

Identifying and understanding digital exclusion: A mixed-methods study

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Abstract

Many of our transactions and interactions are now exclusively online, however, whilst we live in a world which is becoming ubiquitously digital, digital exclusion remains a complex societal issue. This study aimed to identify the scale and characteristics of 'digitally excluded' individuals in one borough in North-East England and investigate factors influencing experiences of digital exclusion. A two-phase, sequential explanatory mixed-methods design was used. Phase One utilised a survey which was sent to every household in the borough (N=>98,000). The surveys (N=9,181) were analysed using exploratory univariate analysis, followed by a two-staged regression model. Of those responses, 1,130 individuals (12.3%) were identified as digitally excluded. Older adults with disability, no or low-level education, residing in specific (micro) geographical areas, were at higher risk of digital exclusion. Smaller household size and lower income also contributed to digital exclusion. To further enhance inclusivity, three focus groups were conducted with groups who were identified as being at higher risk of digital exclusion (N=10). Discussions highlighted the complexities of digital exclusion and digital use across communities and within individual circumstances. Digital exclusion is multi-factored and complex. It requires regional institutions and local communities to collaborate in an integrated governance framework to improve digital inclusion.

Keywords: Digital exclusion, Digital divide, Social exclusion, Mixed-methods

Introduction

There is an expectation that technology is used ubiquitously across most of the globe. For many, COVID-related lockdowns demonstrated the necessity of having remote digital access, and digital skills to remain connected. However, the way in which individuals utilise digital tools is complex, and multi-tiered, through individual and socio-economic factors such as, cost, skills, choice, and availability [1]. Despite the need for this rapid online shift during the COVID-19 pandemic, not everyone was able to keep pace with these changes. Digital exclusion gaps remained extensive through this time, and

continue for many to the present day [2] with basic digital skills set to become the largest skills gap in the UK by 2030 [3].

Whilst there are no longer 'stay-at-home orders' which were experienced during the COVID-19 pandemic, the digital shift is ever-present and many services, and ways of working, remain 'digital by default'. This fast-paced digital, and social, change requires constant adjustment from both digital users and non-users [4]. However, the digital agenda, which is progressing in local, national, and global organisations, such as government, healthcare services, educational, and financial services, is at odds with the experience of those who are digitally excluded. This has potential wider detrimental impacts on a person's social and economic capital, as well as impeding civic participation and creating a greater sense of societal disconnect [5].

Digital exclusion is a complex, multi-tiered issue with multiple definitions. 'Digital exclusion' has been defined in many ways in the literature [62,71,72]. For example, in disability studies, understanding digital exclusion has been guided by established theories of the social model of disability and the adoption of the biopsychosocial model of disability to address systemic barriers and promote inclusive design practices in developing and deploying digital technologies [75, 76]. This approach aims to empower individuals with disabilities to fully participate in digital society and reduce inequalities in access, skill, and use of technology. Similarly, multiple conceptual frameworks for digital exclusion exist, including those that highlight the importance of access to digital tools, digital skills, and the impact of confidence. More recent literature posits digital exclusion across three levels, digital access, digital skills and usage, and finally the tangible outcomes of using technology that can result in offline benefits [6]. The definition of digital exclusion that we used within this current study builds on existing models, theories, and definitions of digital exclusion [6-9]. The term 'digital exclusion' used in this current study refers to the lack of digital access, digital use, digital confidence, or digital skills. This conceptual framework of digital exclusion was purposively comprehensive to ensure that the most digitally excluded individuals were identified and otherwise would have been classed as 'hard exclusion' within other policy reports [2].

In order to access digital technology, an individual must rely on micro, such as their location cost, and meso/macro factors associated with infrastructure and accessibility of digital facilities [10]. Whilst broadband connectivity and speed are primarily considered issues in rural areas, inadequate broadband connectivity in urban and sub-urban communities still remains to be an issue [11]. In fact, 1.7 million households in the United Kingdom have no mobile or broadband internet at home [3]. Furthermore, physical, psychological, and social barriers of digital use also impact digital inclusion, such as challenges with dexterity and eyesight [12, 13], confidence and self-efficacy [12, 14, 15], fear, trust, and security concerns [12-14], and lack of social capital [12, 16-18]. The landscape of digital equipment is ever-changing. These issues highlight the various inequalities and characteristics that heighten the risk of being digitally excluded including, low economic status [19-25], lower educational attainment [20, 23, 26-28], older age [18, 21, 23-25, 27-32], health status and disability [20-22, 24, 25, 27], and English being a second language [25, 33, 34]. These inequalities exacerbate digital inequalities but are two-fold in that digital inequalities further exacerbate existing health and social inequalities, further impacting experiences of social exclusion [35]. Therefore, the digital divide is considered as a critical social policy issue [4, 35, 36].

Understanding people's attitudes towards digital facilities is also crucial for studying the digital divide. Digital attitudes include factors such as peoples' willingness to use digital resources and their overall attitudes towards the benefits and risks of technology [6, 15, 17]. These attitudes contribute to shaping patterns of digital inclusion and exclusion within societies [21]. By examining digital attitudes, researchers can better understand why there are disparities in digital access and skills across different populations. Additionally, studying digital attitudes helps policymakers and educators design more

targeted interventions and initiatives to reduce the digital divide and promote equitable access to technology and its benefits.

Despite this now widespread recognition of ubiquitous digital living, and the day-to-day impact that digital exclusion can have for individuals across society, existing research in this area has predominantly focused on smaller specific population groups, for example, mental health service users [37], migrants [38], or older people [39]. There is a dearth of research that has investigated digital exclusion on a population level. Furthermore, studies have tended to use quantitative measures with small sample sizes [40, 41], purely qualitative methods [42, 43], or secondary data sources [44, 45] instead of developing specific instruments to focus on the complex nature of digital exclusion. Often, research has also tended to exclusively use online data collection tools; this is problematic because it excludes individuals who are digitally excluded. Identifying effective measures and methods to capture various forms of digital exclusion represents a knowledge gap that this study aims to bridge by establishing primary data collection using mixed methods incorporating a participatory co-design approach to ensure the investigation content is relevant and engaging. The strength of a mixed method design resides in integrating both quantitative and qualitative data, which enriches the research process [47] and enhances the depth of understanding of the multifaceted construct of digital exclusion [34]. The participatory co-design approach can also contribute to the study's strength through its ability to generate contextually rich insights, develop inclusive solutions and foster collaboration among stakeholders to address the complex issues of digital exclusion throughout the research process [73, 74]. This collaborative approach also empowers participants to contribute their knowledge, expertise, and perspectives, ensuring that research objectives, methods, and outcomes are co-created and reflect the needs and priorities of those affected [73].

