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ORIGINAL RESEARCH

Internet use and the Well-Being of the Elders. A Quantitative Study in an Aged Country

Ana Suárez-Álvarez[1] · **María Rosalía Vicente**[1]

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Abstract
In recent years, digital technologies have become an essential part of our lives. At the same time, the well-being of the elderly has raised great concern in developed countries due to the ageing of the population. In this context, our paper seeks to link these two issues by analysing the relationship between digital technologies and the well-being of the elderly, taking into account that the use of the former is endogenous. Such an issue has been little addressed in the literature. For this purpose, we use microdata from the European Social Survey since it includes both measures of individuals' subjective level of well-being and of their use of the internet. We focus on Spain because it is a rapidly aging country, which also has the highest life expectancy in the European Union. Our main findings show that using internet daily is negatively associated with individuals' happiness, but we observe a positive relationship between internet use and their social life. Additionally, these associations are enhanced for individuals aged over 60 years.

Keywords Ageing · Digital divide · Well-being · Internet · Digital transition · Elders

1 Introduction

Since mid-90 s with the Bangemann report (European Commission, 1994), the widespread diffusion of information and communication technologies (ICT) has been a keystone of the European development strategy. Nowadays the focus is on the integration of digital technologies on individuals' lives so that they can make the most of them and, ultimately, societal well-being is improved. In this sense, the recent European declaration on digital rights and principles for the digital decade highlights that "people are at the centre of the digital transformation (…). Technology should serve and benefit all Europeans and empower them". This digital transformation should leave "nobody behind. It should notably include elderly people, persons with disabilities, or marginalised, vulnerable …" (European Commission, 2022b, pp.2–3).

As regards the elderly, achieving such goal faces at least two major challenges. The first challenge refers to the bridge of the so-called "grey" or "age-related" digital divide

✉ Ana Suárez-Álvarez
suarezaana@uniovi.es

[1] Applied Economics, University of Oviedo, Oviedo, Spain

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(Millward, 2003). Though the rates of use of digital technologies have generally increased across all groups of population, the elderly still lag behind (Francis et al., 2019; Halmdienst et al., 2019; Huxhold et al., 2020; Rice & Katz, 2003; Tirado-Morueta et al., 2021). The second challenge relates to the need of a better understanding of the association of digital technologies with people's well-being, in general, and the elders', in particular (OECD, 2019a, 2019b). This is an issue of increasing importance in developed countries due to the sharp ageing of the population and the consequent need to ensure the quality of life of this group of population and the cares provided (Eurostat, 2019; OECD, 2013). Despite the potential of some digital solutions "to increase the well-being of millions of citizens" (European Commission, 2018a), empirical evidence shows no conclusive results yet on the links between their use and well-being (Orben et al., 2022).

In this framework, the aim of this paper is to analyse the role played by age both in well-being and internet use as well as their interactions, with special focus on older individuals. We make two main contributions to the literature. First, we treat internet use as an endogenous variable in line with all findings on the digital divide. Most previous studies have considered internet as exogenous when analysing its relationship with well-being. Second, we provide evidence for Spain. We believe that it is interesting to analyse the Spanish population since it is the country with the highest life expectancy in the European Union (EU) (European Commission, 2020b) and, by 2050, will have the first and second largest shares of population aged 60 years and over in Europe and the world, respectively (United Nations, 2017), with an old-age dependency ratio expected to increase more than 30 percentage points by 2070 (European Commission, 2021b; United Nations, 2020). These facts make Spain an interesting case of study as it might allow to anticipate future situations in countries that have not yet reached such high levels of aging.

The remaining of the paper is structured as follows: Sect. 2 presents the literature review, Sect. 3 describes the empirical approach, including data and methods, and Sect. 4 summarises the results. Finally, Sect. 5 concludes.

2 Literature Review

With developed societies becoming more and more "grey", guaranteeing the well-being of the elderly has become a key priority of the European agenda (European Parliament, 2021).

While the old age is generally associated with some deterioration (Lelkes, 2013), medical progress and healthier lifestyles have led to a time like never before when "have so many people enjoyed such long and healthy lives" (European Commission, 2021a, p.10). The literature on ageing and well-being highlights that "ageing affects every aspect of our lives, throughout our lives"(European Commission, 2021a, p.2) and its relevance could be comparable with major life events such as becoming unemployed or disabled (López-Ulloa et al., 2013; Lucas & Donnellan, 2007).

