COVID

Article

Understanding Technology Use During the COVID-19 Pandemic Through the Lens of Age-Friendly Cities and Communities: An International, Multi-Centre Study

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Abstract: Research on age-friendly cities and communities (AFCC) has primarily taken a qualitative approach. This article extends insights from a quantitative perspective to understand the international perspectives of community living and well-being during the COVID-19 pandemic. Employing an intersectional approach, this online survey aimed to understand human behaviour within AFCC. This article contextualises the digital practices and the impact of technology experienced through the age-friendly city lens of adults aged 18–50+ years living in different types of communities. Using an original dataset collected from 2020 to 2021 across 11 sites and in 13 languages, the study gathered responses from a sample size of 3422 participants. Findings indicate that adults aged 50+ years reported significantly lower loneliness scores, and higher well-being scores compared to adults aged below 40. Factors including gender, education level, and marital and employment status were found to impact loneliness and well-being significantly. From a community perspective, individuals living in rural areas and small towns reported significantly lower loneliness scores and higher well-being scores than those living in metros and cities. These findings contribute to the ongoing discourse in AFCC and have the potential to aid policy responses intended to reduce loneliness and improve well-being through public health and pandemic preparedness planning.

Keywords: age-friendly cities and communities; AFCC; technology; digital practices; user experience; frameworks; pandemic; COVID-19; coronavirus

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1. Introduction

According to the United Nations (UN) [1], the global ageing population is increasing rapidly, with projections estimating it may reach 8.5 billion in 2030, 9.7 billion by 2050, and 10.4 billion by 2100. In 2022, there were 771 million people aged 65 years or older, and it is suggested by the UN that by 2030 that there will be 994 million adults aged 65+ years, and 1.6 billion by 2050. Life expectancy across Europe and North America is also expected to increase from 77.2 years in 2021 to 83.8 years (for both men and women) [1]. The population of adults aged 65+ years is also set to rise across these regions, from 18.7% in 2022, to 22% in 2030, and 26.9% by 2050 [1]. With this in mind, scholars, policy makers and organisations, both nationally and internationally, are attempting to improve the lives of contemporary ageing populations by employing various approaches in an attempt to

ensure that health and social care [2] strategies are appropriately delivered, together with greater understanding of the impact relating to the physical and built environments [3], ensuring that they are suitable for people who are ageing and/or with disabilities [4,5].

During the COVID-19 pandemic and its aftermath, there has been greater attention paid by organisations, policy makers, and scholars attempting to alleviate loneliness [6–9], improve well-being and enhance social connections [10,11]. Importantly, these factors align with the domains of the age-friendly model published by the World Health Organization (WHO) in 2007 [12]. Moreover, a recent push is underway by the WHO European Regional office to connect the dots regarding digital eHealth across the European Union [13] and Africa [14]. However, in the context of AFCC technology and digital practices, these have not been acknowledged in sufficient depth and detail by the WHO AFCC in their age-friendly city model [2007], as highlighted by Marston and van Hoof [15]. The COVID-19 pandemic brought technology and digital practices to the forefront of societal behaviour and living, playing an integral role within people's lives, whether young or old, employed (e.g., working from home) or retired, facilitating social connections via social media platforms such as Facebook [11].

The aims and objectives of this paper are to present the findings and outcomes of the analyses from the sub-set of data pertaining to the discourse of AFCC in the context of technology use and digital practices associated with digital device usage of online survey responders, aged 18–50+ years. Furthermore, the notion of intergenerational perspectives was always part of the WHO Global Age-friendly Cities Guide (p. 6, ensuring AFCC applied a life course approach (pp. 72–74)). However, to date, limited scholarly research has adopted an intergenerational approach, and this work aims to address this knowledge gap. This work extends and influences the contemporary discourse situated within the AFCC domain by providing a novel insight into this arena within the context of the COVID-19 pandemic, utilising a dataset collected across Europe, Asia, and North America. We anticipate that the findings presented here will feed into local, national, and global age-friendly initiatives and strategies, contributing to disciplines including the social sciences, public health, social care and the built environment. This notion relates to the sharing of findings to local authorities and municipalities to ensure that respective policies at a local level can reflect health and well-being policies. Furthermore, these findings contribute to the global discourse surrounding the WHO age-friendly network and approaches by scholars [15,16]. Finally, this work aligns with the UN Sustainable Development Goals (SDGs), specifically Goal 3 (good health and well-being) and Goal 9 (industry, innovation, and infrastructure) [17] and the UN Decade of Healthy Ageing [18].

Over the last 30 years, there has been a growing body of discourse and literature in the area of AFCC [19–28]. This growing interest is based on the WHO, which published the Global Age-friendly Cities Guide [29] and the accompanying Checklist of Essential Features of Age-Friendly Cities in 2007 [12]. In 2021, a collection of 30 papers including an editorial were published as part of a Special Issue focusing on the current state of the art and future perspectives of AFCC [22,23]. This compendium of research is a key resource for academics and policy makers, navigating and working in the AFCC arena and interested in the broader topics of thermal heating, co-production, well-being, transport, and spatial indicators. This Special Issue features research from an international perspective, encompassing countries such as the UK, USA, Australia, New Zealand, Russia, Canada, Romania, the Netherlands, and Italy, and aligns with one or more of eight domains: 1. Social participation, 2. Communication and information, 3. Civic participation and employment, 4. Housing, 5. Transportation, 6. Community support and health services, 7. Outdoor spaces and buildings, 8. Respect and social inclusion of the WHO age-friendly cities model [12].