There has also been little research carried out within some of the most digitally excluded populations in the UK. Within England, the North East area has the greatest numbers of those who are digitally excluded particularly in terms of access, internet use, cost, and lack of digital skills (46). A secondary analysis of Ofcom data (2018–19) illustrates that over half of respondents (53%) within the North East of England are non-internet users or are 'very limited users', representing the largest digital divide between 'extensive Internet users' and 'non-users' across the UK [46]. Therefore, it is critical to understand this complex issue in more depth, building an evidence base which can support complex solutions to be delivered for those experiencing digital exclusion across the North East of England and nationally. Investigation in the North East area can shed light on digital inclusion patterns, barriers, and digital literacy levels with broader implications beyond regional boundaries. Understanding these dynamics can contribute to global knowledge about digital divide and its impact on society. In addition, studying the North East's experiences can offer comparative perspectives for other regions across the UK or countries dealing with similar issues. For example, understanding the specific challenges faced in the North East, such as access to digital tools, digital skills, or economic disparities, can provide valuable context for broader policy discussions and practical initiatives aimed at reducing digital disparities and promoting equitable access to digital technologies worldwide. This study aimed to explore and gain a more in-depth understanding of digital exclusion across one borough within the North East of England using a co-designed, mixed-methods approach. Specially through:

- Identifying the scale and key characteristics of digitally excluded groups
- Understanding key factors contributing to digital exclusion
- Investigating digital attitudes as a determining factor in digital exclusion
- Mapping solutions to improving digital inclusion

Materials and Methods

Research design

A sequential explanatory mixed methods design based in critical realism [47] was developed with two phases: (1) a large cross-sectional survey of household residents across one borough within the North East of England; and (2) focus groups to further explore experiences with digitally excluded cohorts. The survey results were used to identify the key characteristics of target participants for the qualitative phase of this study. The qualitative findings supplement and contextualise the quantitative results in a sequential mixed-methods design [48]. Applying this mixed methods research strategy enabled us to achieve an in-depth understanding of lived experiences of digital exclusion. Furthermore, the survey was developed using participatory co-design principles through inclusion of several key stakeholders across the health and social care sector, local authority, charitable organisations, and a patient and public group. These stakeholders were fundamental in designing the study, designing and pilot testing the survey tool, recruitment for both phases, and dissemination. The co-design approach was instrumental in enhancing the research process by making it more collaborative, relevant, ethical, and impactful. This approach also enabled the study to acknowledge the expertise of diverse stakeholders and recognise the value of collective knowledge and experience in producing meaningful research outcomes [73, 74].

This study was approved by [40123] and Integrated Research Application System (IRAS) for health and social care/community care research (*Project ID Number: 304555*). Participants were informed that participation in this study was voluntary, confidential, and anonymous, and they could decline to participate at any stage in the study.

Sampling and Recruitment

Phase One - Survey recruitment

Inclusion criteria included age (18+ years) and resident location (living in the borough). A survey package was mailed to each household (>90,000) (census approach) between January and March 2022. The package included: invitation letter, participant information sheet, resident's survey, a pre-paid envelope for survey return directly to the research team. An informed consent statement was provided on the first page of the survey which required acknowledgement before proceeding. To increase inclusion, distribution was to all residence types, i.e., houses (rented/owned), care homes, sheltered homes, Independent Supported Living services, hostels, etc. Participants could complete the survey on paper, via telephone, or online.

To ensure the inclusion of underserved and digitally excluded groups, the research team supported local organisations (i.e., Healthwatch, Community Healthcare Forum, the local authority, Age UK, VODA, North Tyneside Citizens Advice Bureau) to champion and share information about the survey launch to increase its reach. Social media was also used in this capacity prior to the survey launch.

Phase Two - Focus Group recruitment

Focus groups allowed the challenges of digital exclusion identified in Phase One to be explored in more depth. Target participants for the focus groups were selected based on the survey findings revealing individual characteristics of populations at high risk of digital exclusion (i.e. based on disability, age,

education level, and economic status) or were suggested by local expert organisations (i.e. women who experienced domestic abuse). A purposive sampling strategy was used to recruit three focus group cohorts who typically experience digital exclusion: (1) individuals from the deaf and hard of hearing community, (2) young adults living in shelter homes, and (3) women who have experienced domestic violence. Inclusion criteria were the same as it was for Phase One, with the addition of falling into one of the three groupings identified above. The focus groups were planned and supported by local volunteers and voluntary organisations who supported recruitment via flyer distribution across the study area. Potential participants were approached by the research team individually and were adequately informed about the research aim and the focus group process.

Data collection methods

Phase One - Survey design, implementation, and data coding

The survey design drew on existing digital exclusion theory [6, 7], which suggests access, skills, and motivation to use digital technology as key measures of digital exclusion. The survey was co-developed with key stakeholders, who drafted, revised, and added further questions/sections for inclusion and removal. The survey also included a section to capture attitudes towards digital tools, based on input from the stakeholders and literature [17, 21].

The survey included three main sections: an individual demographic section, a household demographic section, and a section related to the use of digital tools. The last section contained Likert-style scale questions about access to digital tools (including tablets, laptops, desktop computers, smartphones, smart speakers, mobile data, and broadbands); use of digital tools and apps (e.g. items measuring the frequency of use of email, social media apps, online shopping, online banking); self-assessment of digital skills (e.g. self-assessing ability to process information online) and confidence in using digital tools (e.g. items measuring confidence in understanding/using terms related to digital tools/internet/apps). The survey also posed dichotomous and multiple-choice questions regarding digital attitudes, such as attending digital skills training classes in the last 5 years, having privacy/security concerns when online, and believing the COVID pandemic's impact on using digital tools. The survey concluded with an open-ended question asking respondents to share their thoughts/suggestions to support the access to/ongoing use of digital tools (a copy of the survey is available upon request).

A draft version of the survey was sent for expert review to nine people within the co-design group who engaged in the survey's design and pilot testing to ensure the validity of measurements. Comments and suggestions were collected covering the content, clarity, style, and formatting. These included, for example, suggestions on measuring access to digital tools/internet via offering options to respondents to specify their ways of access, including their own access, access through someone else living in their household or outside of their household (e.g. friends, family), access through local services (e.g. local library) or no access at all, which were not separated within existing measures introduced by digital exclusion theory [6,7]. Amendments and revisions were made accordingly, and the validity of the survey was confirmed by independent experts from North Tyneside's digital inclusion steering group. The final survey was piloted with 35 local participants aged 20 to 85 years ($M= 54$, $SD=19$). After data collection, Cronbach's alpha was calculated by grouping five-point Likert questions covering related topics such as digital confidence, digital skills, and digital willingness. The reliability value according to Cronbach's alpha coefficient was 0.844, ranging from 0.772 to 0.871 across various variables, indicating a good level of reliability. The Cronbach's alpha value of 0.887 for digital use, consisting of 13 items, also indicated a good internal consistency of subscale measurements.

Phase Two -Focus group data collection

The interview guide for the focus groups was co-developed through a participatory approach between the research team and key stakeholders, including the health and social care sector, local authorities, and charitable organisations. The interview guide was developed to elicit information regarding the participants' experiences of accessing/using digital tools and their attitudes towards digital facilities. Focus group schedules were semi-structured, based on findings from the survey (Phase One). The schedule was adapted to suit each participant group and included collection of non-identifiable demographic information. Two trained and experienced researchers [GE, HDL] planned and facilitated focus groups and were guided by the interview guide. A qualified BSL interpreter was also used to facilitate communication during the focus groups with deaf participants. Focus groups lasted between one to two hours and were conducted in accessible community settings. All participants provided written informed consent, and a £10 voucher was given to each individual to thank them for their participation. All three focus groups were audio recorded, transcribed verbatim, and transcriptions anonymised by removing any names, placenames or identifying text.

