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Who benefits from digital transformation in (health) care? Internet use among informal carers and care recipients in Europe

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Abstract

Introduction:

Across Europe, informal care is an important source of long-term care provision. Governments and companies offer an increasing supply of online support and digital solutions for the domains of health and care. Large-scale evidence on the diffusion of digital technologies among older persons involved in family care is scarce. The article aims to investigate digital inequalities in the context of informal care and to explore the role of socio-economic aspects, health-related factors, and social-environmental factors.

Methods:

Data source is the Survey of Health, Ageing and Retirement in Europe (SHARE), waves 5, 6, 7, and 8. Samples for analysis include 14,059 care recipients and 15,813 caregivers aged 50 years and older. Multivariate logistic regressions model the probability of not using the internet.

Results:

For both caregivers and care recipients, the following characteristics are significantly associated with a higher likelihood of being offline: older age, cognitive limitations, severe impairment of close-up vision, and living in a rural area. In contrast, individuals with a higher level of education, a good financial situation, who are active in the labour market, living with a partner, and have children are more likely to be onliners.

Conclusions:

To ensure that all population groups benefit equally from digital transformation, knowledge about the characteristics of the target users and non-users is crucial. Experts and policy-makers, who consider digital solutions as one remedy for reducing the burden of care and tackling the care crisis, should consider that a large proportion of people involved in informal care are currently offliners.

Keywords: internet use, old-age, digital divide, informal care, Europe

Kurzfassung

Einleitung:

In ganz Europa wird ein Großteil der Langzeitpflege privat durch An- und Zugehörige erbracht. Öffentliche und private Anbieter stellen ein wachsendes Angebot an Online-Unterstützung und digitalen Lösungen für die Bereiche Gesundheit und Pflege zur Verfügung. Es gibt einen Mangel an groß angelegten Untersuchungen über die tatsächliche Verbreitung digitaler Technologien bei älteren Menschen, welche in familiäre Pflege involviert sind. Der Artikel zielt darauf ab, digitale Ungleichheiten im Kontext der informellen Pflege zu untersuchen und die Rolle sozioökonomischer Aspekte, gesundheitsbezogener Faktoren und sozialer und umweltbezogener Faktoren zu untersuchen.

Methode:

Datenquelle ist der Survey of Health, Ageing and Retirement in Europe (SHARE), Wellen 5, 6, 7 und 8. Die Stichproben für die Analyse umfassen 14.059 Personen mit Pflege- und Unterstützungsbedarf und 15.813 Pflegepersonen im Alter von mindestens 50 Jahren. Multivariate logistische Regressionen modellieren die Wahrscheinlichkeit der Nichtnutzung des Internets.

Ergebnisse:

Sowohl für Pflegepersonen als auch für Pflegebedürftige sind die folgenden Merkmale signifikant mit einer höheren Wahrscheinlichkeit verbunden, offline zu sein: höheres Alter, kognitive Einschränkung, starke Sehbeeinträchtigung, und das Wohnen in einer ländlichen Gegend. Im Gegensatz dazu sind Personen mit einem höheren Bildungsniveau, einer guten finanziellen Situation, die auf dem Arbeitsmarkt aktiv sind, als Paar zusammenleben und Kinder haben, mit größerer Wahrscheinlichkeit Onliner:innen.

Schlussfolgerungen:

Um sicherzustellen, dass alle Bevölkerungsgruppen gleichermaßen vom digitalen Wandel profitieren, ist evidenzbasiertes Wissen über die Eigenschaften der Zielgruppen entscheidend. Expert:innen und politische Entscheidungsträger:innen, die digitale Lösungen als ein Mittel zur Verringerung der Pflegebelastung und zur Bewältigung des Pflegenotstands betrachten, sollten bedenken, dass ein großer Teil der Menschen, die an der informellen Pflege beteiligt sind, derzeit ‚offline' sind.

Schlüsselwörter: Internet, Alter, Digitale Ungleichheit, Informelle Pflege, Europa

Table of Contents

1 Introduction 5
2 Theoretical Background 6
3 State of Research 7
3.1 Older Population and Internet/Technology Use 7
3.2 Informal Care and Internet/Technology Use 8
4 Data and Methods 10
5 Results 11
6 Discussion and Conclusion 18
References 20
Appendix 24

1 Introduction

Informal care, provided by family members and other unpaid caregivers, is a vital source of long-term care provision across Europe (European Commission, 2021). In Germany, about 84% of care recipients live at home, receiving help from informal caregivers (Statistisches Bundesamt [Destatis], 2022). Tasks provided by informal carers often resemble those of professional carers and can include personal care, dressing, transportation, medication, cooking, social companionship, household chores, or paper work. The average caregiver is a female spouse or daughter of middle- or old-age. Informal caregiving can be associated with negative consequences for the caregiver, an outcome known as *burden of care*. Negative effects relate to the carer's mental and physical health, well-being, financial and social situation, or labour market participation (Bohnet-Joschko, 2020; European Commission, 2021; Li & Song, 2019; Pinquart, 2016; Schulz et al., 2020).

Considering demographic developments, the shortage of care staff and the predicted decline in care potential within families, much potential is seen in digital solutions. In the future, digital technologies will support care not only in inpatient contexts, but also in private households. Thus, family caregivers and those in need of care are potential users of technologies (Endter, 2021; Kricheldorff, 2020). Almost two decades ago, Blackburn et al. (2005) stated that "[i]nformal carers have been identified as a population of people who could benefit from the provision of online information and other services" (2005, p. 201).