Since the COVID-19 pandemic, there has been a growing body of theoretical research aiming to enhance the AFCC discourse to reflect contemporary technological challenges, issues, and enablers. This body of work initially started with the notion of the 'Smart Age-friendly Ecosystem' (SAfE) framework (Figure 1), employing a case study approach to explore and understand how contemporary technologies, including the Internet of Things (IoT), together with digital practices within the built environment experienced by residents across the life course [15,30–32]. Quickly following the SaFE framework, the 'Concept of Age-friendly Smart Ecologies' (CASE) framework (Figure 2) was posted to explore how AFCC in a post-pandemic society [30]. However, there is still a paucity in knowledge gap within the AFCC literature pertaining to the understanding of technology [14,30], and this paper aims to contribute new knowledge and fill this gap in the literature.

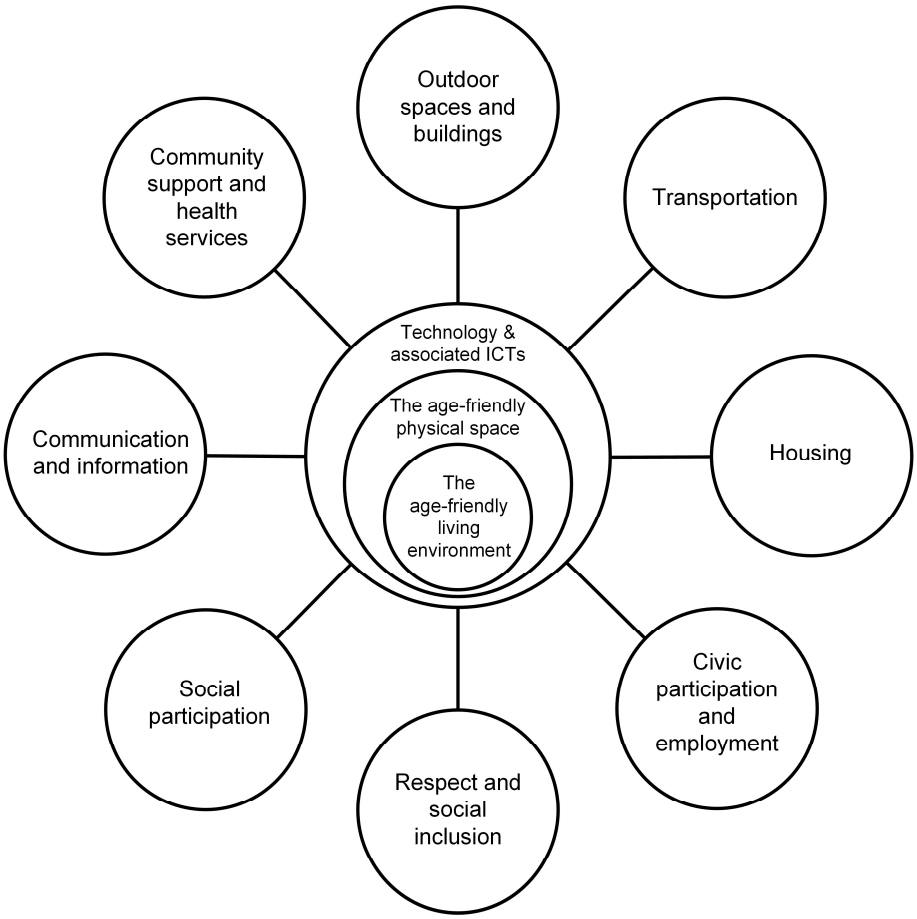

Figure 1. 'Smart Age-friendly Ecosystem' (SAfE) framework [15].

Earlier frameworks pertaining to technology and age-friendly discourse have been discussed previously [16], and, more recently, Marston and colleagues [32] explored and highlighted the most recent framework—the Dementia-Friendly Cities model [33] published by the WHO in 2021. Indeed, this model acknowledges the important role that technology and digital practices play in the context of dementia research and in the broader context of social care delivery within the community [34–36]. For example, the ATTILA (Assistive technology and telecare to maintain independent living at home with dementia) project aimed to investigate the benefits, challenges, issues, and cost analysis benefits of utilizing technologies such as telecare and assistive technologies (AT) to maintain independent living of people with dementia [37,38].