Data analysis

Phase One – Survey data analysis

On completion of Phase One data collection, all paper-based survey responses were inputted into an electronic database in Microsoft Excel. Data gathered from both paper-based and web-based surveys were consolidated and combined into a single master database. Data cleaning involved checking the accuracy of data entry, the inclusion criteria for minimum age and location (i.e. residents within the borough), missing values, and outliers. The master database was exported into the IBM SPSS Statistics version 28 for analysis. Initially, descriptive and univariate statistical analyses were performed to understand the sample and identify significant variables (using t and chi-square tests). Then, a two-stage model was developed to explore the key factors influencing digital exclusion.

Phase Two – Focus Group analysis

Focus group transcripts were analysed using inductive, latent Thematic Analysis [49, 50]. Thematic Analysis, unlike many other qualitative data analysis methods, is a theoretically flexible tool which may be used in alignment with a range of philosophical positions such as critical realism which views social reality as complex and multi layered [51]. Two members of the team [KB, GWM] analysed the focus groups. Thematic analysis followed six steps suggested by Braun and Clarke (2006); familiarity with the dataset, generating initial codes, developing themes, reviewing and adapting themes, and finally producing the final product. In the first step, all transcripts were read carefully to obtain a better contextual understanding of each focus group discussion. In the next step, descriptive codes were developed (e.g. comments on experiences of accessing/using digital tools). Designated analytical themes were developed to classify the barriers and facilitators to technology adoption for each focus group. The findings were discussed, challenged, added to and agreed by the wider research team (AS, GE, KB, WC, LYM). This procedure was repeated for several iterations, resulting in multiple enhancements of the primary themes and sub-themes to provide an explanatory understanding of digital exclusion in the region. NVivo11, QSR International, software was used to store and manage qualitative data.

Results of Residents' survey

Sample population

After removing duplicates and data cleaning, 9,181 completed surveys were analysed (7,513 paper-based, 1,668 web-based, and 12 telephone). To our best knowledge, this is the first survey study of this sample size that focuses explicitly on digital exclusion. It is hypothesised that such a large sample size was gained (9.3%) through dissemination strategies which covered the entire household population across the borough, and through offering different modes of participation. Table 1 presents sample characteristics.

Most respondents reported being female (60%), married (61%), white residents (97%), and aged between 60-79 years old (54%). The average age was 63 ($SD= 15.05$), with a median age of 66 years (range 18–101 years). The majority of respondents indicated certain educational qualifications, while a minority of less than 11% disclosed having no qualifications. Although most respondents were homeowners (62%), the annual household income (54%) for the majority was £40K or below. These results were generally consistent with the demographic characteristics of the study area population – enhancing the generalisability of results. On average, the respondents of this study are relatively old, possess some levels of education, and predominantly belong to the white ethnic group who own their homes outright, representing demographic characteristics for the whole study-area population.

[Insert Table 1 here]

Digital exclusion construct

The dependent variable to be explained in the regression modelling of this study is digital exclusion (as defined above). This was identified using several questions from the survey to construct the 'digital exclusion' variable, as follows. Access to digital devices was captured by asking respondents if they had access to tablet, laptop, desktop computer, smartphone, and smart speaker. A lack of digital access was determined when a respondent had selected 'no access' to all digital tools. Using digital tools was captured by asking residents how often they had used Email, Social media sites, Online shopping, Online banking, Online GP appointments, entertainment (e.g., BBC iPlayer), Video calling (e.g., FaceTime, Skype, Zoom, Teams) and Microsoft 365. Respondents lacking digital use were identified if they had selected 'never use' or 'choose not to use' or 'may use digital tools annually' responses. Similarly, a respondent lacking confidence in using digital devices was counted if the respondent had selected 'no confidence at all' in using all digital tools. Finally, a lack of digital skills was identified if a respondent had selected 'very poor' in responding to assessing their digital skills. Therefore, respondents were clustered as 'digitally excluded' when they reported one or more of these four indicators within the survey.

The maps below illustrate the geographic distribution of respondents (by each of the postcode areas) with 'no access' to digital tools ($n=290$ in total, see Fig 1), respondents with 'no or very limited use' of digital technologies ($n=448$ in total, Fig 2), respondents with 'no confidence' in using digital tools ($n=868$ in total, Fig 3), and respondents with 'very poor' digital skills across four primary care areas of the borough ($n=752$ in total, Fig 4).

[Insert figures 1-4 here]

The digitally excluded cohort illustrated in Table 1 shows that the following individuals are more likely to be digitally excluded: Those who are older than 60; Retired; With lower income; No educational qualifications / lower levels of qualifications; Living in a smaller household; Living with a disability or living in a household with someone else with a disability or long-term health condition. This suggests the inclusion of these independent variables in the regression analysis (as described in the next section).

Multistage modelling

Two logistic regression models were developed to gain insight into the determinants that explain digital exclusion among the residents of a North East of England borough. In the first model, we examined socio-demographic variables as potential predictors of being digitally excluded, while for the second model, we added variables related to digital attitude to the regression equation. Table 2 presents the results of both models, which include the estimated coefficient (β), standard error (S.E.), statistical significance (p-value) and odds ratio ($\text{Exp}(\beta)$) for each explanatory variable. Each coefficient indicates the change in the odds of the given outcome, which in this study is a digital exclusion instead of digital inclusion for a one standard deviation increase in the socio-demographic and digital attitude characteristics.

Findings from both regression models were sufficiently robust to estimate digital exclusion. The enhancement of the model's predictability was achieved through the inclusion of explanatory variables on digital attitudes. The first model yielded a Nagelkerke R-square value of 0.308, indicating that socio-demographic factors account for over 30% of the variability in digital exclusion, with the remaining portion explicable by other factors. After adding digital attitude variables, such as concerns regarding privacy and online security or willingness to use digital devices, the Nagelkerke R-square value increased to 56.8% (or 0.568), i.e. both socio-demographic and digital attitude variables contribute to understanding digital exclusion within the borough. The Hosmer and Lemeshow statistics, which showed insignificant p-values for both models, indicate the adequacy and effectiveness of both models in predicting the likelihood of experiencing digital exclusion within our sample. Furthermore, model 1 and model 2 achieved an overall percentage of correctly classified cases of 92.7% and 94.4%, respectively. This indicates that when the chosen predictor variables are considered a collective set, they serve as reliable indicators for comprehending digital exclusion within the borough.

[Insert Table 2 here]

Model 1: Used socio-demographic characteristics to predict digital exclusion

The first model used logistic regression analysis to examine whether the socio-demographic characteristics influence the likelihood of being digitally excluded. The results demonstrate that several independent determinants significantly contribute to digital exclusion, including gender, age, educational attainment, employment status, the presence of residents aged 18-59 with a self-reported disability in the household, and residing in Area 4 and Area 3.