The relationship between age and well-being has been extensively studied, with research finding that there is a U-shaped relationship between happiness and well-being (Blanchflower, 2021; Blanchflower & Oswald, 2008; Blanchflower et al., 2023; Gwozdz & Sousa-Poza, 2010; López-Ulloa et al., 2013), whilst other research contests this U-shape pattern (Bartram, 2021, 2024; Bittmann, 2021; Glenn, 2009; Hellevik, 2017; Kratz & Brüderl, 2021; Morgan & O'Connor, 2017). In fact, Bartram (2024) shows that happiness decreases with age with recent data from the European Social Survey (ESS).

Along with this, several efforts have been devoted to unveiling the potential of ICT to support the well-being of elders (European Commission, 2018a, 2018b, 2020a; European Innovation Partnership on Active & Healthy Ageing, 2021). Much of this potential focuses on health care solutions to promote healthy active ageing. As the European Commission, (2018a) indicates: "Europe's health and care systems face serious challenges. These are ageing, multi-morbidity (…). Digital solutions for health and care can increase the well-being of millions of citizens and radically change the way health and care services are delivered to patients".

Moreover, latest digital developments may facilitate the access to information by the elderly and enhance their communication and social participation – boosting their social capital and thus avoiding social isolation-, all of which ultimately contribute to higher well-being (Castellacci & Tveito, 2018; European Commission, 2021a; Ma et al., 2021; Nakagomi et al., 2022; OECD, 2019a). Nonetheless, the realisation of these benefits faces some threats (European Council, 2020; OECD, 2019b). Of special concern is the so-called "grey digital divide" (Millward, 2003), that is, the systematic lag of elderly people in the use of ICT, compared to the rest of the population. Even though the divide in access is less wide than before, there is still a gap in use, with the elders showing lower levels of ICT usage, which is related to the lack of digital skills and the rapid evolution of technology (not always designed in an accessible way) in addition to socio-economic features ((Boni) Li & Perkins, 2007; Francis et al., 2019; Halmdienst et al., 2019; Huxhold et al., 2020; Loos & Ivan, 2022; Lucendo-Monedero et al., 2019; OECD, 2021; Rice & Katz, 2003; van Dijk, 2020; Vicente, 2022; Watts, 2020).

Moreover, as Kraut et al. (1998) early stated, the internet might have some negative effects on people's well-being to the extent that they substituted offline activities (that usually required some socialization) for the internet which allowed to do them alone at home, fostering individuals' isolation.[1] However, the available empirical evidence is not conclusive either for the population in general or the eldest in particular. Kraut et al. (1998) showed that, at that time, the internet had a negative effect on individuals' well-being. A couple of years later, these same authors observed that most of this negative effect had faded (Kraut et al., 2002). Nonetheless, both works focused on teenagers.

Later studies have reported various results as regards the link between the use of the internet and well-being (Aggarwal et al., 2020; Ali et al., 2020; Beneito-Montagut et al., 2018; Castellacci & Tveito, 2018; Gaia et al., 2021; Hasan & Linger, 2016; Johannes et al., 2022; Kavetsos & Koutroumpis, 2011; Lelkes, 2013; Lifshitz et al., 2018; Lohmann, 2015; Lu & Kandilov, 2021; McDool et al., 2021; Nie et al., 2017; Orben et al., 2022; Pénard et al., 2013; Schmiedeberg & Schröder, 2017; Sen et al., 2022; Stockwell et al., 2021; Szabo et al., 2019). For instance, among three of the most recent studies, two of them report no statistically significant association between the use of digital technologies and individuals' well-being (Johannes et al., 2022; Orben et al., 2022), whilst a third finds that such usage would be positive for the elderly as it would contribute to lower their feelings about isolation (Sen et al., 2022). Such discrepancies in results might be explained by diverse reasons. In the first place, different measures of ICT are analysed: in some cases, the focus is on the general use of the internet in general, in others either on the utilization of particular services and applications (e.g. online social media) or the ownership of devices (e.g. smartphones). In the second place, several measures of well-being are