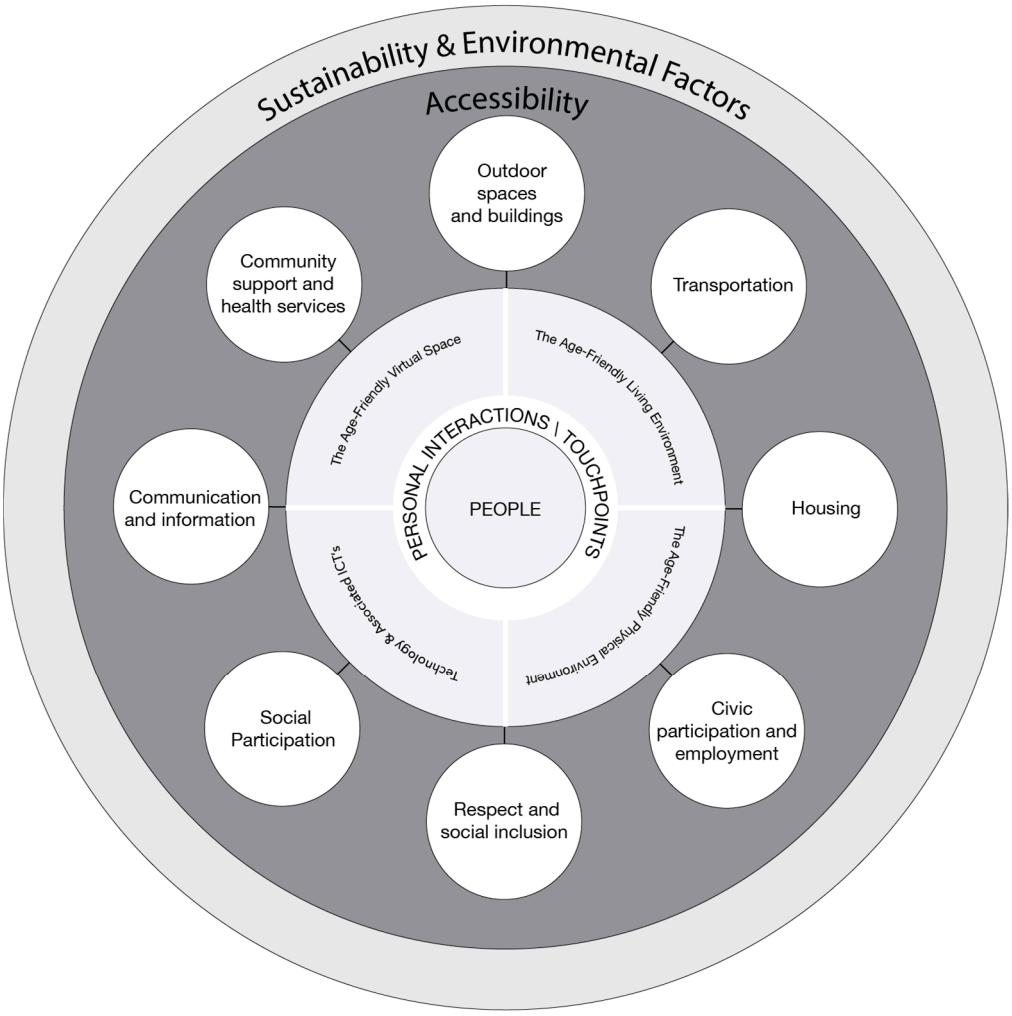

Figure 2. 'Concept of Age-friendly Smart Ecologies' (CASE) framework [30].

In this study, we employed an intersectional approach including age, marital status, gender, education, employment, and we will present findings focusing on the type of communities that people live in, together with the type of technological use. This international dataset is original and contributes to the international discourse pertaining to several research areas aligned to and intersecting with AFCC, including loneliness and social connections. Moreover, this work contributes to the associated literature in the disciplines of social sciences, gerontology, gerontechnology, social policy and public health. The objective of this paper is to present findings relating to technology use during the COVID-19 pandemic through the lens of AFCC.

2. Materials and Methods

The objective of this study is to provide insights and findings from a sub-set of data relating to the role of technology and digital practices in the context of the 'type of community/residence' reported by respondents completing an online survey during the COVID-19 pandemic. These data are part of a larger dataset and project with a study protocol published by Marston and consortium partners in 2020 [39].

2.1. Ethical Approval

Ethical approval of the COVID-19: Technology, Social Connections, Loneliness, and Leisure Activities project was initially approved by the Human and Research Ethics Committee (HREC) at The Open University [HREC/3551/Marston] [39]. Each consortium

partner joining the project communicated with the project lead, regarding their respective institutional ethics approval for the deployment of the site survey. The initial survey created in English was deployed on 4 April 2020. Following the publication of the study protocol, an additional two countries (the United States and Canada) joined the consortium with respective surveys deployed in 2021—known and referred to as Wave 2.

2.2. Participant Recruitment

Participant recruitment (Table 1) employed a snowball purposive sampling approach [40] with a generic weblink deployed across the project website [41] across social media platforms such as X (formerly known as Twitter) and Facebook. Each partner site utilised its own network within the respective time period of three months [39]. Prospective participants aged 18+ years living in the respective countries, and who had access to the link to complete the online survey in the language of that country, were welcome to complete the online survey [39].

Table 1. Breakdown of survey deployment and response rates per site (Wave 1 and Wave 2).

Site (Country) and Language	Date Survey Opened	Date Survey Closed	Sample (n = 3244), (%)
Austria, German	5 June 2020	5 September 2020	240 (7.4)
Canada, English	1 June 2021	31 September 2021	209 (6.4)
France, French	12 May 2020	12 August 2020	135 (4.2)
Germany, German	4 June 2020	4 September 2020	329 (10.1)
India, English, Hindi	31 May 2020	31 August 2020	320 (9.9), 49 (1.5)
Malta, English	19 May 2020	19 August 2020	103 (3.2)
Portugal, Portuguese	29 May 2020	29 August 2020	37 (1.1)
Romania, Romanian	20 April 2020	20 July 2020	447 (13.8)
Singapore, English, Mandarin	17 May 2020, 13 May 2020	17 August 2020, 13 August 2020	82 (2.5), 17 (0.5)
Spain/South America, Catalan, Spanish	4 May 2020	4 August 2020	163 (5.0), 219 (6.8%)
Turkey, Turkish	29 June 2020	29 September 2020	108 (3.3)
UK, English	3 April 2020	4 July 2020	548 (16.9)
USA, English	29 March 2021	18 June 2021	238 (7.3)

2.3. Measures

A total of eight sections forms the survey as noted in the study protocol [39] to capture various insights relating to technology use, the purpose of using technology, user experiences and behaviours. This is based on previous iterations of surveys [42–47] (Section A) and required respondents to select an answer (from a pre-determined list) per question or provide additional text (Sections A–D and Section G) if they wished—more information can be found in the study protocol [39]. To capture how technology was being used during the COVID-19 pandemic, Section B focuses on questions of user experience, and Section C focuses on the type of daily activities conducted during lockdowns, community support, social connections, time spent and key worker responsibilities [39].