According to the results, there is a digital gender disparity between males and females. Male residents exhibit a higher likelihood of being digitally included compared to female residents, i.e. females face a greater risk of being digitally excluded. Age also emerges as a significant determinant in predicting digital exclusion as older residents are more likely to experience digital exclusion than younger residents. Additionally, educational level is a significant predictor of the probability of experiencing digital exclusion. Individuals without a university degree or equivalent, such as those with no or minimal education, vocational education, or other qualifications, are more likely to experience digital exclusion.

Statistical evidence suggests that household income level is another noteworthy determinant of digital exclusion among residents in the borough. It is observed that individuals earning less than £40K annually have a higher probability of experiencing digital exclusion. Individuals reporting lower income levels (below £40K annually) are less likely to possess digital inclusion compared to those earning more than £80K (considered as the reference category).

Another significant contributor to the digital exclusion model is the employment status of individuals. Individuals who are employed whether on a part-time or full-time basis, are more than twice as likely to be digitally included compared to those who are 'unable to work'. Being employed reduces the likelihood of experiencing digital exclusion. Furthermore, individuals who are unable to work due to a disability or living with someone with long-term health conditions are also more likely to be digitally excluded. Specifically, households that reported having a disability are more likely to experience digital exclusion. However, as indicated by household size, residing in a larger household significantly decreases the likelihood of digital inclusion compared to smaller households.

It becomes evident that residents residing in Area 1 and Area 3 are at a higher risk of digital exclusion than those in Area 4. Choosing Area 4 as the reference category was due to its self-reported lowest proportion of digital exclusion and lack of digital access, use, skills, and confidence than all other areas. Tenure status also explains the probability of being digitally excluded. The results reveal that individuals who rent are more likely to experience digital exclusion compared to homeowners, regardless of whether they have a mortgage or not. However, it is worth noting that this association lacks statistical significance when considering other forms of dwelling.

Model 2: added digital attitude variables to predictors of digital exclusion model

The integration of digital attribute variables resulted in a slight decrease in the number of participants, from 6,863 in Model 1 to 6,315 in Model 2. Table 2 shows that three reported digital attitudes were statistically significant in predicting digital exclusion while controlling for gender, household size, disability, employment status level, and tenure status. These socio-demographic variables were found to be statistically non-significant, indicating no significant difference in these variables between digitally included and excluded cohorts in the second model. However, other sociodemographic determinants, such as education and age, remained highly consistent as additional variables were entered into the model. This suggests that the digitally excluded individuals were more likely to be older residents with limited or no education, while we accounted for this discrepancy by including these variables in the logistic model. The odd ratio for individuals who reported 'no qualifications' and 'GCSEs or equivalent', further supports the previous findings in the first model, indicating residents with lower educational attainment are at higher risk of digital exclusion.

Furthermore, the variables on primary care location and income level remained statistically significant at a 10 per cent level in the second model. Model 2 also reveals that individuals with lower incomes

residing in Area 1 and Area 3 exhibit a decreased likelihood of digital inclusion compared to those living in Area 4, which aligns with the results of the first model.

Individuals with 'privacy/security concerns when using digital tools online' are less likely to be digitally excluded, i.e. those who reported concerns about privacy and security when using the internet are more likely to be digitally included rather than excluded. Moreover, respondents who express their 'willingness to incorporate digital tools into their daily lives' are more likely to be digitally included rather than excluded. A significant association exists between the willingness to adopt digital tools and an increased probability of being digitally included instead of excluded.

Ultimately, individuals who believed that 'the COVID pandemic pushed them to use digital tools more often' are less likely to be digitally excluded. The proportion of digitally included respondents is approximately twice as high as the likelihood of being excluded among those who acknowledged the pandemic's influence on their digital tool usage. The results show that 'attending digital skills classes in the last five years' was statistically insignificant in predicting this study's outcome of interest.

Results of focus groups

Three focus groups were conducted (see the characteristics of the focus groups in Table 3). Two themes, each with subthemes, were generated: Technology adoption and Barriers to technology use.

[Insert Table 3 here]

Technology adoption

Individuals within the focus groups discussed the characteristics around their own technology adoption which was impacted by both contextual and personal factors, such as age and cost. The timing in which individuals adopted technology, as well as their motivations for doing so, impacted the way in which they used technology.

Early vs. late adoption

There were clear generational differences impacting digital inclusion across focus groups. These differences could often be explained by characteristics of technology adoption – particularly timing of technology initiation. P001 (female) was a "late adopter" to new technology in her personal life, for example, she had opted for a simple mobile phone rather than a smart phone. It is important for those who consider themselves to be 'late adopters' to recognise the benefits of a new digital device (in this case a smart phone) or that upgrade would have for them. In buying a new device, or upgrading an existing one, there is both financial investment and time commitment in doing so.

"I'm a late adopter to smart phones. It's quite a simple one. [...] Most people have got them. And a friend of mine had one and she said, oh, I've got this one and it's for stupid old people [...]. And they said this was a good one for people with hearing loss" (P001, deaf community)

In P001's case, the smart phone she chose was specifically related to her hearing loss however the self-depicted ageism is clear from P001's language, assuming older adults need simpler technology. This also affected her own decision to choose this particular smart phone.

P002, a younger participant within the deaf community group, was confident and familiar with smart phones. He had started to use smart technology in his "early teens". Similar experiences were discussed within the youth group, with individuals having grown up with technology since they were as young as five.

"I think it's because since we've grown up with it our whole lives, we've just got used to it" (P007, youth group)

These participants were confident in their use of technology and did not need support to use it. In fact, they sometimes supported their friends or family to use technology.

"I've helped people before, with, like, installing things and stuff like that. [...] They were asking for a movie app for their phone, so they could, like, any movie in the world. And I helped them download ShowBox. [...] it was one of my friends" (P007, youth group)

The confidence levels observed among younger participants provided insight into their comfort level with technology and possibly their interest in its use. However, these confidence levels may not always represent their attitudes toward digital tools. While positive attitudes may indicate a certain level of comfort, they might not necessarily be indicative of their actual skills or underlying confidence in using technology.

Understanding motivations for technology adoption

Individuals discussed the adoption of smart technology in their everyday lives for various reasons, including communication, banking, shopping, gaming, and general browsing. However, the motivations for using smart technology were unique to each individual. For example, P002, a younger male within the deaf community group, used digital tools to facilitate connections and communication, indicating the importance of accessibility and inclusivity in technology adoption.

"If I go out, like, myself – I need to communicate with hearing people. I can sign, I can text... Text that down. And then they've got, like, speech to text on the phone. So, it's like... Yeah, I never really knew about that until last year" (P002, deaf community)

For other participants of all ages, smart phones were key for accessing financial support and information. They were motivated to adopt smart technology to access and review their personal financial needs.

"A lot of my ladies would use smartphones, especially for those who get universal credit. So they can check their accounts" (P005, women's group)

"[I regularly use] My banking app. Because it's the only way to know if I've got money in the bank or not [...] I check it every day, just in case someone puts something in" (P007, youth group)

This banking information was readily available to support individuals with their finances when needed. Furthermore, several of the women who had experienced domestic violence said that they 'did everything' on their smart phone but used other forms of smart technology as security measures such

as digital doorbells and home security cameras. In one instance, support was received online which was critical for this participant in realising that she was living in an abusive relationship. The participant exemplified how digital technology could serve as a powerful tool for addressing issues related to domestic abuse among women. It demonstrated the role of online platforms in raising awareness, providing support, and ultimately empowering survivors to take steps towards leaving abusive relationships.