[1] Other negative effects are related to the development of some addictive behaviours (OECD, 2019a, 2019b); however, this has been observed for other groups of population and not particularly among the elderly.

studied: happiness, life satisfaction, mental health, social participation and quality of life, among others. In the third place, various populations and groups are considered: hence, there are works which focus on the general population and accordingly take representative random samples in order to unveil the links in the triplet age-internet-well-being; whereas, some studies pay attention exclusively to the eldest group and consider convenience samples to do some qualitative research (e.g. groups discussion) or, on the contrary, try to take random representative samples of this particular group of population to accomplish quantitative research that allow for making inferences.

Overall, some major limitation of much of the previous empirical research is that the use of technologies is mainly considered as exogenous. Taking internet use as exogenous disagrees with the rich empirical evidence from the literature on the digital divide which has shown that the use of ICT is largely shaped by individuals' sociodemographic background (Helsper, 2021). Nonetheless, there are some recent exceptions that properly address the endogenous nature of digital usage (Ali et al., 2020; Lu & Kandilov, 2021; Suárez Álvarez & Vicente, 2023; Zheng et al., 2023, among others).Against this background, the present paper aims to shed some light on the association between internet use and the level of well-being of elders, taking into account the endogenous nature of internet use and several measures of well-being. We seek to answer the following research questions (RQ): **RQ1:** Is internet use related to the well-being of individuals? And **RQ2:** How does individuals' age influence the relationship between internet use and well-being?

3 Empirical Approach

3.1 Data and Descriptive Analysis

Microdata from the European Social Survey (ESS) will be used. The ESS is the most appropriate database to fulfil the goals of this paper since it includes three essential pieces of information for our analysis: (1) measures of individuals' subjective level of well-being (SWB), (2) measures of their use of the internet, and (3) sociodemographic information.[2] Data from Rounds 8 and 9 (2016 and 2018, respectively) will be used. We focus on these rounds because they refer to periods of extensive diffusion of the internet. Pooling these data, we get a sample of 3,614 individuals.

Two different types of subjective well-being variables are considered. We include two variables about individuals' happiness and life satisfaction, *Happy* and *Satflife*, both in a scale 0–10 that measures how happy/satisfied with life individuals are, from 0, extremely unhappy/dissatisfied to 10, extremely happy/satisfied. Additionally, we include three variables to measure individuals' social life: *Meetings* in a scale 1–7 which measures how often the respondent meet with friends, relatives or colleagues from 1, never to 7, every day, *Discuss* in a scale 0–6 which considers the number of people the respondent can discuss with intimate and personal matters, from 0, none to 6, at least 10 persons; and finally, *Sactiv* in a scale 1–5 measures individuals' participation in social activities compared to others of the same age from 1, much less to 5, much more.

[2] While the Spanish National Statistical Office publishes the annual Survey on equipment and use of ICTs in households, with detailed information on ICT usage, this survey does not include any data of individuals' well-being, and hence it does not serve to the purpose of this paper. Neither merge it with other surveys containing measures of well-being is a feasible option.

Table 1 Mean test of SWB variables by frequency of internet use

	Daily internet	No daily internet	Sig. Difference
Happy	7.83	7.47	***
Satflife	7.45	7.17	***
Meetings	5.33	5.06	***
Discuss	3.21	2.72	***
Sactiv	2.59	2.74	***

*** $p<0.01$, ** $p<0.05$, * $p<0.1$. The measurement scales are for: Happy and Satlife 0–10 scale; Meetings 1–7; Discuss 0–6; Sactiv 1–5

As internet variables, we include a dichotomous variable to measure the frequency of use, *Daily internet* which takes value 1 if the individual use internet daily or mostly daily. Taking into account the literature on ICT diffusion and the digital divide, this variable will be considered endogenous. Additionally, we include the average maximum internet speed at regional level (NUTS[3] 2 regions); unlike the previous variable this one might be considered exogenous and will be used as instrument in our models. Data on speed are sourced from Fundación Telefónica (2019).