A series of psychological well-being [48,49] items were included, covering six factors (1. autonomy, 2. environmental mastery, 3. personal growth, 4. positive relations with others, 5. purpose in life, and 6. self-acceptance of psychological well-being). Further questions included exploring and understanding digital literacy [50], which uses a 1–5-point Likert scale (strongly agree to strongly disagree) and includes eight items (Section E). The UCLA v3 Loneliness scale [51–53] uses a 1–4-point Likert scale (1 = never, 2 = rarely; 3 = sometimes; 4 = always) and includes 20-items (Section F). Section G asks respondents about their national emergency alert systems, and Section H focuses on demographic items such as gender, age, ethnicity, education, employment status, marital status, type of community, the number of people living in the dwelling, the number of children living in the dwelling, disability, self-isolation because of COVID-19, and whether the respondent was vulnerable because of health condition [54–58].

2.4. Procedure

The creation of the online survey was conducted using Qualtrics software. For each site/language version a new survey was created enabling an anonymous link to be deployed across various social media platforms including X (formerly known as Twitter), Facebook, and individual mailing lists. Each site lead would communicate directly with the Principal Investigator (PI—lead author) regarding backwards translation of the survey before submitting ethical approval at the respective institution. The study protocol [39] provides more in-depth information regarding the process undertaken between the PI and site leads. Additionally, upon ethical approval being granted by the respective institution, the anonymous link for the respective survey would be deployed by the site lead, shared online via X (formerly known as Twitter) and/or Facebook by the PI and other site leads to reach as many people as possible. Each anonymous link would be open for a period of three months (Table 1).

2.5. Statistical Analysis

A total of 3244 participants started the survey, with 1928 (60%) completing it. The remaining 1316 participants (40%) partially completed the survey and were excluded from the analysis. However, prior to data analysis, respondents who did not complete the UCLA-20 Loneliness Scale, the Psychological Wellbeing Scale, or the technology and digital devices questionnaires were excluded following the completion of data collection. Bivariate analyses were conducted to evaluate how various sociodemographic predictors (income status, age, gender, education, marital status, employment, and community of residence) impacted outcomes measured on continuous scales (UCLA 20 Loneliness Score, and Psychological Wellbeing Score). A two-sided one-way Analysis of Variance (ANOVA) and independent sample *t*-tests were conducted based on the number of levels for the predictor. Tukey's post hoc tests were performed to identify differences between groups in the case of significant omnibus ANOVA tests. For analysis of categorical variables, crosstab analyses followed by a Pearson χ^2 test and a likelihood ratio χ^2 test were performed. An alpha level of $p < 0.05$ indicates statistical significance.

2.6. Lockdown Directives

Globally, national and regional governments, local authorities and municipalities enforced a myriad of lockdown directives [58–76] in an attempt to reduce transmission and mortality rates, and pressures on respective health services. In some instances, directives were rolled out in February 2020 and continued into the spring of 2021 [58–76]. Various measures and directives were implemented, including the closure of all nonessential retail outlets, such as clothing stores, equipment shops, florists, and hardware stores. Essential shops allowed to remain open included pharmacies and food retailers, such as grocery stores, bakeries, and butchers. Additionally, many countries introduced work-from-home (WFH) mandates, extending to all levels of education, including primary and high schools, colleges, and universities [58–76]. In some countries/sites, residents who broke the lockdown directives would be fined [65,67–73,75], while in other sites their directives included the enforcement of roadblocks [65,74] and border controls [58–76].

3. Results

3.1. Descriptive Statistics

The respondent characteristics in Table 2 below show that the fewest respondents were from the 60+ age group, and most were from the 18–29 age group. Overall, 70% of respondents were female, and only <2% reported being non-binary or preferred not to answer across both groups. Approximately ~90% of respondents had a university degree

or higher level of education (bachelor's, master's, or Ph.D.), and 50>% of participants were married/had a partner. Finally, over 70>% of participants were employed, and ~50% reported residing in a metropolitan/city.

Table 2. Respondent characteristics.

Demographics	Number of Respondents N = 1928 (%)
Age group (in years)	
18–29	596 (30.9)
30–39	465 (24.1)
40–49	425 (22.0)
50–59	232 (12.0)
60 and older	210 (10.9)
Gender	
Male	524 (27.2)
Female	1371 (71.1)
Non-binary	13 (0.7)
Choose not to answer	20 (1.0)
Education level	
Primary or less than high school	46 (2.4)
High school	149 (7.7)
College diploma/some college or university	310 (16.1)
Bachelor's degree/professional degree	527 (27.3)
Masters	593 (30.8)
Ph.D.	303 (15.7)
Marital status	
Having a partner/married	981 (50.9)
Divorced/separated	118 (6.1)
Widowed	46 (2.4)
Single	725 (37.6)
Prefer not to say	58 (3.0)
Employment status	
Employed	1383 (71.7)
Retired	124 (6.4)
Not employed (out of a job)	421 (21.8)
Type of community (Residence)	
Metropolitan/City	910 (47.2)
Suburban	398 (20.6)
Small town	343 (17.8)
Rural area	277 (14.4)

3.2. Primary Findings

Data analysis focused on several sociodemographic variables (e.g., education level, employment, type of community, marital status, gender, and age), including loneliness, well-being, and e-Health literacy (e-Heals scores). We observed several significant observations, which are described below in the following sections. For the statistical analysis, we combined the 50–59 age group with the 60+ age group to create a 50+ category. From Table 2 above, it can be noticed that 30.9% of respondents fall into the 18–29 age group, 24.1% into the 30–39 group, and 22.0% into the 40–49 group. However, only 12.0% of respondents were in the 50–59 group, and 10.9% were in the 60+ group. By merging the 50–59 and 60+ groups into a single 50+ category, we created a more balanced and homogenous group, with each category representing approximately 20% of the total respondent population.

Additionally, we collected data from multiple countries, and in many of these countries, individuals aged 50 and above are often considered older adults. For instance, the UN defines an older person as someone over 60 years, although this threshold can vary by country and context [77].