“I think it was having access to digital technology that actually managed to get me out of the relationship. Because I went onto Mumsnet. Which is... It’s anonymous. [...] I didn’t even realise I was in an abusive relationship [...] And I kind of got support from people. And they put me in touch with other organisations” (P006, women’s group)

Whilst technology played a crucial role in an individual’s online security and support, there was a risk when using it too and they were aware of the abusive ways in which technology could be used or had been used against them.

“He was going, like, on my universal credit account. But all my recovery passwords were his email address. And they really worried me. [...] But still now I think, like, am I being...? Sort of, am I still being safe?” (P003, women’s group)

Across the group, there were similar motivations for technology adoption, particularly the impact of early vs late adoption on digital use and the functions for which individuals used digital technologies. However, their experiences determined how safe individuals felt when online and impacted both frequency and type of digital use.

Barriers to technology use

There were two prominent barriers which reduced and hindered individuals’ use of technology: problematic functionality and/or accessibility and cost.

Problematic functionality and/or accessibility

Many individuals primarily used smart technology to communicate with others, as discussed in the theme above. This was often through text, social media, and video calling. However, there was often a lack of functionality which impeded users, particularly those in the deaf community. For example, P001 (female, age 66) felt that she needed to make calls on a landline, as opposed to her mobile phone, due to better *“sound quality”*. Furthermore, various devices and apps aim to support hearing communication for hearing loss and impairment, such as speech-text apps. However, these apps are not free from their own issues, particularly issues around poor translation, or the need for data connectivity. This highlights the importance of infrastructure and the cost of accessing mobile data for deaf and hard-of-hearing users to use these applications

“Most of the time it’s good, you know, if I’m talking about live, live transcript, yeah. Live transcript. It’s good, but it’s not perfect. Speech will come up on the screen, sometimes you get different words. Something you haven’t said [...] There’s another problem that I have with that, I need to connect to Wi-Fi. Like, instead of data. Or Wi-Fi or data. So, there’s a limit on data. So, you can’t use it every time” (P002, deaf community)

These tools are particularly useful when the conversation is one-to-one, however, there is often too much environmental noise when conversing with larger groups that is further problematic. Hard-of-hearing participants reflected on the difficulties in using apps in certain conditions and their adaptive strategy to overcome these issues, indicating the need for developers/designers to prioritise accessibility features that cater to diverse user needs, including those related to auditory disabilities, to promote inclusivity and usability for all users.

"I just turn the volume up to maximum" (P001, deaf community)

"I have an app where I work, yeah... I'm the only one deaf where I work [...] They use that for speech, so we can communicate together. Sometimes it's not good – if there's, like, a big group and there's lots of people having a conversation. It's better if it's one-to-one. Like, there's too much noise if lots of people are talking" (P002, deaf community)

Cost

The cost of smart technology and broadband were prohibitive for individuals and for some participants within the youth group, this impacted their ability to go online, for example, when broken or pre-dating smart technology.

"I used to have an old mobile. There was no, like, obviously, Snapchat and stuff like that. And, obviously, it does the exact same thing - you just don't get social media and stuff like that" (P009, youth group)

"I've got a tablet, but it's broken at the moment" (P007, youth group)

Whilst some were able to choose which device to use for particular functions, others relied on one piece of technology only for all online matters. This was directly due to the cost of devices which restricted options.

"I think a lot of my clients wouldn't have the money for laptops. For those extra devices. They would be absolutely dependent on their phone" (P005, women's group)

The cost of smart technology not only has an impact on the individual themselves, but their wider family. Not being able to afford devices suitable for education, or multiple devices for themselves and their children, had a great impact, particularly during COVID restrictions as demand was higher.

"I've got a laptop at home, which I bought in the lockdown, or just before that, for... So that the kids could do work. Because I had nothing for them to use. And no help was given getting the... I've got three kids, and they were all meant to be on... You know, like Google classroom things, all at the same time [...] And then I started getting complaints from school" (P006, women's group)

Whilst some individuals received financial support to acquire technology, this was not available for all. Some felt this was inequitable.

"Some of our high-risk ladies have managed to get funding to get cameras and Alexa [...] so they can get the... You know, the front doorbell things, so they can see people. Especially, like, high-risk ladies. And cameras on the back that go to their phone, so if they heard stuff at the back they can see [...] it's such a postcode lottery [...] There's no system of who needs them" (P005, women's group)

It was not only the technology itself that was an issue. The cost of broadband and data was restrictive. This constant renegotiation was challenging.

"It's just annoying that every time a contract comes to an end, there... You have to negotiate... You have to have a... Not a fight. Not quite a fight, but an argument"
(P001, deaf community)

Charges for data also impacted accessible communication enabled by technology, inhibiting an individual's use of their smart technology but also inhibiting its use of supportive technology for communication.

"I ran out of data through the day yesterday. And it means that I can use that app after that point [...] So, then I changed to texting notes after that. So, yeah... Or, you know, asking someone to write it down [P002, deaf community]"

There were differences to digital barriers across groups, based on accessibility needs, particularly for those from the deaf community, and cost, which was particularly a barrier for younger participants and women who had experienced domestic violence.

Discussion

Original contribution to knowledge

The aim of this study was to explore and gain a more in-depth understanding of digital exclusion across one area within the North East of England. To our knowledge this study has obtained the largest sample in digital exclusion research to date and adds new internationally relevant insights to the existing evidence base. Taking a mixed methods study design, we were able to identify the scale and key characteristics of digitally excluded groups, understand key factors that contribute to digital exclusion, and map solutions to improve the digital inclusion of most digitally excluded groups. This original method, which included multiple methods for survey completion, increased the reach of participation and increased the inclusion of those most digitally excluded within the population (n=1,130).

The results of the logistic regression modelling indicate that multiple factors contribute to predicting digital exclusion, particularly increased age, lower income, lower (or no) education levels, living with a disability or living in a household with someone else with a disability, and residing in a smaller household. These findings support previous international evidence of digital exclusion predictors [52]. The findings show social exclusion and digital exclusion can exacerbate one another. Rogers (1995) and others suggested that, through digital transformation, usually *'new ideas make the rich richer and the poor poorer, widening the socio-economic gap between the earlier and later adopters'* [53, 54]. Evidence calls for a reduction in costs affiliated with digital technology and internet use, such as the cost of broadband, of which other evidence highlights the need for mandatory social tariffs across providers, free internet-enabled devices for those in need, and free access to digital skills training [2]. Furthermore, the Department for Digital, Culture, Media, and Sport (2022) have delivered plans for a UK Digital Strategy by highlighting the need to improve digital access and skills for all (73). They do not, however, highlight the critical links between social inclusion across the UK and digital inclusion. This current study demonstrates the complex link between digital and social exclusion and the importance of reducing the digital divide to support social equity, supporting international evidence in this area [4, 55, 56]. For example, social exclusion can be a major obstacle to digital inclusion by

creating barriers related to economic disadvantage, limited educational opportunities, cultural and linguistic challenges, psychosocial factors, and systemic inequalities [36, 65, 69].