We also incorporate sociodemographic and socio-economic variables. Regarding age, we consider individuals' age as a (quantitative) variable and also build a dummy variable for those individuals over 60 years old. Likewise, we include a series of dummy variables to control for other socio-economic and sociodemographic characteristics: gender (= 1, female), employment situation (= 1, employed individuals at the time of the interview), family (= 1, living with a partner), bad health (= 1, individuals who report having bad or very bad health status) and hampered status (1 =, if the person reports being hampered in daily activities by several reasons including illness, disability, infirmity or mental health problem-). We also control for the type of area where the person lives through the categorical variable, *domicile*, which distinguishes five types of areas: 1, a big city; 2, suburbs or outskirts of big city; 3, town or small city; 4, country village; and 5, farm or home in countryside. From this variable, we also build the dummy *rural* which takes value 1 when the person lives in a country village or in the countryside. To measure income, two types of variables are considered; an objective variable, i*ncome*, with three categories: 1, individuals' income below the 5th decile; 2, income above the 5th decile; and 3, don't know/ don't answer; and a subjective one, *hincfel,* which takes into account individuals' feelings about their household income in four categories: 1, living comfortably on present income; 2, coping on present income; 3, difficult on present income; 4, very difficult on present income and. We also include a variable of educational levels according to the categories of the International Standard Classification of Education (ISCED)[4] and control for the ESS Round.

Tables 1 and 2 provide the results of the mean differences test for the SWB variables by frequency of internet use and age, respectively. Figure 1 shows the share of

[3] NUTS refers to the Nomenclature of Territorial Units for Statistics, and in particular to its French version Nomenclature des Unités Territoriales Statistiques. This is a hierarchical system for dividing up the economic territory of the European Union. In the case of Spain, there are 19 NUTS 2, that correspond to the 17 Autonomous Communities and the 2 Autonomous Cities (Ceuta and Melilla).

[4] The ESS data distinguish 7 levels of education: 1, less than lower secondary; 2, lower secondary; 3, lower tier upper secondary; 4, upper tier upper secondary; 5, advanced vocational, sub-degree; 6, lower tertiary education, i.e., Bachelor's or equivalent level; 7, higher tertiary education, i.e., Master's, Doctoral or equivalent levels.

Table 2 Mean test of SWB variables by age

	Over 60 years	Below 60	Sig. difference
Happy	7.49	7.80	***
Satflife	7.35	7.36	No
Meetings	5.15	5.28	**
Discuss	2.87	3.13	***
Sactiv	2.59	2.74	***

See notes below Table 1

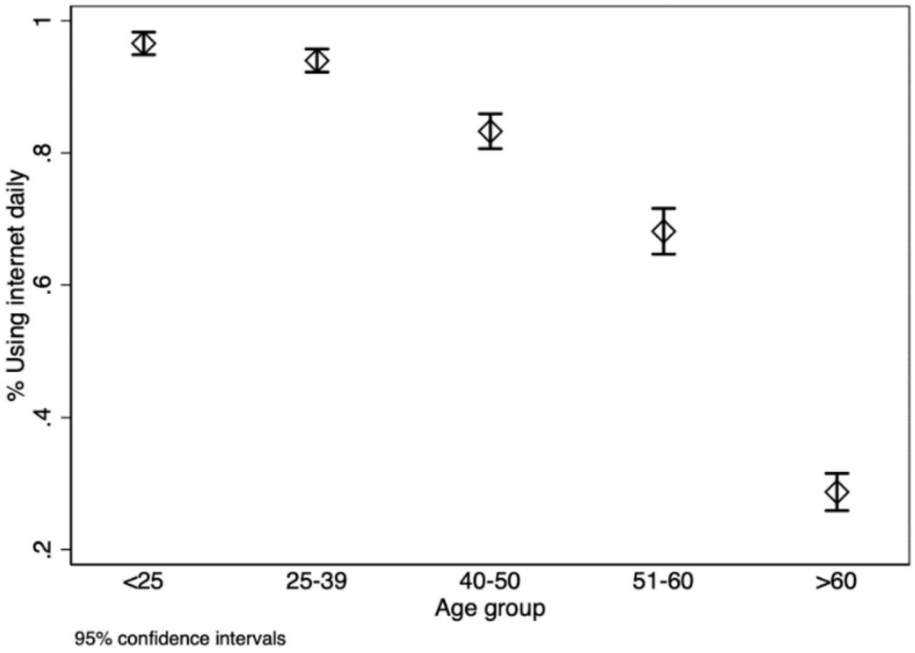

Fig. 1 Share of individuals using internet daily by age group

individuals who use internet daily by age group. These figures indicate that, in general, levels of SWB significantly differ in relation to the frequency of internet use and age.