Many governments and companies are offering an increasing number of online support and digital solutions for family care. For example, Germany passed a law, making digital health and care-related applications available on prescription, with costs covered by health or care insurance[1].

However, in order for digital technologies to unfold their potential, they must arrive in real care settings and be accepted and used by the target groups. Although the development of such 'solutions' has steadily increased, the use of digital technologies in practice, especially in home contexts, has not yet been widespread in European countries such as Germany (Braeseke et al. 2022; Kricheldorff 2020).

Scientifically, there is currently a lack of large-scale evidence on the diffusion of digital technologies among people involved in informal care. To address this gap, this research article aims to investigate digital inequalities in the context of informal care. Using large-scale European survey data, it explores which population groups may – and which may not – benefit from digital transformation in the area of care.

[1] BfArM - Digitale Gesundheits- und Pflegeanwendungen (DiGA, DiPA)

2 Theoretical Background

The theoretical background of this research article draws on the concepts of *digital divide* and *Technology Acceptance Models* (TAM). The digital divide is a theoretical concept and refers to the gap between individuals, households, or other units that have access to and use information and communication technologies (ICT) and those that do not. The digital divide is often associated with socio-economic and demographic factors, such as age, education, and income. Hence, it is also spoken of as digital inequality. Analytically and empirically, a digital divide can be located on three levels: The first level divide refers to *access* to the internet, IT infrastructures, or digital devices. The second level divide is about the disparities in *skills* (digital literacy) of using the internet and related devices. The third level divide concerns the *benefits* or outcomes of using the internet. Benefits of being online can be experienced in both the digital and the analogue worlds, and may include economic, political, cultural, social, or personal benefits (e.g., political participation, advantages of being part of certain social networks, better health) (Bonfadelli & Meier, 2020; UNECE, 2021; van Dijk, 2018).

Age and age-related factors can be determinants and mediators of digital inequalities. Age-specific factors can contribute to digital participation or digital exclusion in later life. For instance, when it comes to handling touch screens or small devices, physical limitations might lead to negative user experiences with technology that is typically built by and for young, male users (e.g., Ivan & Cutler, 2021). Age-related barriers to access, skills and benefits of using digital media may include impaired eyesight, hearing, mobility, or finger dexterity, cognitive limitations, reduced chances of access to technology due to retirement, fear and self-stereotyping, just to name a few (cf. Bonfadelli & Meier, 2020; Wilson et al., 2021).

The second component of the theoretical background is Technology Acceptance Models. In a broad sense, (technology) acceptance is the result of a reciprocal process characterised by the conscious perception and subsequent positive evaluation of an object (e.g., a computer) by a subject (e.g., a caregiver) within a context of acceptance (e.g., home care). This process can be associated with a consequence of action (e.g., the use of the computer) (Lucke, 1995; Sauer et al., 2005).

There are several psychological and social science models of technology acceptance. One of the most dominant models in this area (Marangunić & Granić, 2015) is the TAM (Davis, 1989; Davis & Venkatesh, 1996). It postulates that the intention to use a technology is the most important factor in predicting actual technology use. The intention to act is in turn determined by the perceived usefulness of the technology as well as the subjectively perceived ease of use (i.e., the effort required to use is assessed as low). Original models do not or only indirectly take into account age(ing) (Misoch et al., 2016).

Integrating age-related characteristics such as cognitive and physical abilities, social support, or self-efficacy, extensions of TAM were developed: Senior Technology Acceptance & Adoption Model (STAM) (Renaud & van Biljon, 2008), Senior Technology Acceptance Model (STAM) (Chen & Chan, 2014; Chen & Lou, 2020), or the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). Those models include the user context "defined by demographic and personal factors such as age and functional ability" (Neves & Mead, 2021, p. 891) as additional predictive factors.

3 State of Research

The following sections provide a brief overview about the current state of research concerning internet use in later life in general and among older adults involved in informal care, specifically.

3.1 Older Population and Internet/Technology Use

There is a growing corpus of evidence on internet, media and technology use of older adults. Baseline information on the use of the internet and digital devices repeatedly shows that use among older populations has been increasing, but that adoption rates are below average. Considerable numbers of older adults do not go online at all, particularly the oldest old. Also IT skills of older adults are on average lower than those of the younger population (Friemel et al., 2021; Initiative D21 e. V., 2022; Merkel & Hess, 2020; Rathgeb et al., 2022; Seifert & Schelling, 2015; SINUS Markt- und Sozialforschung GmbH, 2016). A review of internet use among older adults, based on large, population-representative survey data, summarises that there are clear social disparities between users and non-users. Internet access and use are more likely among the younger old, those with higher levels of education and higher incomes. Results concerning gender differences are inconclusive. Disability or reduced functional status and cognitive limitations in particular, are assumed to be related with reduced online activity (Hunsaker & Hargittai, 2018).

Empirical investigations of older Europeans reveal that private internet use is driven by health, education, income, prior experiences with technology, social and contextual influences, and country of residence (König et al., 2018). Additional factors, proven to be linked to internet use in old-age, are technology biography and affinity, perceived usefulness, positive attitude and perceived ease of the internet (in a sample of Swiss older adults) (Seifert & Schelling, 2015). Considering the oldest-old cohorts (age 80+), ICT device adoption as well as patterns of internet use were found to be associated with functional health, age, education, and attitudes towards modern technology (Reissmann et al., 2022; Schlomann et al., 2020).