Ageing is a key predictor of digital exclusion. Within this study, digital exclusion was noteworthy for those over 60 years old, with more than 94% of those identified as being digitally excluded reported being aged 60 or older. However, living with younger generations in the household (aged between 18-59) can significantly reduce the probability of being digitally excluded. These results indicate that the digital divide *between* the older population and the younger populations is vast. The older generation, who did not grow up with technology, may not have easily adopted these innovations as much as the younger generation. These findings are consistent with other studies which also illustrate the relationship between digital exclusion and getting older [18, 57, 58] through inequalities and disadvantages experienced throughout their life course [59]. Studies have also shown the link between COVID-19 and the exclusion from digital technologies and public services experienced by older adults [60, 61]. This contributed to increased social exclusion through directive orders. This has a strong indication for key stakeholders including policymakers and the public about how to support older residents in mitigating or minimising digital exclusion which can lead to social exclusion. Tackling digital exclusion is crucial to sustain digital societies and to increase societal equality throughout the lifecycle [4, 62].

Interestingly, whilst socio-demographic predictors were significantly related to digital exclusion, the socio-economic profile of areas was shown to contradict assumptions of digital exclusion across geographic populations. Through approximate geographical location of participants, this study measured the impact of spatial variations on digital exclusion. As both models confirm, when controlling for socio-demographic variables, geographical variations contribute to predicting digital exclusion. However, living in the higher socio-economic areas of the borough did not necessarily indicate higher levels of digital inclusion. For example, area four is associated with a higher deprivation status (lower IMD decile) compared to area one; however, this study shows that those living in area one (higher IMD decile) were more likely to lack digital access, digital skills, digital confidence, and digital use, and therefore were more likely to be digitally excluded, than those living in area four. These findings support recent evidence from Belgium, which highlights the need to avoid stereotypical targeting, and instead target all citizens [63].

Whilst academics, local authorities, and UK governmental policies have considered digital exclusion through large geographical parameters such as urban vs rural communities (71), and North East vs South East England (1,46), this study evidences the role of micro-geographic differences as a determining factor of digital exclusion in one borough [64, 65]. Regional policy initiatives could and should focus on these micro-geographical differences when spending money and introducing interventions to bridge the existing digital divide *within* the borough. It is critical to understand these differences so as not to waste financial investment on incorrect solutions for the wrong populations. These findings may also have resonance beyond the UK as research has also evidenced key determinants of digital exclusion within rural localities across the world, through issues of both supply and demand, but this research has also acknowledged 'digital disadvantages' which occur on a similar level in urban areas through inequality [66]. This current study shows that this is indeed the case and digital exclusion needs understanding not only on a 'rural vs urban' level but on a micro-geographical level.

The focus group findings are consistent with findings from phase one, identifying differences in digital use between different genders, generations, and social groups. There were also many differences within focus groups based on individual circumstances. For example, there were differences in digital use between early and late adopters throughout all focus groups. The 'early adopters' were primarily those within younger generations and had higher levels of digital skill, functioning as 'digital natives' and even 'experts' [67, 68].

Digital tools had benefits across all focus groups, including for use of accessible communication, daily services, and security. However, there were also downfalls, such as functionality of accessible applications, and security risks. Cost was another barrier to digital use. This demonstrates the importance of individual choice. Van Deursen and Helsper (2015) consider the tangible offline benefits of digital use, including economic, social, political, institutional, and educational benefits [6]. Whilst many cannot access digital technology, others choose not to do so as they do not consider digital tools to be beneficial for them [25, 69] or see the harmful impact that technology can bring, as the findings from the focus groups demonstrate. This enhances the importance of choice provided by organisations through equitable access to services that are now 'digital by default' [10, 22] [70]. The detrimental impact of many services only being available online is receiving increasing criticism and there is national support to support the need for non-digital access options to be offered alongside online [32, 71]. Evidence emphasises the need to consider digitally excluded individuals and those who are non-digital users by choice differently and to understand these groups of people separately, and see how the concepts of exclusion and choice relate, in order to support digital and social connectivity [72].

We acknowledge that people often engage in some practices related to using digital tools, which are not always verbalised. For instance, individuals may engage in digital multitasking (e.g. simultaneously checking emails, browsing social media, and listening to music) without explicitly discussing this attitude in their narratives. This practice has become common among younger generations in various contexts, from work to leisure, impacting attention spans and productivity [77, 78]. The co-design methodology allowed us to include and explore these non-verbalised aspects of digital use by involving stakeholders in activities such as survey design, focus group schedules, and interpreting results.

Implications for policy, practice, and research

This study illustrates the role of socio-demographic and micro-geographical factors in predicting digital exclusion and the bi-directional link between social exclusion and digital exclusion. Digital exclusion is therefore a complex issue that requires complex solutions, and it is necessary to consider this complexity within digital-related policy and practice initiatives. To support this, it is recommended that digitally excluded and socially excluded groups support these decisions and policy-making processes.

This study identified the diversity and complexity of the digital exclusion issues. It is essential that agencies operate within an integrated governance framework across multiple institutions, across multiple sectors, and at all levels, to deal with such a complex issue.

Having the choice to access information and services in accessible ways is imperative to not further exclude communities who cannot, or choose not to, access and use digital technology. It is necessary for organisations across sectors to review their own policies and practices (such as ensuring that information and services are not available online only). This has the potential to reduce the risk and scale of digital exclusion across services. This study is a comprehensive examination of digital exclusion at the borough level. Utilising a diverse set of data collection methods increased inclusivity and accessibility of participation so that even those who are digitally excluded could participate. This in turn increased the reliability and validity of the results. It is recommended that studies in this arena consider the methods used to collect data around digital exclusion, ensuring that the most marginalised communities, and therefore those who may be at most risk of digital exclusion, could participate and have their voices heard. However, a limitation of this study is that the sample was solely recruited from the North East of England, which may raise concerns about the generalisability

of the findings to other regions or countries with potentially different sociodemographic and psychocultural configurations.

Clustering survey respondents based on four indicators of digital exclusion is a practical way to identify and discuss disparities across digital access, skills, usage, and confidence among different population groups. This method helps to identify the most digitally excluded individuals and informs policies and interventions to bridge the digital divide. By understanding the specific challenges faced by these groups, targeted strategies can be developed to improve digital inclusion.

Finally, this study excluded those aged below 18 years. Levels and experiences of digital exclusion for those under 18 years old are not well understood, particularly from the perspective of children and young people themselves. Further research efforts should focus on this area.

Conclusion

This study aimed to explore and gain a more in-depth understanding of digital exclusion within a major metropolitan borough in the North East of England.