It can be observed that mean levels of SWB are higher when the internet is used daily (Daily internet = 1) (Table 1) and for individuals aged below 60 years (Table 2).

Similarly, it is important to note that the share of individuals using internet on a daily basis significantly decreases with age, as shown in Fig. 1. Finally, Table 3 reveals that the average level of SWB is in general significantly higher for those individuals aged over 60 years who use internet daily, compared to those of the same age who do not use it.

Table 3 Mean test of SWB variables for individuals over 60 years by frequency of internet use

	>60 & daily internet	>60 & No daily internet	Sig. Difference
Happy	7.76	7.39	***
Satflife	7.51	7.29	No
Meetings	5.21	5.12	No
Discuss	3.30	2.70	***
Sactiv	3.00	2.42	***

See notes below Table 1

3.2 Data Analysis

From ESS Rounds 8 and 9, we will specify and estimate econometric models that relate individuals' subjective level of well-being with their use of the internet. They will be built upon existing subjective well-being models which consider the importance of personal, family, and job-related characteristics and economic context variables (Akay et al., 2017; de Pedraza & Vicente, 2021; de Pedraza et al., 2020; Tella et al., 2001).

Given the endogenous nature of the use of internet, our modelling will be based on an instrumental variables two-equation model. The first equation focuses on explaining whether an individual uses the internet daily or not and includes, as explanatory variables, the main sociodemographic features that the literature of the digital divide has found to significantly shape the use of the internet (age, gender, employment situation, income, location). The variable Speed will be also included as an instrument variable. The assumption is that the speed of the internet connection is correlated with internet use but not with an individual's level of well-being; in other words, speed will not exert any effect on well-being apart from that through internet use. The second equation focuses on identifying the variables that shape the level of well-being of an individual. Since we consider five measures of well-being, we will have to estimate five pairs of equations.[5] To properly isolate the association between the internet and well-being, we incorporate as controls the previously described socio-economic and sociodemographic variables. Moreover, we include interaction terms between our group of interest, i.e., the eldest and internet use to study any differential outcomes on the well-being of this group. Some other interaction terms (between internet use and women and individuals with disabilities) are included as controls.

4 Results

Table 4 shows the results of the regressions performed for our two-equations models: the first equations on internet use and the second equations on the five related variables on well-being. We note that most of the regressors included in the two -equations models are found to be statistically significant.

Specifically, we find that the use of the internet daily is negative and statistical and significantly related to age and rural areas. A negative relationship is also observed for individuals that did not report their income. In contrast, daily internet use is positive and

[5] Estimations have been run by means of the Stata command cmp (Roodman, 2011) through the maximum likelihood method. All SWB variables have been treated as continuous variables. Alternatively, they could have been treated as ordered categorical variables. In any case, estimates show similar results.

is statistically significantly related to being employed, individuals' educational level and income and the average speed of the connection in the region where they live. Besides, the control variable for the round of the ESS (Round 9) shows a positive sign.[6]

As regards the well-being equations, the variable of internet use is found to be statistically significant in three out of the five dimensions considered. In particular, it is statistically significant with a negative coefficient on the happiness equation, and positive and statistically significant on the equations related to people's levels of social participation and the number of people with whom they can discuss, whereas it is not statistically significant neither on the life satisfaction nor the meetings equations.

The sociodemographic and socio-economic controls included in the well-being equations are mostly found to be statistically significant. Hence, the variables about age, having a bad health status, being hampered and feelings of insufficient income shows some negative and statistically significant coefficients. In contrast, the age dummy for the 60 + age group and location categories related to rural areas are positive and statistically significant. Nonetheless, the significance of the interaction terms included between some of these variables and daily internet use moderate some of these relationships.