3.3. Well-Being

Data analysis (Table 3) shows that older adults (50+ years) reported the highest well-being scores (98.5 ± 11.6) and varied significantly (p-value = 0.01) from younger adults (18–29 years) and middle-aged adults (30–39 years). Finally, when comparing older adults (50+ years) to those aged between 40 and 49, we observed that older adults reported higher well-being scores. However, these differences were not statistically significant (p-value—0.06). The education levels had a significant impact on well-being (p-value = 0.02), whereby respondents self-reporting holding a graduate degree (master's, Ph.D.) reported having the highest well-being scores compared to respondents self-reporting holding a high school certificate, a college diploma/some college, or a university degree. Furthermore, we observed that gender showed a significant impact on respondents' well-being (p-value < 0.01), whereby female respondents (97.5 ± 11.2) reported higher scores than the male respondents (94.6 ± 13.2). Marital status and employment status had a significant impact on well-being scores (p-value < 0.01) whereby respondents who reported being married or having a partner (95.1 ± 11.2) and those respondents who reported being employed (94.6 ± 12.3) reported having a higher well-being score compared to their counterparts. Finally, the type of community (rural, urban, metropolitan/town) was also shown to have a significant impact (p-value < 0.01) on the well-being score of respondents. Specifically, respondents who reported living in a small town (95.1 ± 10.7) and/or rural area (93.1 ± 13.3) reported having a higher well-being score compared to respondents living in metropolitan or urban communities.

Table 3. Respondent characteristics and well-being scores.

Demographics	Average Well-being Scores (Std Dev)
Age group (in years)	
18–29	91.2 (13.9)
30–39	92.7 (13.9)
40–49	95.8 (14.5)
50+ years	98.5 (11.6) *
Gender	
Male	94.6 (12.3)
Female	97.5 (11.2) *
Non-binary	91.2 (18.9)
Choose not to answer	86.5 (14.2)
Education level	
Primary or less than high school	88.8 (15.2)
High school	92.1 (13.5)
College diploma/some college or university	89.4 (15.2)
Bachelor's degree/professional degree	93.2 (13.4)
Masters	96.8 (13.5) *
Ph.D.	96.3 (14.0) *
Marital status	
Having a partner/married	95.1 (11.2)
Divorced/separated	94.6 (14.6)
Widowed	94.8 (16.1)
Single	90.3 (14.1) *
Prefer not to say	93.0 (13.7)
Employment status	
Employed	94.6 (14.0)
Retired	98.4 (13.2)
Not employed (out of a job)	90.5 (14.1) *
Type of community (Residence)	
Metropolitan/City	92.3 (13.7)
Suburban	92.1 (14.0)
Small town	95.1 (10.7) *
Rural area	93.1 (13.3) *

* Significantly different from the rest of the categories.

3.4. Loneliness

Additional analysis was conducted to understand the relationship of loneliness (Table 4). The findings ascertained that the age of the respondents was associated with loneliness, whereby the loneliness scores (p-value < 0.01) relating to older adults (50+ years) were reported (44.7 ± 5.1); this demographic was shown to have the lowest levels of loneliness and varied significantly from younger adults (18–29 years, 48.2 ± 5.3) who showed higher levels of loneliness. The education levels of the respondents was also shown to have a significant impact on loneliness (p-value = 0.03), whereby the respondents who self-reported having a graduate degree (master's, Ph.D.) also reported having the lowest loneliness scores; this, too, varied for the respondents who self-reported having a high school certificate or a primary school certificate.

Table 4. Respondent characteristics and loneliness scores.

Demographics	Number of Respondents N = 1928 (%)
Age group (in years)	
18–29	48.2 (5.3)
30–39	46.6 (5.1)
40–49	46.0 (5.4)
50+ years	44.7 (5.3) *
Gender	
Male	47.6 (4.6)
Female	45.7 (5.1) *
Non-binary	47.5 (5.9)
Choose not to answer	48.8 (6.7)
Education level	
Primary or less than high school	47.5 (4.5)
High school	46.8 (5.5)
College diploma/some college or university	47.4 (5.6)
Bachelor's degree/professional degree	46.6 (5.1)
Masters	46.0 (5.2) *
Ph.D.	46.2 (5.1) *
Marital status	
Having a partner/married	45.4 (5.1) *
Divorced/separated	47.3 (5.4)
Widowed	45.5 (5.2)
Single	47.9 (5.2)
Prefer not to say	46.7 (5.3)
Employment status	
Employed	45.8 (3.7)
Retired	44.9 (5.4)
Not employed (out of a job)	47.9 (5.4) *
Type of community (Residence)	
Metropolitan/City	48.2 (4.3) *
Suburban	46.7 (5.3)
Small town	46.3 (5.2)
Rural area	46.4 (5.2)

* Significantly different from the rest of the categories.

The gender of the respondents also had a significant impact on their experiences of loneliness (p-value < 0.01), whereby female participants reported (45.7 ± 5.1) lower scores than the male respondents (47.6 ± 4.6). Marital status and employment status also had a significant impact on the loneliness scores (p-value < 0.01), and the respondents who reported being married/having a partner (45.4 ± 5.0) and those who reported being employed (45.8 ± 3.7) reported lower loneliness scores compared to their counterparts. Finally, the type of community also had a significant impact (p-value < 0.01) on the loneliness scores, whereby those respondents who reported living in a small town (46.3 ± 5.2) reported having lower levels of loneliness compared to those respondents who lived in metro/cities (48.2 ± 4.3).