This is the largest study to date which has collected and analysed primary data focussed on digital exclusion at a borough level. Therefore, while this study was carried out in one area of the UK, it has raised and identified issues of importance which undoubtedly have relevance for many national and international contexts. The findings of this study support the importance of data-driven insights into practice and decision-making processes, identification of common challenges, comparative analysis, evidence-based policymaking, and the facilitation of global initiatives aimed at achieving digital equity and inclusion. By leveraging empirical research, stakeholders can collaborate effectively to address digital disparities and promote universal access to digital resources and opportunities.

Descriptive statistics and logistic regression models were estimated to identify and understand the determinants of digital exclusion using recent data from a survey of 9,181 respondents. Findings support international literature which illustrate statistically significant associations between sociodemographic variables and digital exclusion, particularly: increasing age, lower income, lower (or no) education levels, living with a disability, or living in a household with someone else living with a disability, and living in a smaller household. Along with other evidence in this area, this study affirms the deep and wide socio-economic divide within society and continuation of barriers to digital inclusion.

Micro-geographical analyses were critical to understanding digital exclusion across the borough. This is an area of analysis which has not yet been considered in this arena yet demonstrated the geographical nuances within experiences of digital exclusion which counter the explanatory socioeconomic variables. Namely, the most affluent area of the borough was considered as most digitally excluded (as a whole) compared to less affluent areas of the borough which were less digitally excluded. Micro-geographical data can support statutory organisations and decision-makers to target the right interventions to the right areas without making assumptions of digital access and digital use using deprivation data only.

The reciprocal relationship between digital and social exclusion was evident in this study. We propose that digital inclusion therefore needs to be considered as a core social policy issue, linked to social exclusion. Within focus group findings, the notion of choice was critical. With public services going 'digital by default', individual autonomy is lessened, and this raises further concerns of social exclusion.

It is evident through the findings of this novel study that digital use, digital exclusion, and digital choice are complex and therefore complex solutions are necessary.

Word count (excluding abstract)

8810

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Table 1: Demographic profile of the total sample and digitally excluded respondents.

Demographic variables	Characteristics	Total sample frequency (%), n=9,181	Digitally excluded (%), n=1,130
Gender	Female	5,537 (60.3)	698 (61.8)
	Male	3,575 (38.9)	420 (37.2)
	Other	9 (0.1)	0 (0.0)
Age groups	<20	7 (0.1)	0 (0.0)
	20-39	794 (9.0)	3 (0.3)
	40-59	2,275 (25.8)	59 (5.2)
	60-79	4,727 (53.7)	592 (52.3)
	80>	1,007 (11.7)	392 (34.7)
Ethnic groups	White	8,904 (97.4)	1,100 (97.3)
	Mixed/multiple ethnic groups	130 (1.4)	11 (1.0)
	Asian/British Asian	73 (0.8)	8 (0.7)
	Black/African/Caribbean/Black British	11 (0.1)	0 (0.0)
	Other Ethnic groups	22 (0.2)	2 (0.2)
Marital status	Single	1,136 (12.5)	144 (12.7)
	Married, civil partnership, co-habiting	5,611 (61.1)	398 (35.2)
	Separated (but still legally married)	172 (1.9)	20 (1.8)
	Divorced	975 (10.6)	160 (14.2)
	Widowed	1,213 (13.2)	395 (35.0)
Educational qualifications	No qualifications	991 (10.8)	408 (36.1)
	GCSEs/O Levels or equivalent	1,848 (20.1)	299 (26.5)
	A levels or equivalent	1,774 (19.3)	136 (12.0)
	First degree (e.g. BA, BSc)	1,416 (15.4)	30 (2.6)
	Postgraduate or professional qualification (e.g. qualified teacher)	2,761 (30.1)	146 (13.0)
Employment status	Employed Full-Time	2,221 (24.2)	42 (3.7)
	Employed Part-Time	1,083 (11.8)	39 (3.5)
	Unemployed	147 (1.6)	20 (1.8)
	Student	43 (0.5)	0 (0.0)
	Self-employed	308 (3.4)	20 (1.8)
	Retired	5,071 (55.2)	949 (84.0)
	Unpaid/Voluntary work	77 (0.8)	8 (0.7)
	Unable to work	158 (1.7)	38 (3.4)
Individual disability	Yes	3,233 (35.2)	622 (55.0)
	No	5,718 (62.3)	451 (40.0)
Household disability	Yes	3,793 (41.3)	645 (57.1)
	No	5,073 (55.3)	399 (35.3)
Household size	1 member	2,880 (31.4)	652 (59.3)
	2 members	4,348 (47.4)	399 (36.3)
	3 members	999 (10.9)	40 (3.6)
	4 or more members	842 (9.2)	9 (0.8)
Tenure	Owner	8,032 (87.5)	865 (76.5)
	Renter	979 (10.7)	212 (18.8)
	Other	122 (1.3)	53 (4.7)
Household income	Less than £20K	2,232 (24.3)	526 (46.5)
	£20K- £40K	2,754 (30.0)	228 (20.2)
	£40K - £60K	1,326 (14.4)	30 (2.7)
	£60K - £80K	744 (8.1)	9 (0.8)
	More than £80K	649 (7.1)	4 (0.4)

Note: Frequencies and percentages may not add up to the total due to missing values and rounding.

Table 2: Logistic regression models developed to understand the key determinants of being digitally excluded in the borough.

	Model 1 tested socio-demographic variables as predictors for digital exclusion				Model 2 added digital attitude variables to the regression equation			
	<i>B</i>	<i>S.E.</i>	<i>p-value</i>	<i>Exp(B)</i>	<i>B</i>	<i>S.E.</i>	<i>p-value</i>	<i>Exp(B)</i>
<i>Socio-demographic variables</i>								
Gender ¹	0.261	0.112	0.020*	1.298	0.148	0.139	0.284	1.160
Age (in years)	-0.087	0.008	0.001**	0.917	-0.042	0.009	0.001**	0.959
Educational level ²			0.001**				0.001**	
No qualifications	-1.433	0.160	0.001**	0.239	-0.846	0.199	0.001**	0.429
GCSEs or equivalent	-0.767	0.160	0.001**	0.464	-0.477	0.195	0.014*	0.621
Vocational education	-0.542	0.179	0.002**	0.582	-0.261	0.217	0.230	0.770
Other qualifications	-0.541	0.219	0.013*	0.582	-0.153	0.267	0.566	0.858
A levels or equivalent	0.072	0.278	0.796	1.075	-0.191	0.329	0.562	0.826
Household income level ³			0.001**				0.056	
Less than £20K	-2.419	1.025	0.018*	0.089	-1.738	1.046	0.176	0.023
£20K - £40K	-1.975	1.019	0.050*	0.139	-1.395	1.035	0.248	0.033
£40K - £60K	-1.320	1.033	0.201	0.267	-1.085	1.051	0.338	0.043
£60K - £80K	-1.263	1.087	0.245	0.283	-1.107	1.111	0.331	0.037
Employment status ⁴			0.324				0.768	
Employed Full-Time	0.757	0.405	0.061	2.133	0.195	0.507	1.216	0.450
Employed Part-Time	0.906	0.408	0.026*	2.474	0.410	0.514	1.506	0.550
Unemployed	0.583	0.555	0.294	1.792	0.695	0.687	2.003	0.521
Self-employed	0.447	0.494	0.365	1.564	0.247	0.612	1.281	0.386
Retired	0.864	0.370	0.020*	2.372	0.276	0.476	1.318	0.518
Unpaid/Voluntary work	1.089	0.662	0.100	2.972	1.160	0.767	3.188	0.709
Tenure groups ⁵			0.012*				0.109	
Renter	-0.470	0.159	0.003**	0.625	-0.423	0.201	0.655	0.442
Other	-0.001	0.379	0.998	0.999	-0.074	0.475	0.929	0.366
Household size (in numbers)	0.362	0.102	0.001**	1.436	0.408	0.120	1.504	1.188
Aged between 18-59 (yes) ⁶	-0.476	0.189	0.012*	0.621	-0.449	0.231	0.638	0.406
Household disability (yes) ⁷	-0.465	0.112	0.001**	0.628	-0.356	0.138	0.700	0.534
Local primary care areas ⁸			0.019*				0.071	
Area 1	-0.442	0.158	0.005**	0.643	-0.385	0.192	0.045*	0.680
Area 2	-0.209	0.161	0.193	0.811	-0.075	0.195	0.701	0.928
Area 3	-0.423	0.171	0.014*	0.655	-0.392	0.210	0.062	0.676
<i>Digital attitude variables</i>								
Privacy/security concerns ⁹					0.445	0.159	0.005**	1.561
Attending digital classes ¹⁰					0.058	0.341	0.864	1.060
Willing to use digital tools ¹¹					3.325	0.147	0.001**	27.801
Believing COVID impact ¹²					0.777	0.141	0.001**	2.175
Constant	10.180	1.196	0.001	26369.59	4.010	1.321	0.002	55.145
N	6863				6315			
R ² Cox–Snell	0.128				0.235			
R ² Nagelkerke	0.308				0.568			
Hosmer and Lemeshow statistic	4.043		0.853		7.146		0.521	
Classification (%)	92.7				94.4			

