refused to participate or dropped out? Reasons?	n/a
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	53-54
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	59
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	100-103
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	65
Repeat interviews	18	Were repeat inter views carried out? If yes, how many?	n/a
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	67
Field notes	20	Were field notes made during and/or after the inter view or focus group?	65, 66
Duration	21	What was the duration of the inter views or focus group?	101
Data saturation	22	Was data saturation discussed?	66, 67
Transcripts returned	23	Were transcripts returned to participants for comment and/or correction?	n/a
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	68
Description of the coding tree	25	Did authors provide a description of the coding tree?	104, 126
Derivation of themes	26	Were themes identified in advance or derived from the data?	69
Software	27	What software, if applicable, was used to manage the data?	70
Participant checking	28	Did participants provide feedback on the findings?	73, 76, 77, 148
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	105-126
Data and findings consistent	30	Was there consistency between the data presented and the findings?	105-126
Clarity of major themes	31	Were major themes clearly presented in the findings?	105-126
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	105-126

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Appendix 18: Risk assessment

Risk Assessment Form

This risk assessment form should be completed electronically and approved and signed by the appropriate responsible person: principal investigator (PI), module leader, tutor, or dissertation mentor. Guidance on completing this form is provided on the University Safety Office website and in the HSE guidance Five Steps to Risk Assessment, which can be downloaded from the HSE website or USO website. It is the responsibility of the person in charge of the fieldwork that this risk assessment is made available to all participants of the fieldwork.

Title of project and/or module:
Strategies to promote digital health equity: the perspectives of underserved communities.

Person conducting fieldwork (PI or student)**:**	Sarah Wilson	**Other people involved in this fieldwork: (If needed attach separate sheet)**	Clare Tolley Riona McArdle Bob Slight
Supervisor/Module Leader (for student fieldwork)**:**	Sarah Slight		
Date(s) of fieldwork	Yet to be organised		
Location(s) of fieldwork	A public place such as a community centre or at a participant's home.		

Field activity outline: (brief synopsis)
Recruiting individuals at community centres, other community hubs and public places.

Semi structured interviews (30–40 minute interview) and a short (5min) questionnaire will be used with underserved groups

Focus groups 60-90 minute and a short (2min) questionnaire will be used with stakeholders.

Hazards, Risks and Controls

It is important to understand the difference between hazard and risk. The **hazard** of a substance/activity/condition is the intrinsic property of the substance/activity/condition to cause harm. The **risk** in relation to exposure to a hazard means the likelihood that the potential for harm will be expressed under the conditions of use and the severity of that harm. The main purpose of your risk assessment is to identify the hazards, decide who is at risk (Bear in mind that as a result of your activities, members of the public might be at risk), assess the level of risks to people, and decide on suitable controls to ensure that the work can be done safely.

List the potential Hazards. Assess the level of risk (E = Extreme: needs immediate action, H = High, M = Moderate, L = Low, N = Negligible). Outline the control measures put in place ('so far as is reasonably practicable') to reduce the risk. Then assess the level of risk with the control measures in place.			
Potential Hazard	**Level of Risk**	**Control measures to reduce the Risk**	**Reduced Level of Risk**
Travel How are you getting to your field work? Think of vehicles, roads, flights, visas, FCO advice			
Public transport (train, bus, metro)		Only approved and reputable travel companies will be used when traveling to meet a participant.	
Walking		If the site where an interview/ focus group is taking place is in walking distance but poorly lit, a reputable taxi company will be used.	
Dealing with other people Think of home/office environment, safety in public places, culture, landowners, authorities, interviewees, lone working etc.			