3.5. Technology, Digital Devices and COVID-19

Data analysis ascertained that younger adults (18–29 years) reported having the highest Internet usage, with the majority of respondents reporting using the Internet daily compared to adults aged 30–49 years and older adults (50+ years). Additionally, we observed how younger adults (18–29 years) who use the Internet daily reported having the lowest well-being scores (89.2 ± 15.1), which varied significantly (p-value < 0.01) from adults aged 30–49 and 50+ years who reported not using use the Internet on a daily basis. Moreover, adults (18–29 years) who reported engaging in frequent Internet use also experienced higher levels of loneliness (50.6 ± 6.3), and these, too, significantly differed for adults aged 30–49 and 50+ years (p-value < 0.01).

Further analysis showed how adults (18–29 years) were more likely to report changes in their use of social networks since the COVID-19 pandemic, with 78.3% of respondents in this group indicating their increased use, compared to 64.5% 42.1% of adults aged 30–49 and 50+ years, respectively Another observation was ascertained relating to the use of digital devices. Adults aged 18–29 years reported (83.1%) an increased use of digital devices, in comparison to 70.5% of adults aged 30–49 years, and even less so for adults 50+ years (51.1%). Furthermore, adults aged 18–29 years reported higher digital device usage and social network use; they, too, reported significantly higher levels of loneliness (p-value < 0.01) and lower well-being scores (p-value < 0.01) compared to those respondents who reported less frequent usage across the groups. Figure 3 below shows the change in the use of social networks and digital devices by age since the COVID-19 pandemic.

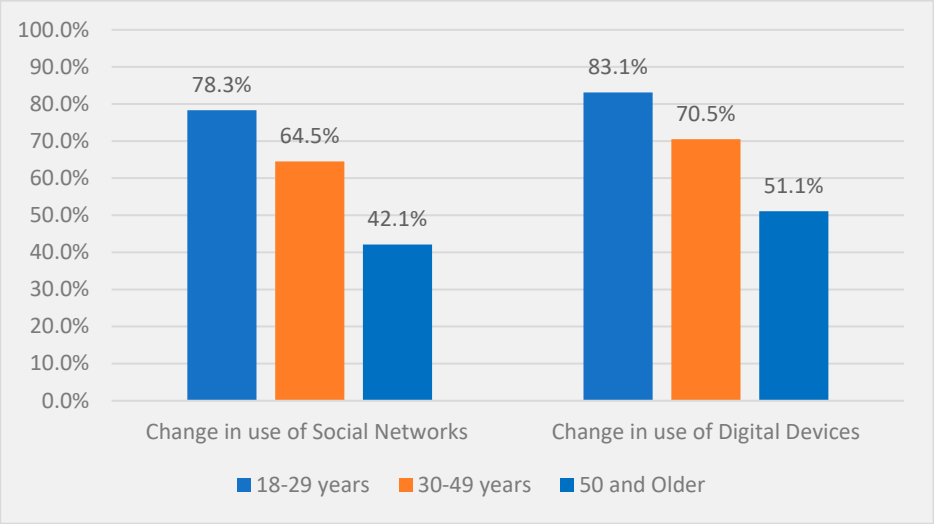

Figure 3. Change in the use of social networks and digital devices by age since the COVID-19 pandemic.

Further investigation into the impact of marital status revealed that single (or unmarried) respondents reported relatively higher Internet usage. The majority of these respondents used the Internet daily, in contrast to married respondents. Additional observations revealed single respondents with frequent Internet usage reported the lowest well-being scores (88.5 ± 14.7), which varied significantly (p-value < 0.01) from married respondents and single respondents who do not use the Internet daily. Moreover, those single respondents with daily Internet usage also experienced higher loneliness scores (51.3 ± 6.0), significantly differing from those respondents who reported being married (p-value < 0.01). Additional analysis shows that single respondents were more likely to report changes in their use of social networks since the COVID-19 pandemic, with 77.6% of this group indicating increased use, compared to 56.4% of the respondents reporting to be

married. Similarly, 82.9% of single respondents reported increased use of digital devices, compared to 62.3% of married respondents. Single respondents who showed higher levels of digital device usage and social network use also had significantly higher loneliness scores (p-value < 0.01) and lower well-being scores (p-value < 0.01) compared to married respondents with less frequent Internet usage. In contrast, married respondents, who generally reported less frequent use of the Internet and social networks, reported higher well-being scores (95.3 $\pm$ 11.1) and lower loneliness scores (44.2 $\pm$ 5.1). Similar patterns were observed in adults aged 50+ years, showing a significant difference (p-value < 0.01) from single respondents. This suggests that marital status, like age, plays a crucial role in influencing well-being and loneliness outcomes associated with Internet and social media usage.

Further investigations were conducted to explore the impact of education and gender on digital device and technology use since the COVID-19 pandemic. Data analysis showed no association between these two sociodemographic variables pertaining to loneliness and well-being.

Additional data analysis was conducted to explore the relationship between employment status and its impact on digital device and technology use, as well as loneliness and well-being since the COVID-19 pandemic. We observed that unemployed respondents reported the highest Internet usage, with the majority using the Internet daily, compared to employed respondents. Unemployed respondents who reported frequent Internet usage also reported having the lowest well-being scores (87.9 $\pm$ 13.8). Moreover, this, too, varied significantly (p-value < 0.01) between unemployed and employed respondents, whereby respondents who reported being unemployed also reported not using the Internet daily. Unemployed respondents with daily Internet usage experienced higher loneliness scores (52.1 $\pm$ 6.5); this significantly differed from employed respondents (p-value < 0.01). Furthermore, the analysis showed that unemployed respondents were more likely to report changes in their use of social networks since the COVID-19 pandemic, with 79.4% of unemployed individuals indicating increased use, compared to 59.2% of employed respondents.