Further research has explored age-specific factors that can contribute to digital participation or digital exclusion. Physical conditions such as impaired vision, fine motor

skills impairments or pain in hand and fingers were identified to be a barrier to using digital devices in an interview study with older adults (Wilson et al., 2021). Quantitative investigations also show that technology use decreases with greater disability and vision impairment, after adjustment for sociodemographic and personal factors. In contrast, hearing or co-ordination impairments had no effect, and technology use was higher in older adults with breathing difficulties and pain issues (Gell et al., 2015).

Age-related changes in different areas of cognitive function have been analysed as moderators between age and technology ownership, concluding that perceptual speed and verbal fluency play distinct moderating roles in the relation of age and technology ownership (Kamin & Lang, 2016). Memory problems (without diagnosis of dementia) have been observed to be connected with a lower likelihood of internet, e-mail, and text messaging usage (Gell et al., 2015). In a 2020/21 sample of people aged 80 and older, 73% of adults with mild cognitive impairment and 84% with early dementia were offline, compared with 51% among adults without cognitive disability (Reissmann et al., 2022). More general psychological factors such as internalised ageism and negative self-stereotypes can also act as a barrier to technology use (Köttl, Cohn-Schwartz, & Ayalon, 2021; Köttl, Gallistl, et al., 2021).

Lastly, technology-related social support (e.g., for learning, trouble shooting) has been presented as another mechanism potentially facilitating the use of technology among older adults (Kamin et al., 2020).[2]

3.2 Informal Care and Internet/Technology Use

Evidence on technology use of subgroups of older people is scarce in general (Kricheldorff, 2020; Poli et al., 2021). Baseline data on computer and internet use of informal carers is hard to find (Blackburn et al., 2005). The landscape of research on digital inequalities among older adults with care needs often neglects older informal carers as users of technology (Ehlers et al., 2020). In some cases, measuring the internet use of carers and cared for persons can be a methodological challenge, especially in the case of cohabitation. There is evidence of *indirect* internet use, meaning a patient accesses online content not personally but indirectly through the use of the carer (Kinnane & Milne, 2010).

Summarising the existing literature, firstly, there is empirical evidence from national investigations. A survey among British carers conducted in 2004 shows that half of informal carers were not using the internet and that age, gender, socio-economic status and hours spent caring shaped the probability of internet use (Blackburn et al., 2005). A survey of German family carers of people with dementia indicates that, regardless of gender, younger

[2] For further comprehensive review of empirical studies with evidence on effects of age, gender, education, instrumental activities of daily living impairments, training, cognitive decline, attitudes, or ability factors on technology/ ICT adoption in advanced age, see Schlomann et al. (2020).

and better-educated caregivers more frequently own a computer with internet access than older carers (Grässel et al., 2009). Second, there is international evidence. A report based on survey data covering the population aged 50 and over in several European countries, claims that regarding the utilisation of ICT, informal carers “show the same access and usage patterns when compared with the overall 50+ population and are affected in the same ways by the digital divides” (empirica & Work Research Centre, 2008, p. 11). Precisely, 40% of family carers were computer users and 34% were internet users, meaning that more than half of them were offliners (ibd.). A more recent survey on European informal carers’ experiences during the COVID-19 pandemic showed carers’ extensive and widespread use of digital tools (mainly smartphones, computers, and social media) in 2020 and 2021. However “77.8% of them have never used care-related technologies; among them, 27% would be interested in accessing them“ (Eurocarers, IRCCS-INRCA, 2021, p. 33). As the study used online questionnaires, people without internet access or usage were not considered a priori.

Additionally, there is specific research on success factors and barriers of implementing digital tools for family care. A review found the following characteristics of informal caregivers to affect the implementation of e-health interventions: expectation of use, psychological state, trust, autonomy, motivation, confidence, frustration, privacy concerns, digital literacy, ethnicity, caregiving workload, and social support (Christie et al., 2018).

Regarding care recipients, the lack of empirical evidence on internet or ICT use is even more pronounced. Empirical literature with general statistics about older adults dependent on support is hard to find.

There is evidence that online behaviours of community-dwelling older adults and those in institutional environments may be distinct (Reissmann et al., 2022; Seifert et al., 2017). For example, internet users living in Swiss residential care facilities were found to be younger, male, not living alone and for a shorter duration in the institution, healthier, and functionally unimpaired, compared to non-users. The share of onliners was 14% (ibd.). Another quantitative study with a German sample identified only 3% of older people in long-term care facilities as users of internet-connected devices. Technology adoption was associated with age, functional health, and care needs. Moreover, different patterns of use emerged for different types of devices (Schlomann et al., 2020).

Finally, data that specifically addresses older adults as users of media and technology or examines the diffusion of health- and care-related technology is often an output from market research (e.g., emporia & Deutsche Seniorenliga e.V., 2019; Fink & Bräunlein-Reuß, 2022).

4 Data and Methods

The data source is the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE is a multidisciplinary longitudinal survey which collects data on social, economic and health conditions of the older European population (Börsch-Supan et al., 2013). Target population of SHARE is persons aged 50 or over at the time of sampling and having their regular domicile in one of the participating countries. Even if respondents move to a nursing home or a residential care facility, they remain part of the sample (see Bergmann, Bethmann, & Luca, 2019 for exceptions and further methodological details).