Potential Hazard	**Level of Risk**	**Control measures to reduce the Risk**	**Reduced Level of Risk**
Health Think of food, drink (incl. clean water), environment, immunizations, allergies, etc.			
Location Specific Think of urban hazards, FCO safety & security advice, cold/hot environment, weather, animals, insect bites, cliffs/crevices, slopes, deep water, tides, soft sediments			

Activity Specific Think of river crossing, instream sampling, entering caves, coring, conducting interviews & observations			
Recruiting participants		Contact will be available between the researcher and at least two other member of the research team who are contactable in case of emergencies (assigning one member with first contact and the other second contact). The researcher responsible for recruiting participants will leave an itinerary with the research team including the exact location of any planned recruitment, the start time and expected end time. Each researcher will have their own mobile phone and have the PI's number. The PI will also have their number. The researcher responsible for recruiting participants will confirm to an agreed member of the team when they have arrived and also when they have left the external site. If researcher recruiting participants does not make contact with a member of the team after 30mins of the time that is expected, a member of the team will contact the researcher to check in. If no response after three attempts, steps will be made to visit the agreed site with a member of the university security or police to minimise risk to the research team. Research staff will be instructed to contact the emergency services if they feel that they are in danger. To prepare for the visits, research staff will ensure their mobile phone is fully charged and switched on, provide their itinerary to the team and inform the team if changes occur, carry only sufficient money for the day and keep it hidden, remove items of jewellery and keep bags close at all times. Researchers will be alert at all	

		times. If the researchers feel uncomfortable for whatever reason with a gatekeeper or public place, they may make the decision not go.	
Conducting interviews and focus groups (general)		When traveling to and from interviewing participants the same safety procedures outlined above will be followed. If the researchers feel uncomfortable for whatever reason with a participant, they may make the decision not go. In the case of any psychological harm occurring to the researcher from interviewing underserved communities about digital exclusion, the researcher will let a member of the team know and seek support from student wellbeing services (https://www.ncl.ac.uk/wellbeing/).	
Conducting an interview/ focus group at a public place		The researcher will meet with a staff member of the public place before meeting the participant to discuss safety procedures (e.g., if the researcher felt threatened or at risk).	
Conducting an interview at a participants home		The researcher will only visit a participant's home if the participant is house bound, thus physically cannot attend an interview in a public place, and a third person is present, such as a translator or member of the research team. If the third person cancels and an alternative is not available, the interview will be postponed. The researcher and third person will discuss a safety plan, e.g., agree on a safe word, in case the researcher or translator feels threatened or at risk during the interview. A member of the team will contact the researcher after an interview at a participants home to check in.	

Equipment Specific Thinks of heavy/hazardous equipment, sharp tools, electrical equipment, fragile equipment, etc.			
Other Hazards			

Personal Protective Equipment (PPE)

Indicate on the list below which PPE is required for this fieldwork

Hi Viz jacket(s)	☐	Walkie talkies Rope	☐
First aid kit	☐	Climbing gear	☐
Hard hat(s)	☐		☐
Hiking boots	☐	Dry suit(s)	☐
Wellington boots	☐	Goggles	☐
Waders	☐	Ear protectors	☐
Emergency blanket	☐	Face shield(s)	☐
Survival bag	☐	Protective gloves	☐
GPS	☐	Satellite phone	☐
Other______________	☐	Other_____________	☐

Risk Control Measures

Indicate the standard risk control measures needed.

Adequate drinking water	☐
Sunscreen / insect repellent Notify	☐
authorities	☐
Notify land owners	☐
Obtain permissions Obtain local weather information Work	☐
in pairs/groups	x
Emergency details/medical form of participants	☐
Mobile phone	x
Insurance cover & documents	☐
	☐

Other Control Measures: (List any other PPE or control measures that will be used)

Training: (Outline any specialist training needs to successfully carry out field tasks)

Emergency Plan

Despite all preparations and no matter how careful you are, accidents can happen. Indicate procedures to follow in an emergency (who do you contact, where do you go).

A member of the research team will be assigned first contact and another will be assigned second contact in case contact cannot be made with the first member of the team. If no response from the data collecting research is received after three attempts, steps will be made to visit the agreed site with a member of the university security or police to minimise risk to the research team. The data collecting researcher will also have contact details for the university security team and emergency services in case of emergencies.