5 Discussion of Results

Our estimates confirm that, despite the increase of internet usage over the period of analysis, the main dimensions of the digital divide still persist, those being, the grey or age gap, the income, the rural versus urban as well as the educational and employment related gaps. Hence, results suggest that the higher the age the lower the likelihood of using the internet. Similarly, people living in rural areas are less likely to use the internet daily than those in more urban environments. This urban–rural gap matters even once we control for internet speed; in fact, people living in areas with higher levels of internet speed are more likely to use the internet daily compared to individuals in areas where speed is poor. In contrast, people having a job, a high level of education and getting some income over the 5th decile are more likely to use the internet daily.

Concerning the association of the internet with the different variables of subjective well-being, the first thing to note is that outcomes depend on the type of the well-being measure. In this sense, we can distinguish two different outcomes: the link with individuals' happiness and life satisfaction and that with individuals' social life. On the one hand, daily users of the internet appear to report lower levels of happiness compared to those who do not use it, while no difference (between these two groups of population) seems to arise in terms of life satisfaction. On the other hand, internet daily users report higher levels of social life variables than non-users.

[6] Initial estimates had included the variable Female in the first equation. However, gender was found not to be statistically significant in several specifications. That is the reason why we decided to drop it from the final estimations and does not appear on Table 4.

Table 4 Coefficient estimates

	(1)		(2)		(3)		(4)		(5)	
VARIABLES	Daily internet	Satflife	Daily internet	Happy	Daily internet	Meetings	Daily internet	Discuss	Daily internet	Sactiv
Daily internet		− 0.3241		− 0.4109**		− 0.0183		0.5244***		0.2760**
Age	− 0.0468***	− 0.0113***	− 0.0468***	− 0.0153***	− 0.0468***	− 0.0157***	− 0.0465***	0.0035	− 0.0466***	− 0.0037**
Age > 60		0.6179***		0.2293*		0.4680***		− 0.0067		0.1789**
Age > 60*Daily internet		− 0.3134*		0.0778		− 0.1509		0.1499		0.2175***
Hampered		− 0.5567***		− 0.3819***		− 0.2935***		0.0802		− 0.3086***
Hampered*daily internet		0.2885		0.0093		0.2106		− 0.0966		0.3060***
Living with a partner		0.4477***		0.5783***		− 0.3461***		0.0005		0.0108
Female		0.0715		− 0.1636*		− 0.1150		− 0.1507*		0.0077
Female*daily internet		0.0753		0.3211***		0.0368		0.1914*		0.0005
Bad Health		− 0.5580***		− 0.4982***		− 0.0659		− 0.1868***		− 0.1280***
Employed	0.2000***	0.0981	0.2002***	0.0167	0.2023***	− 0.1712***	0.1976***	0.0371	0.1950***	0.0072
ISCED Level of education	0.2649***		0.2643***		0.2647***		0.2662***		0.2656***	
Income: < 5th decile (reference category)										
Income > 5th decile	0.1646**		0.1691**		0.1663**		0.1760**		0.1768**	
Income: dk/da	− 0.1408**		− 0.1348*		− 0.1223*		− 0.1217*		− 0.1240*	
Hincfel: living comfortably (reference category)										
Hincfel: coping on present income		− 0.4909***		− 0.2715***		− 0.1845***		− 0.2574***		− 0.1177***

Table 4 (continued)

	(1)		(2)		(3)		(4)		(5)	
VARIABLES	Daily internet	Satflife	Daily internet	Happy	Daily internet	Meetings	Daily internet	Discuss	Daily internet	Sactiv
Hincfel: difficult on present income		− 1.0429***		− 0.4921***		− 0.2419***		− 0.4220***		− 0.2589***
Hincfel: very difficult on present income		− 2.1813***		− 1.1597***		− 0.4258***		− 0.6332***		− 0.2850***
Rural	− 0.2368***		− 0.2373***		− 0.2391***		− 0.2302***		− 0.2348***	
Domicile: big city (reference category)										
Domicile: suburbs or outskirts of big city		0.0119		0.0662		0.0778		0.1710*		0.0719
Domicile: town or small city		0.2163**		0.0733		0.2140***		0.1331**		0.0578
Domicile: country village		0.2208***		0.0257		0.2505***		0.0017		0.0649
Domicile: farm or home in countryside		0.2149		− 0.1468		0.1894		0.0819		− 0.0940
Internet speed	0.0265***		0.0258***		0.0251***		0.0258***		0.0234**	
Round 9	0.1382**	0.0718	0.1378**	− 0.0785	0.1382**	0.0277	0.1391**	− 0.0488	0.1365**	− 0.0841***
Constant	1.2694***	8.2164***	1.2876***	8.8208***	1.3069***	6.2687***	1.2543***	2.7824***	1.3461***	2.7933***
Observations	3,613	3,613	3,614	3,614	3,614	3,614	3,613	3,613	3,613	3,613