For this study, *informal carers* are defined as persons stating to give one or more of the following types of help to someone inside or outside the household: personal care (e.g., dressing, bathing or showering, eating, getting in or out of bed, using the toilet), practical household help (e.g., home repairs, gardening, transportation, shopping, household chores), help with paperwork (e.g., filling out forms, settling financial or legal matters). Looking after or taking care for grandchildren is excluded. *Care recipients* are defined by stating to receive personal care or practical household help from someone inside or outside their household – from family members, friends, or neighbours. In fact, the question on caregiving between household members asks only for one type of care (personal care). Another criterion of inclusion is the frequency of help given or taken, which must be at least daily or weekly.

For analyses, I exploit all waves of SHARE that contain a module with questions on IT use, that is waves 5, 6, 7, and 8 (Börsch-Supan, 2022a, 2022b, 2022c, 2022d). To maximise sample size, the four waves are pooled (interview years: 2013, 2015, 2017, and 2019/2020). For each respondent, I kept only the most recent observation. Only individuals aged 50 or older with valid responses to the questions concerning care are considered. Thus, I arrived at one sample of 14,059 care recipients and a second sample of 15,813 caregivers, coming from 26 EU countries and two non-EU countries (Switzerland, Israel)[3]. Table 1 provides an overview of the two samples.

Study Variables

Internet use: The dependent variable is a binary indicator of no internet use during the past seven days. It is derived from the question *"During the past 7 days, have you used the Internet, for e-mailing, searching for information, making purchases, or for any other purpose at least once?"*. [4]

Based on the theoretical background and past empirical evidence, I include several independent variables in the models. *Socio-economic status:* age, gender, education

[3] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland.
[4] For the documentation of SHARE questionnaires see Questionnaires (share-eric.eu)

(derived from ISCED-1997 coding), financial situation (as a measure of how easily the household is able to make ends meet with its monthly income), and employment status (a binary indicator of working/non-working with non-working defined as being retired, unemployed, homemaker, or permanently sick/disabled). *Health conditions assumed to affect technology use*: major impairment of close-up vision (having bad eyesight for close seeing even with glasses), impairment of fine motor skills (having difficulties picking up a small coin from a table), and impairments of cognitive function (defined as having one or more of the following long-term difficulties of activities of daily living: Using a map in a strange place / Making telephone calls / Taking medications / Managing money).

Multiple environment-related factors are used as explanatory variables, including social factors and technical-spatial environment (cf. Schlomann et al., 2020): *Social, institutional and technical-spatial environment*: cohabitation with a partner (yes/no), having one or more living children (natural, step, or adopted), type of living area (either rural (i.e., a rural area or village) or urban (i.e., big city / suburbs / large town / small town)), and country of residence. For care receiving persons, I add a variable for residency in a nursing home (yes/no). Using a pooled sample of multiple survey waves, I control for the year of interview in all models.

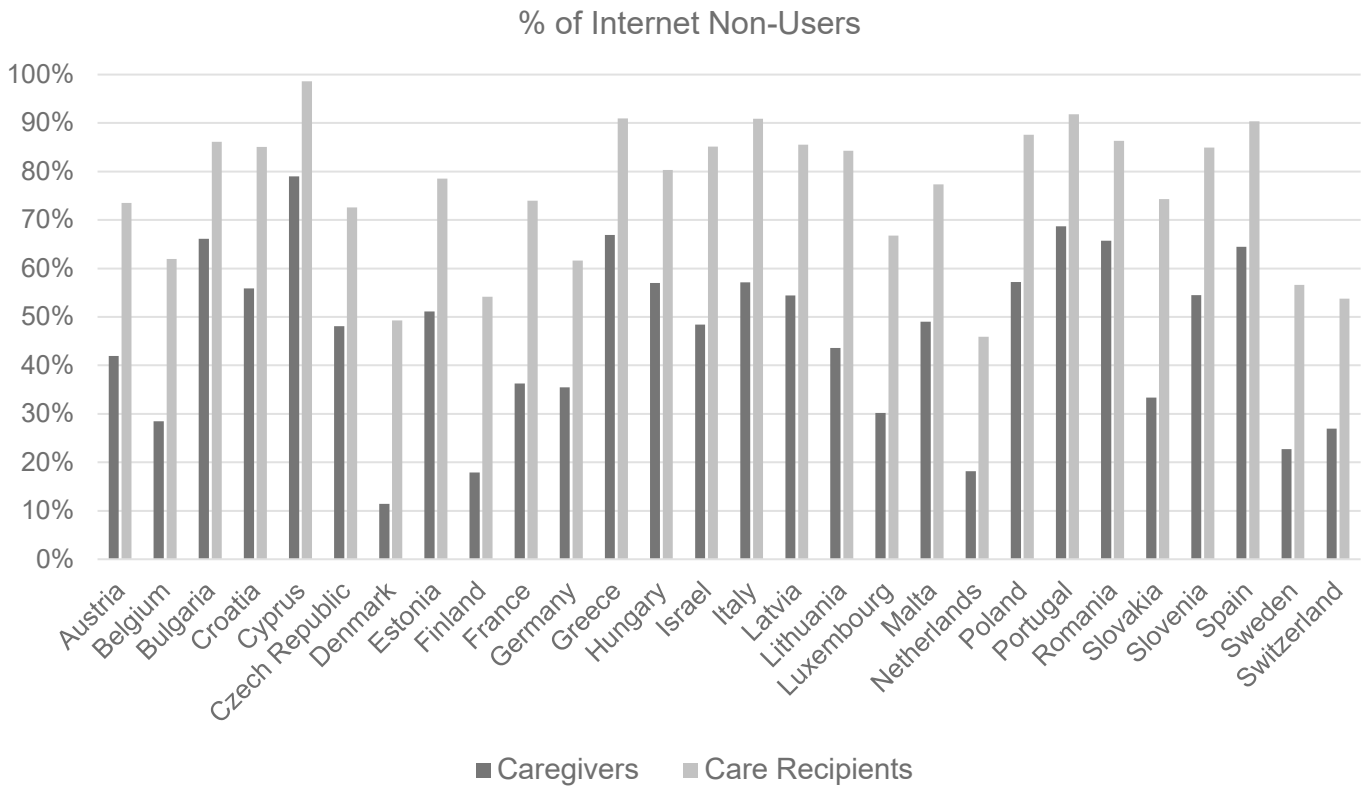
Multivariate logistic regressions were used to model the probability of not using the internet. I calculated robust standard errors to avoid inaccurate significance values and biased standard errors. All analyses were conducted with the statistical software Stata Version 17.