Contacts

Contact	Address/Telephone Number
Accommodation	
Emergency Services	999
Nearest Hospital	
Police	999
British Embassy/Consulate	45 Nottingham Place, London, W1U 5LY, United Kingdom
Insurance contact & policy no.	
Other	
University Emergency Telephone Number	+44 (0)191 222 6666

Comments and additional information:

Assessor:	**Name**	**Signature**	**Date**
Risk Assessment Completed by:	Sarah Wilson	S.Wilson	27/10/2023

Approval:	**Name**	**Signature**	**Date**
PI/Module Leader/ Tutor/ Dissertation Mentor			

Submit:

Review: When multiple field visits are planned, please review this risk assessment after each visit and revise where necessary.

Appendix 19: Public dissemination feedback form

Gathering feedback on my results

Hi, I'm Sarah Wilson, a Research Assistant and PhD Student at Newcastle University. Earlier this year, I talked to many people across North and South Tyneside about how they use technology to access healthcare. We wanted to find out how we can make these services better. After listening to everyone, we worked with an artist to create a picture showing what we learned and the importance of tailoring technologies and services to meet the needs of different groups. Now, we would like your help! Please take some time to have a good look at the image below. Then answer questions on pages 2 to 6 in as much detail as possible to share your ideas on how we can make the picture easier to understand. Feel free to look back at the image when completing these questions.

Questions

1. What is your overall impression of the artist's visual representation of these findings?
   ………
   ………
   ………

2. What caught your attention first or stood out to you the most?
   ………
   ………
   ………

3. What images or words should we change to make it more understandable?
   ………
   ………
   ………

4. Going through each section one by one, are there any images, words or fonts that we should change to make it more understandable or appropriate? Is there anything you really like about that section?
   Please use the table on page 2 to answer this question.

Section	Things you like	Things you don't like
		
		

 EDUCATION LOW EDUCATIONAL ATTAINMENT EDUCATIONAL DIGITAL SUPPORT SERVICES PROVIDED BY TRAINED STAFF SHOULD HAVE SUFFICIENT GOVERNMENT FUNDING & ADVERTISED WIDELY, INCLUDING NON-DIGITAL AVENUES SUCH AS ON PUBLIC TRANSPORT PROVIDE		
 RESIDENCE RURAL, DEPRIVED or HOMELESS PROVIDE SMS messages to REMIND individuals of upcoming APPOINTMENTS that DO NOT NEED a REPLY HOMELESS INDIVIDUALS may not have ACCESS to LETTERS, reliable BROADBAND to recieve EMAILS, or FUNDS on phone to send CONFIRMATION messages PROVIDE SIM CARDS with SUFFICIENT DATA PLANS RURAL or DEPRIVED areas my not have RELIABLE BROADBAND INFRASTRUCTURE		

 Seeing where to SIMPLIFY LOGIN PROCESSES AGE 65+ YEARS OLD AVOID the use of PASSWORDS use BIOMETRICS SIMPLIFY the PROCESS of RESETTING PASSWORDS AVOID methods that REQUIRE flicking from SMS message to APP RURA areas RELIA INFR		
 ASYLUM not have DOCUME IMPLEMENTATION of NEW POLICIES, Such as REDUCED PAYMENT PLANS for BROADBAND & PHONE PLANS REGULATIONS on the PRICE of TECHNOLOGIES DO NOT NEED INDIVIDUALS PROVISION of DEVICES, WIFI or VOUCHER to replace damaged devices SOCIOECONOMIC STATUS LOW INCOME or UNEMPLOYMENT USE of FREE COMMUNICATION PLATFORMS Such as WhatsApp		

5. Was any of this information new or surprising to you?

………
………
………

6. What questions do you still have looking at this information? Is there anything missing? Final thoughts overall?

………
………
………
………
………
………