Similarly, 81.7% of unemployed respondents reported increased use of digital devices, compared to 65.4% of employed respondents. Those unemployed respondents with more frequent digital device and social media usage also reported significantly higher loneliness scores (p-value < 0.01) and lower well-being scores (p-value < 0.01) compared to those with less frequent usage across both groups. In contrast, those respondents who reported being employed generally reported less frequent use of the Internet and social networks and had higher well-being scores (96.2 $\pm$ 10.7) and lower loneliness scores (43.5 $\pm$ 5.3), similar to the patterns observed in married respondents. These findings suggest that employment status, like marital status, is associated with significantly different outcomes related to well-being and loneliness, with employed individuals having better scores than their unemployed counterparts (p-value < 0.01).

3.6. Type of Community

The type of community had some interaction effect. Data analysis shows those respondents living in metro/cities were more likely to report changes in their use of social networks, with 81.6% of respondents who reported living in metro/cities indicating an increased use of social media, in comparison to a 57.2% increase among respondents living in rural and small-town areas. Similarly, 79.1% of respondents living in metro/cities reported an increased use of digital devices, compared to a 61.7% increase among respondents living in rural and small-town areas. Those respondents living in metro/cities reported a greater frequency of digital device and social media usage, and they also reported having signifi-

cantly higher loneliness scores (p-value < 0.01) and lower well-being scores (p-value < 0.01) compared to those with less frequent usage across all other community types (Figure 4).

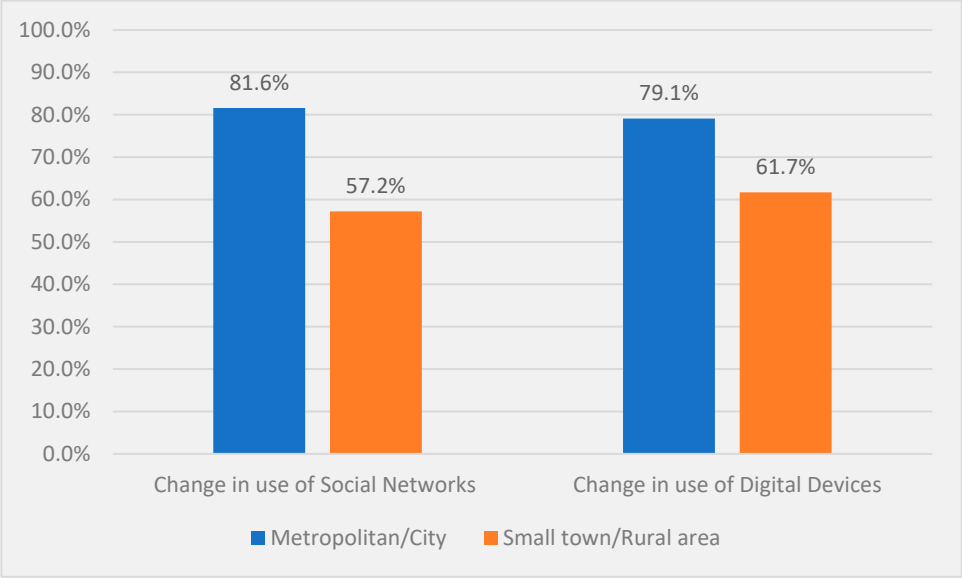

Figure 4. Change in the use of social networks and digital devices by community of residence since COVID-19.

4. Discussion

During and since the COVID-19 pandemic, there has been a notion of how technology and digital devices are the key tools to living in a new society. The findings presented here demonstrate how digital devices can facilitate individuals in society, but they can also be detrimental to well-being and increase loneliness. Through the lens of the AFCC framework and the background literature [78,79], technology was not initially conceived as an important stand-alone domain by the WHO when the age-friendly city model was published in 2007. Yet, Dikken et al. [80] have demonstrated that finance should have been integrated into each of the WHO AFC domains. Additionally, in further theoretical framework iterations, the respective authors have offered alternative proposals to elicit AFCC to incorporate the wide breadth of technologies now available in our society.

This study examined the engagement of technology in the context of AFCC and through an intersectional lens, including the type of community where respondents were living, well-being, and the experience of loneliness. Through the data analysis conducted, we found differences between socio-demographics including age, gender, and marital and educational status. Such findings are in line with similar studies in which technology use has been explored, using the age-friendly city framework (see, for example, [81]). Overall, the most notable findings are associated with age, whereby respondents aged 18–29 years use technology more so than adults aged 30–49 years and 50+ years, and the type of community in which the respondents were living in. Other studies conducted during the COVID-19 pandemic show the digital gap between young and old segments of the populations and the fact that older adults do not necessarily use more digital devices during that period of time (see [82] for an example). Also, the findings presented in the current study illustrate how respondents living in metro/city communities experienced greater loneliness and a greater level of digital device use than other areas such as urban or rural. Such findings are consistent with studies conducted during the COVID-19 pandemic using qualitative approaches, in which perceived loneliness was explored by interviewing people from different areas (see, for example, Mandache & Ivan [82] and Cotterell et al. [83]).

To date, existing age-friendly city frameworks [19,84–86] do not distinguish between metro/city, suburban, or rural environments, and from this perspective our study contributes to the current critical literature on the AFCC. Instead, the original WHO age-friendly city framework provides eight domains posited to be mapped against all types of environments (rural, urban, city) without additional consideration to the long-term impact or challenges to healthy living, access to services (e.g., transport), or various sorts of infrastructure, which are also known to have been impacted by the COVID-19 pandemic [87,88]. Further, and consequently, adults aged 18–29 years who were also living in metro/cities reported experiencing greater loneliness and lower well-being, and this finding supports similar research relating to adults' (18–29 years) experiences during the COVID-19 pandemic [7,8] compared to adults aged 50+ years living in other environments (urban or rural). However, these findings do differ from other studies which have, in turn, ascertained greater loneliness and depression in adults aged 50+ years [89,90]. Additionally, the data also show that those respondents who reported being employed and married reported greater well-being and lower levels of loneliness compared to those respondents who self-reported as being unemployed and unmarried/single. The data here support the findings published by Payne [91], who reports that the rates of loneliness across the UK during the COVID-19 pandemic are associated with unemployment, age, and marital status [91–93].