5 Results

Figure 1 gives an overview of the percentage of caregivers and receivers who stated that they have not used the internet during the past week. Across all countries, the care dependent adults are the group most likely to be offline. Over 90% of persons receiving support in Cyprus, Greece, Italy, Portugal, and Spain report no current internet use. In only two countries less than half of the care dependent older adults state to be offline: the Netherlands (46%) and Denmark (49%). The average share of internet non-users among care dependent persons is 76%, across countries. As far as informal carers are concerned, there is a lower mean value of internet non-users (42%). Most caregivers reporting to be offline are found in Cyprus (79%), Portugal (69%), Greece (67%), Bulgaria, Romania (66% each), and Spain (64%). In contrast, the lowest proportions of carers not using the web live in Denmark (11%), Finland, the Netherlands (both 18%), and Sweden (23%). In Germany, on average 62% of persons receiving support in old-age and 35% of persons providing support report no internet use. Descriptive results of the study variables for the two samples of analysis can be found in Table 1. Both population groups of interest, caregivers and receivers, are mostly female (>62% each). Care recipients are on average of higher age

than caregivers. Especially, more adults receiving care are over 80 years old (38%) than those providing care (11%). Besides, carers are better off financially, have higher levels of education, and are more often active on the labour market. Regarding health limitations, it is the care dependent adults who have more severe impairments, particularly in the cognitive domain (10% of carers compared to 43% of care receivers impaired in cognitive activities of daily living). In both groups of respondents, over 65% live in urban areas and over 90% have at least one child. The share of nursing home residents is 3%. 75% of carers live together with a spouse or partner, among care recipients the figure is 53%.

Figure 1. *Share of internet non-users among informal carers and care receivers across countries*



Note. N(caregivers)=15,813; N(care receivers)=14,059. Data: SHARE w5,6,7,8_rel8-0-0. Unweighted. Own calculations.

Table 1. *Samples of Analysis: Descriptive Results*

	Caregivers	*Care Receivers*
	%	*%*
Internet use		
Internet use past 7 days	58.00	24.34
No internet use past 7 days	42.00	75.66
Sex		
Female	62.66	62.85
Male	37.34	37.15
Age		
50-60	28.27	11.57
61-70	36.72	19.93
71-80	24.18	30.06
81+	10.82	38.45
Education (ISCED-1997)		
No/primary education	18.66	34.54
Secondary education	57.26	51.73
Tertiary education	24.07	13.73
Financial situation		
Some/great financial difficulties	36.88	47.91
Making ends meet (fairly) easily	63.12	52.09
Active on labour market		
No	76.75	93.49
Yes	23.25	6.51
Eyes/vision impairment		
No	94.09	85.24
Yes	5.91	14.76
Fine motor skills impairment		
No	95.08	82.17
Yes	4.92	17.83
Cognitive health impairment		
No	89.70	56.60
Yes	10.30	43.40
Cohabitation with partner		
No	25.33	47.50
Yes	74.67	52.50
Children (alive)		
No	8.34	9.24
Yes	91.66	90.76
Area of living		
Urban	67.43	65.06
Rural	32.57	34.94
Nursing home resident		
No	-	96.79
Yes	-	3.21
Observations	15,813	14,059

Note. Data: SHARE w5,6,7,8_rel8-0-0. Unweighted. Own calculations.

Results of a multivariate logistic regression on the probability of not using the internet can be seen in Figure 2 (informal carers) and Figure 3 (care receivers). The graphs display post-estimated, plotted average marginal effects (AME) with 95% confidence intervals. Additionally, Table 2 presents a tabular display of the regression results including AME, standard errors, and p-values.

Analyses reveal that for both caregivers and care recipients, certain characteristics are significantly associated with a higher likelihood of being offline. These include: higher age, cognitive limitations, severe impairment of close-up vision, and living in a rural area. In contrast, individuals with a higher level of education, a good financial situation, who are active in the labour market, are living with a partner, and have children are more likely to be using the internet.