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

6 Conclusions

The sharply aging of the population in developed countries has gone along with the increasing digitalization of daily lives, a process in which the elder population are lagging behind. Digital technologies are seen as an opportunity for raising societal well-being but there also some threats and challenges. Moreover, empirical evidence is not clear about the association between the two, that is, whether is positive or negative, or there is a mix of positive and negative effects that lead to some non-significant outcomes.

This paper has tried to contribute to this debate by linking the analysis on individuals' well-being with the empirical evidence provided by the literature on the digital divide, which poses that ICT usage is clearly shaped by people's socio-economic and demographic features.

As concerns our first research question, results show that, once controlled for the endogenous nature of internet use, its relationship with the well-being of individuals depends on the type of well-being measure. In this sense, we find that using the internet on a daily basis is negatively associated with individuals' happiness and life satisfaction but positively related with their social life.

To address our second research question, which focuses on how the use of the internet and the well-being of the elders are related, we have included in our analysis an interaction term between a dummy variable which considers individuals aged over 60 years and daily internet usage. The inclusion of this term allows us to see that the associations described above -between the use of the internet and well-being- become stronger for the elderly. These results suggest that on the old age, individuals who use internet daily are less happy and satisfied with life than those who do not use it. On the contrary, the elders who use the internet find themselves to have more social life compared to others of the same age. Such a positive association is also observed for people hampered. These results are in line with all the literature that claims that the internet may play an important role in preventing loneliness and improving communication and social participation at the old age (Castellacci & Tveito, 2018; European Commission, 2021a; OECD, 2019a; Sen et al., 2022).

Our findings have some implications both for the academia and policy makers. On the one hand, the importance to link the findings of the literature on the digital divide and those on well-being to properly assess the effect that digital technologies might exert on individuals' levels of well-being. This is especially important in the case of elders who suffer from the well-known grey digital divide which, though attenuated over time, has not still disappeared as it happened for other groups of population (e.g., gender). On the other hand, it would be important to consider that the use of digital technologies might have different effects on the different dimensions of well-being. For instance, they might facilitate people's social life but not directly raise their level of well-being in terms of happiness. Then, tailored actions should be designed to achieve gains in specific areas of well-being. Knowing that the old age tends to be accompanied with social isolation, the promotion of ICT-related measures towards overcoming this particular problem might be more effective and easier to evaluate than stating a general goal of raising well-being.

7 Limitations of the Study

There are some considerations to take in our analysis. First, we are identifying just associations, and no causality claims can be made about the use of the internet and elder's well-being. In the particular case of the positive link between internet use and social

participation, there could be some double causality. In this sense, not only would using the internet daily lead to a greater social life, but having a more intense social life *per se* could lead to individuals using the internet more. Second, we analyse the use of the internet in general, however specific services and applications might show different associations with well-being. Unluckily, our data do not allow us to address such an issue. Finally, it is important to take into account that all our well-being measures are subjective and the scales of measurement are different. While an individual' self-perceived levels of well-being have some comparative nature (de Pedraza & Vicente, 2021), the question on social participation is the only one that explicitly states that, i.e., how do you perceive yourself compared to others in the same age group. There could be some bias there.

As lines of future research, it would be interesting to carry out longitudinal studies which allow to assess how the use of ICTs varies with age and throughout the lifecycle. In this sense, it would be worthy to assess whether advanced users in previous stages of life, keep on being it in later stages and the role of digital skills throughout all this process.