Notes: The reference categories selected in the model were: ¹ female, ² university degrees or equivalent, ³ more than £80K, ⁴ unable to work, ⁵ homeowners (with or without a mortgage), ⁶ no household member aged between 18-59, ⁷ households who do not have a disability (or health conditions), ⁸ those who reside in postcode area 4, ⁹ those who do not have privacy/security concerns when online, ¹⁰ those who have not attended any digital classes in last 5 years, ¹¹ those who do not willing to use digital tools in daily life, ¹² those who do not believe COVID pandemic pushed them to use digital tools more often. ⁴ The category of 'students' was excluded from the analysis due to the small amount of data. * Significant at the 5% level, **Significant at the 1% level.

Table 3: Characteristics of the focus groups

Focus group	Characteristics	Number of participants (M/F)	Mean age (range)
Deaf community	Individual disability	3 (2/1)	47 (25-66)
Women's group	Mothers experienced domestic violence	4 (0/4)	43 (30-54)
Youth group	Young, unemployed men	3 (3/0)	20 (20-21)
Total	NA	10 (5/5)	36.7 (20-66)

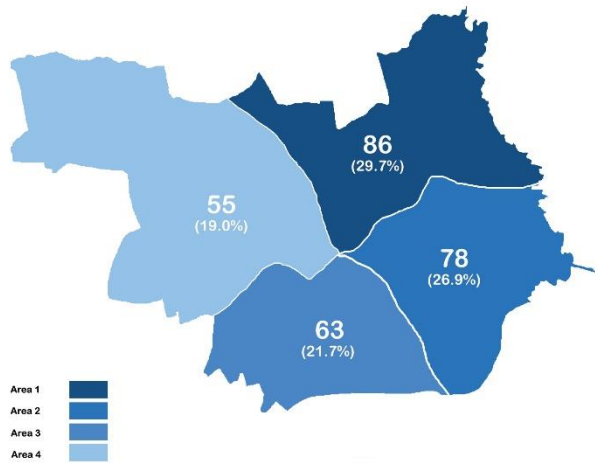


Fig. 1: Frequency distribution of respondents who self-reported 'no digital access'

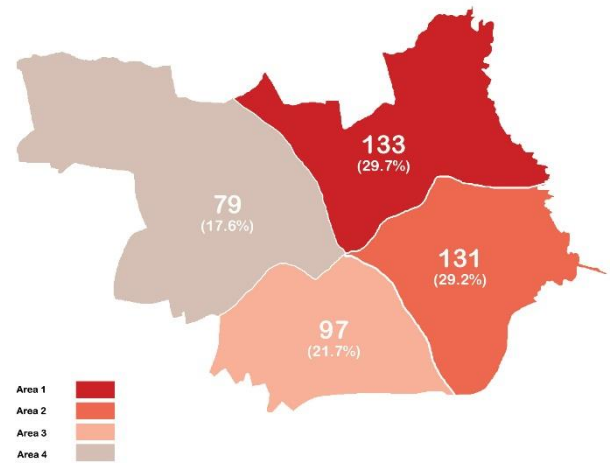


Fig. 2: Frequency distribution of respondents who self-reported 'no digital use'

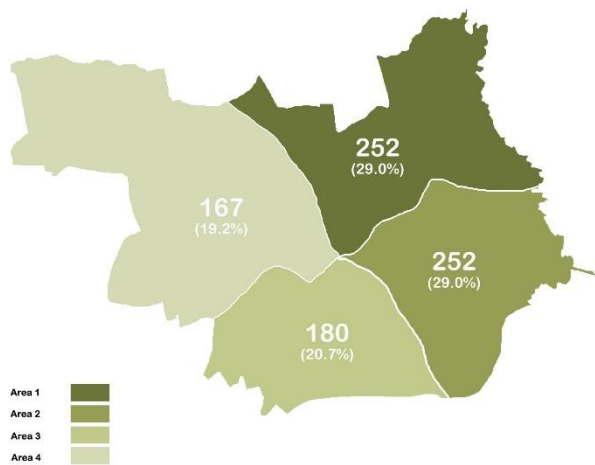


Fig. 3: Frequency distribution of respondents who self-reported 'no confidence in using digital tools'

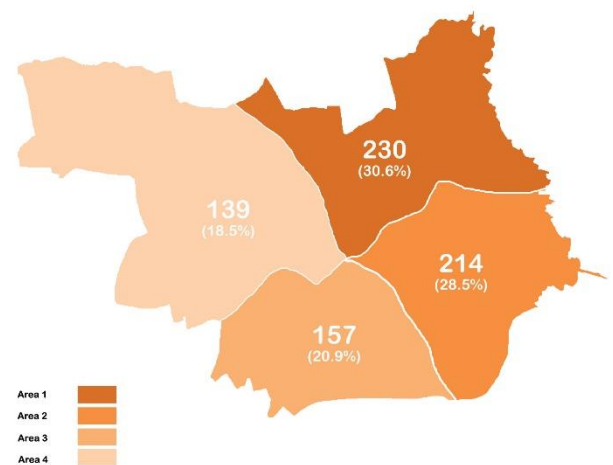


Fig. 4: Frequency distribution of respondents who self-reported 'very poor digital skills'