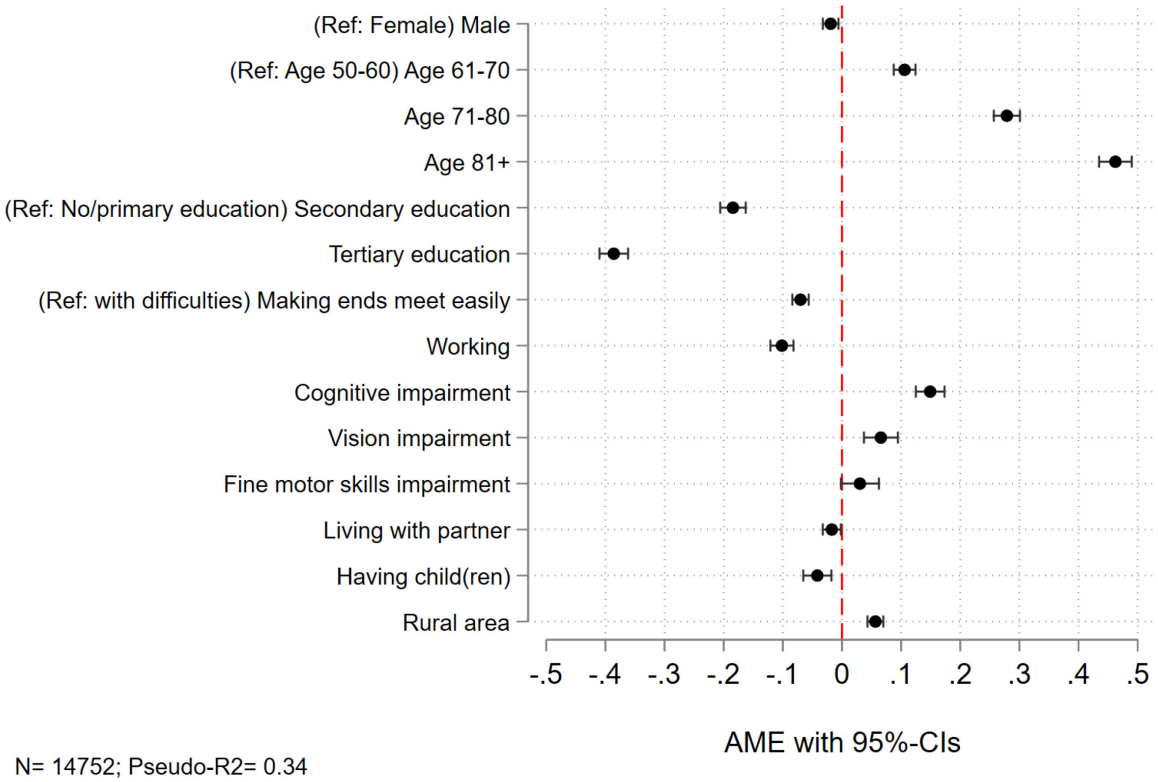
More specifically, both age and education show the greatest effect sizes. On average, the probability of being offline increases by almost 50 percentage points for informal carers over age 81, compared to those between age 50 and 60. For the oldest care receivers (age 81+), the probability of being an offliner is almost 40 percent points higher. Carers with tertiary education show a decreased likelihood of being offline by almost 40 percentage points; tertiary education of care dependent older adults decreases the likelihood of being offline by nearly 30 percentage – in contrast to those with very low levels of education. Being able to make ends meet with one's household's income easily or fairly easily, reduces the chances of being offline, compared to persons with financial difficulties (AME: caregivers=-0.070; care recipients=-0.041; $p<0.001$). Similar effects can be observed for being active on the labour market (AME: caregivers=-0.101; care recipients= -0.092; $p<0.001$).

Among the age-related health conditions that are assumed to affect technology use, it is cognitive impairment that has the greatest effect on internet usage. Problems in cognitive activities of daily living are associated with an average 15 percentage point increase in the likelihood of not using the web. Both informal carers and receivers who have problems with close-up vison, even when wearing glasses, are less likely to be active internet users (AME: caregivers=0.066; care recipients=0.40; $p<0.001$). Difficulties in finger dexterity appear to play no significant role regarding online behaviour. On the reasons for these outcomes, one can only do some speculating. For instance, technology providers are offering a range of accessibility features to improve the user experience for persons with visual impairments and other disabilities. Examples are text-to-speech software for reading text aloud, adjustable font sizes and colours for better legibility, screen magnification tools and high-contrast display settings for better visibility, alternative input methods via voice recognition, audio descriptions for videos or images, and haptic feedback for touchscreens. Such accessibility features may be one of the reasons for the finding that there are older adults engaging in online activities despite physical limitations.

The results for gender are less clear. Gender differences are only found in caregivers. Being a male carer is a factor that lowers the chances of being a non-user of the internet – as compared to female carers. Effect size is low, however (AME=-0.019; $p<0.05$). Concerning the social environment, cohabitation with a partner decreases the chances of being inactive on the internet (AME: caregivers=-0.017; $p<0.05$; care recipients=-0.028; $p<0.001$). Similar effects can be observed for having at least one child (AME: caregivers=-0.042; care recipients=-0.040; $p<0.001$).

A noteworthy finding is that there remains a significant urban-rural digital divide – even after controlling for individual and socio-economic factors and country context. Both population groups are more likely to be inactive in terms of internet use if they live in a rural area, compared to urban dwellers (AME: caregivers=0.057; care recipients=0.043; $p<0.001$). For that, many interpretations are possible. On the one hand, there might be less advanced digital and service infrastructures in rural than in urban areas (e.g., less access to broadband or mobile connections (Merkel & Hess, 2020)). On the other hand, infrastructure might not be the underlying causal mechanism. It may be that there are stronger and more numerous real-life social networks in rural areas, leading to less need for the take-up of digital services.