Technology (e.g., Internet, social media and communication platforms) and associated digital devices cannot be ignored in the context of AFCC, as argued by Marston and colleagues [15,16,30–32]. This is especially true given the role these types of technologies played during the COVID-19 pandemic, which, in turn, facilitated people to work from home, maintaining online social connections for geographically displaced people during lockdowns and the ability to access services and information. However, as the data presented here show, adults aged 18–29 years reported using the Internet more than respondents aged 30–49 years and 50+ years, resulting in greater levels of loneliness and low well-being. Similarly, digital device usage also increased among respondents aged 18–29 years, more than other survey respondents; likewise, there were greater experiences of loneliness and lower well-being. Yet, AFCC discourse is not just associated with older adults living in our communities, but, indeed, it is associated with everyone living within their respective community including people aged younger than 18 years. Furthermore, and since the COVID-19 pandemic, health and social care providers, local and national authorities, and organizations are seeking out alternative modes of information delivery because of reduced capacity, associated with the cost-of-living crisis, and financial resource restrictions. Thus, technology and associated devices are perceived as a means to continue an alternative approach to delivering social care, service provision, and wider dissemination of information.

Contribution and Implications

This international multicentre study was launched as a rapid response to the WHO declaring a pandemic [94], leading to this organically grown consortium of the project partners from across different geographic locations. Thus, the data presented here provide researchers in the fields of urban design, public health, gerontology, and gerontechnology the opportunity to understand how digital technologies impact different types of communities relating to health and well-being.

The proposed SAfE [15] and CASE [30] frameworks do require evaluation employing a multi-stakeholder approach across different types of communities (rural, urban, and metropolitan). However, these two theoretical frameworks afford scholars the foundations for evaluation and placing technology centrally in the AFCC domain. Moreover,

one approach to evaluating the respective frameworks and domains is to employ a similar approach conducted by Dikken and colleagues [80,95,96], whereby they developed a specific survey—the Age-Friendly Cities and Communities Questionnaire (AFCCQ). The AFCCQ encompasses the original eight domains situated within the age-friendly city framework published by the WHO [12,28], together with a ninth domain—finance. Dikken et al. [80] conducted a validation process, following the criteria set out in COnsensus-based Standards for selection of health Measurement INstruments (COSMIN), whereby the four phases of COSMIN were followed: (1) development of the conceptual model, themes and items; (2) initial (qualitative) validation; (3) psychometric validation; and (4) translating the instrument using the forward-backward translation method; these steps ensure a rigorous process and approach to developing a validated survey.

Likewise, future work and evaluations by researchers should consider a similar approach towards the two specific proposed frameworks to complement the existing work by Dikken et al. [80] and to afford greater insights into technology and digital practices at a community level. This, in turn, would allow local government/municipalities to identify appropriate mechanisms for information sharing, access to services and social care delivery via technology. Specifically in the context of England, many local authorities are reducing services because of financial pressures; indeed, some local authorities have declared bankruptcy [97,98], and are seeking alternative modes of delivery (e.g., social care) through innovative technologies and IoTs [99,100].

5. Conclusions

The findings presented here contribute to several disciplines including gerontology, the built environment, social sciences, and planning, due to the intersectional and intergenerational approach employed. This paper presents a sub-set of data collected from a large, international, multi-sited study intersecting across several socio-demographics including the impact of technology and digital practices in the context of AFCC. A limitation of this work is that we did not use the AFCC framework as part of the survey. Through our analysis, we have successfully demonstrated a clear connection. Furthermore, the WHO have now posited technology into their toolkit [101], which acknowledges technology more so than previous frameworks. Furthermore, these findings should inform public health policies at local and national governmental levels and programmes associated with loneliness and well-being targeting younger people; this is because, as our data have shown, younger people engaging with technology, particularly those who are unemployed and single/living alone, experience greater loneliness and lower well-being than adults in mid and later life. Future work in the area of AFCC should include greater insights and mixed-methods data not only from developed countries but also from the least developed countries [101] to enable cross-cultural analyses. Moreover, this work complements the ongoing quantitative work conducted by Dikken et al. relating to the AFCCQ (Age-Friendly Cities and Communities Questionnaire) [80]. To date, the AFCCQ has been validated in several countries including, Poland [84], Romania [19], North Macedonia [102], Japan [103], Russia [104], Israel [86], and Turkey [105], with many more countries undertaking the validation and reliability process [106]. The AFCCQ, in the respective studies featured [106], has demonstrated a ninth domain—Finance—to be more important than the existing eight domains of the WHO AFC model [11]. Furthermore, this ongoing work is critical for progressing the critical discourse in the AFC arena and has significant implications for both scholars and organisations such as the WHO, who continue to grow their global network, now constituting 1700 members [107].

Overall, the work presented here does contribute to the ongoing AFCC literature because of the gap in existing literature pertaining to technology and digital practices

through this lens. Moreover, AFCC research should consider its role and impact relating to health, well-being, and loneliness experienced by residents; this, too, is an avenue for future work. Yet, the findings here culminate insights associated with well-being, loneliness, technology, and digital practices, setting a foundation for scholars in the disciplines of gerontology, sociology, gerontechnology, and urban planning to expand and contribute to the ongoing AFCC literature, thus reducing the gap in the existing literature.

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Data Availability Statement: We are still conducting analysis from this dataset as part of a large international study, and we cannot provide the full dataset at present. Persons interested in accessing the data may contact the corresponding author.

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