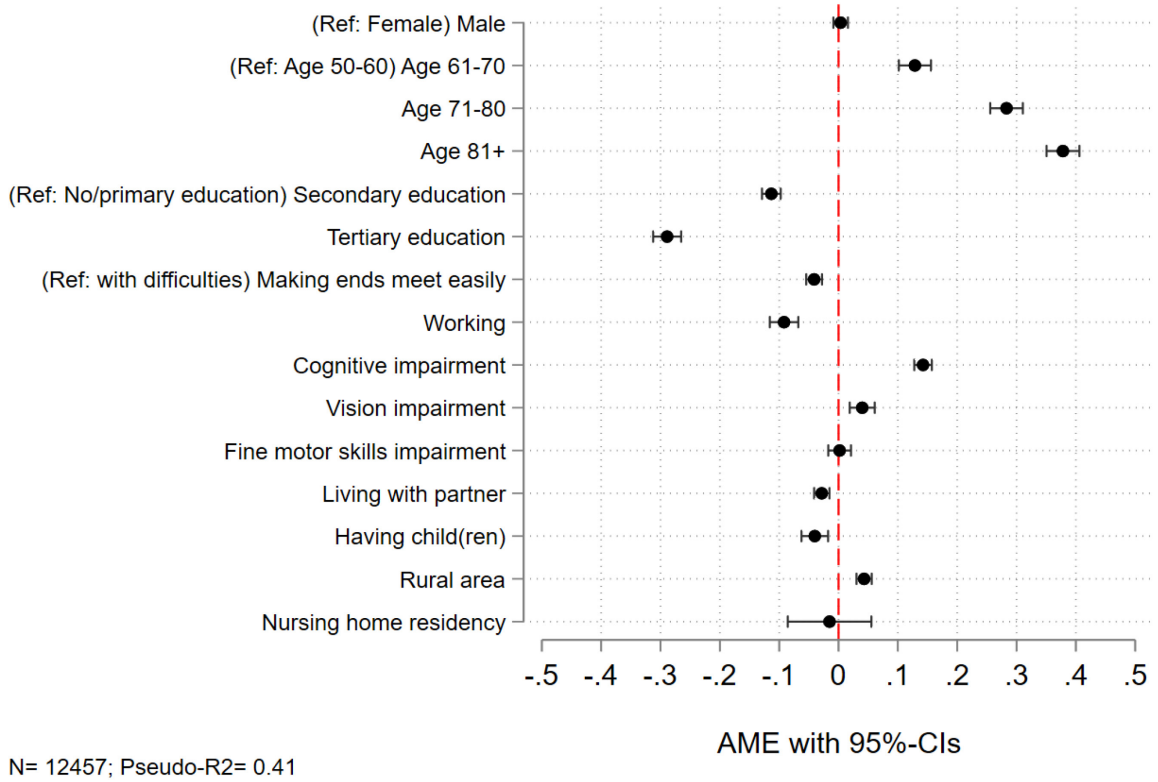
Figure 2. *Logistic regression on the probability of not using the internet – informal carers.*



N= 14752; Pseudo-R2= 0.34

Note. Logistic regression using robust standard errors. Plots of AME with 95% confidence intervals. Controlling for year, country (not shown). Data: SHARE w5,6,7,8_rel8-0-0. Own calculations.

Figure 3. *Logistic regression on the probability of not using the internet – care receivers.*



N= 12457; Pseudo-R2= 0.41

Note. Logistic regression using robust standard errors. Plots of AME with 95% confidence intervals. Controlling for year, country (not shown). Data: SHARE w5,6,7,8_rel8-0-0. Own calculations.

Table 2. *Results of logistic regressions on the probability of not using the internet.*

	Caregivers	**Care Receivers**
	AME (s.e.)	**AME (s.e.)**
Male	-0.019*	0.004
	(0.007)	(0.006)
(Ref.: Age 50-60)	0.000	0.000
	(0.000)	(0.000)
Age 61-70	0.106***	0.129***
	(0.009)	(0.014)
Age 71-80	0.279***	0.283***
	(0.011)	(0.014)
Age 81+	0.462***	0.378***
	(0.014)	(0.014)
(Ref.: No/primary education)	0.000	0.000
	(0.000)	(0.000)
Secondary education	-0.184***	-0.113***
	(0.011)	(0.008)
Tertiary education	-0.386***	-0.289***
	(0.012)	(0.012)
Making ends meet (fairly) easily	-0.070***	-0.041***
	(0.007)	(0.007)
Active on labour market	-0.101***	-0.092***
	(0.010)	(0.012)
Cognitive health impairment	0.149***	0.142***
	(0.012)	(0.008)
Vision impairment	0.066***	0.040***
	(0.015)	(0.011)
Fine motor skills impairment	0.030	0.002
	(0.016)	(0.010)
Cohabitation with partner	-0.017*	-0.028***
	(0.008)	(0.007)
Having child(ren)	-0.042***	-0.040***
	(0.012)	(0.011)
Rural area of living	0.057***	0.043***
	(0.007)	(0.007)
Nursing home resident		-0.015
		(0.036)
Observations	14,752	12,457
Pseudo-R^2	0.34	0.41

Note. AME=average marginal effects; s.e.=standard errors (robust). Controlling for year, country (not shown). * p<0.05; * p<0.01; *** p<0.001. Data: SHARE w5,6,7,8_rel8-0-0. Own calculations.

6 Discussion and Conclusion

Aim of the article was to analyse population groups involved in family caregiving in their roles as intended users of digital support tools. Effective internet usage is a prerequisite of the successful utilisation of digital health and care applications. I presented population representative evidence on internet use among persons involved in private home care, shedding light on potential explanatory factors. Knowledge of characteristics of older adults as target groups of technology "is crucial for the development and success of products and services" (Wöckl et al., 2012, p. 30).

Most important, I identified non-negligible proportions of internet non-users among those involved in informal care, ranging from 42% (carers) to over 75% (care dependents). Using European survey data, I replicated previous evidence on digital inequalities in old-age (Hunsaker & Hargittai, 2018), and showed that these disparities exist also among specific subgroups of the older population, that is persons involved in informal care. Among them, onliners are of younger age, highly educated, better off financially, urban, and active in the labour market. A very small positive gender effect was only observed in male caregivers. In addition, age-related health conditions proved to be a relevant factor, while cognitive impairments had greater effects than physiological impairments on the likelihood of not using the internet. These findings indicate that socio-economic and health-related factors play a key role in determining who benefits from digital transformations in healthcare.

Limitations

First, there are limitations concerning the data source. Using a cross-sectional, pooled sample allows no causal interpretations and no projections for future cohorts. Besides, measures of informal caregiving in SHARE have their shortcomings: the variables for care inside and outside the household are not measured identically. Care that is provided within the household is only defined as personal care in the questionnaire; whereas informal care given or received from someone outside the household is defined as personal care, practical help, and paperwork. Moreover, internet-related survey measures in SHARE are, to date, very broad and general measures. Details of technology use or adoption covered by (S)TAM, such as perceived usefulness, ease of use etc., are not available. However, additional analyses of informal caregivers' and care receivers' computer skills using SHARE found similar associations to the results of internet use. With the exception, that being male reduced the chances of having low computer skills for *both* caregivers *and* receivers; the presence of children and a partner had significant negative effects on having low skills only among the care dependents, not the helpers (for regression results see Appendix, Table A1). A major methodological challenge is to capture the fast changing nature of digital technologies with longitudinal surveys, at the same time using questions that remain comparable across survey waves (Hunsaker & Hargittai, 2018). Second, there are

limitations with regard to theory. Models of general technology acceptance cannot cover the heterogenous product range of digital (health) care services. Acceptance and use(fulness) of a product for informal care might change with the specific technology. Also, there is no theoretical foundation for internet or technology use of subgroups of older adults, such as informal caregivers.[5]

Conclusion

In conclusion, this research article provides valuable insights into the digital inequalities that exist in the context of informal care. It highlights the need for more research on the diffusion of digital technologies among older persons who are involved in family care. Furthermore, it emphasises the importance of considering socio-economic and health-related factors in determining who benefits from digital transformations in healthcare. The evidence can inform policy makers and practitioners who support family caregivers about unequal access to digital support. In order to make all population groups benefit from digital transformations equally, it is crucial to have knowledge about the characteristics of target users − and non-users. Policy makers and experts, who consider digital (health) care solutions as a remedy for reducing the burden of care and tackling the care crisis, should take into consideration that a large proportion of people involved in informal care are offline. To address this issue, it is necessary to design digital (health) care solutions that take into account both the specific characteristics of older adults who may not have access or skills to use technology. To tailor digital services to specific target groups, developers of care-related technologies might learn about improving usability, for example for users with different kinds of impairments.

[5] Scholars are working on new theoretical foundations for studying technology adoption among the heterogenous group of older people. For example Neves and Mead (2021) use the concept of affordances, to “show how adoption of a new communication technology is shaped by its design, learning contexts and surrounding social actors [, contributing] to novel sociological understandings of technology adoption that are critical for digital inequality research“ (2021, p. 888).

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Appendix

Logistic regression on the probability of having no or bad computer skills.

Dependent variable: Having no or bad computer skills (self-assessment). (Question: *"How would you rate your computer skills?"* Answer options: excellent/ very good/ good/ fair/ bad/ I never used a computer).[6]

Table A1. *Results of logistic regressions on the probability of having no or bad computer skills.*

	Caregivers	**Care Receivers**
	AME (s.e.)	**AME (s.e.)**
Male	-0.024***	-0.015*
	(0.007)	(0.007)
(Ref.: Age 50-60)	0.000	0.000
	(0.000)	(0.000)
Age 61-70	0.092***	0.117***
	(0.010)	(0.015)
Age 71-80	0.244***	0.258***
	(0.012)	(0.015)
Age 81+	0.415***	0.354***
	(0.015)	(0.015)
(Ref.: No/primary education)	0.000	0.000
	(0.000)	(0.000)
Secondary education	-0.210***	-0.149***
	(0.011)	(0.008)
Tertiary education	-0.417***	-0.349***
	(0.013)	(0.013)
Making ends meet (fairly) easily	-0.078***	-0.041***
	(0.007)	(0.007)
Active on labour market	-0.100***	-0.088***
	(0.010)	(0.014)
Cognitive health impairment	0.142***	0.115***
	(0.013)	(0.008)
Vision impairment	0.079***	0.052***
	(0.015)	(0.011)
Fine motor skills impairment	0.014	0.002
	(0.017)	(0.010)
Cohabitation with partner	-0.006	-0.019*
	(0.008)	(0.007)
Having child(ren)	-0.021	-0.028*
	(0.012)	(0.012)
Rural area of living	0.062***	0.048***
	(0.007)	(0.007)
Nursing home resident		-0.035
		(0.033)
Observations	14,589	12,280
Pseudo-R^2	0.29	0.36

Note. AME=average marginal effects; s.e.=standard errors (robust). Controlling for year, country (not shown). * p<0.05; * p<0.01; *** p<0.001. Data: SHARE w5,6,7,8_rel8-0-0. Own calculations.

[6] For the documentation of SHARE questionnaires see Questionnaires (share-eric.eu)