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Declarations

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References

Aggarwal, B., Xiong, Q., & Schroeder-Butterfill, E. (2020). Impact of the use of the internet on quality of life in older adults: Review of literature. *Primary Health Care Research & Development, 21*, e55. https://doi.org/10.1017/S1463423620000584

Akay, A., Constant, A., Giulietti, C., & Guzi, M. (2017). Ethnic diversity and well-being. *Journal of Population Economics, 30*(1), 265–306. https://doi.org/10.1007/s00148-016-0618-8

Ali, M. A., Alam, K., Taylor, B., & Rafiq, S. (2020). Does digital inclusion affect quality of life? Evidence from Australian household panel data. *Telematics and Informatics*, *51*. https://doi.org/10.1016/j.tele.2020.101405

Bartram, D. (2021). Age and Life Satisfaction: Getting Control Variables under Control. *Sociology, 55*(2), 421–437. https://doi.org/10.1177/0038038520926871

Bartram, D. (2024). To evaluate the age–happiness relationship, look beyond statistical significance. *Journal of Happiness Studies*, *25*. https://doi.org/10.1007/s10902-024-00728-9

Beneito-Montagut, R., Cassián-Yde, N., & Begueria, A. (2018). What do we know about the relationship between internet-mediated interaction and social isolation and loneliness in later life? *Quality in Ageing and Older Adults, 19*(1), 14–30. https://doi.org/10.1108/QAOA-03-2017-0008

Bittmann, F. (2021). Beyond the U-Shape: Mapping the functional form between age and life satisfaction for 81 countries utilizing a cluster procedure. *Journal of Happiness Studies, 22*(5), 2343–2359. https://doi.org/10.1007/s10902-020-00316-7

Blanchflower, D. G. (2021). Is happiness U-shaped everywhere? Age and subjective well-being in 145 countries. *Journal of Population Economics, 34*(2), 575–624. https://doi.org/10.1007/s00148-020-00797-z

Blanchflower, D. G., Graham, C., & Piper, A. (2023). Happiness and age: Resolving the debate. *National Institute Economic Review, 263*, 76–93. https://doi.org/10.1017/nie.2023.1

Blanchflower, D. G., & Oswald, A. J. (2008). Is well-being U-shaped over the life cycle? *Social Science & Medicine, 66*(8), 1733–1749. https://doi.org/10.1016/J.SOCSCIMED.2008.01.030

Castellacci, F., & Tveito, V. (2018). Internet use and well-being: A survey and a theoretical framework. *Research Policy, 47*(1), 308–325. https://doi.org/10.1016/j.respol.2017.11.007

de Pedraza, P., Guzi, M., & Tijdens, K. (2020). Life satisfaction of employees, labour market tightness and matching efficiency. *International Journal of Manpower, 42*, 341–355. https://doi.org/10.1108/IJM-07-2019-0323

de Pedraza, P., & Vicente, M. R. (2021). Are Spaniards happier when the bars are open? Using life satisfaction to evaluate COVID-19 non-pharmaceutical interventions (NPIs). *International Journal of Environmental Research and Public Health, 18*(19), 10056. https://doi.org/10.3390/ijerph181910056

di Tella, R., Macculloch, R. J., & Oswald, A. J. (2001). Preferences over inflation and unemployment: Evidence from surveys of happiness. *American Economic Review, 91*(1), 335–341.

European Commission. (1994). *Europe and the Global Information Society: recommendations to the European Council: Conference G7 - Raport BANGEMANN*. https://op.europa.eu/es/publication-detail/-/publication/44dad16a-937d-4cb3-be07-0022197d9459/language-en

European Commission. (2018a). *Communication on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society*. https://ec.europa.eu/info/publications/economy-finance/joint-report-health-care-and-long-

European Commission. (2018b). *The Silver Economy: final report.* https://op.europa.eu/en/publication-detail/-/publication/a9efa929-3ec7-11e8-b5fe-01aa75ed71a1/language-en

European Commission. (2020b). *The impact of demographic change*. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1056

European Commission. (2020a). *AAL Programme: Supporting older adults before, during and after COVID-19 crisis*. https://digital-strategy.ec.europa.eu/en/news/aal-programme-supporting-older-adults-during-and-after-covid-19-crisis

European Commission. (2021a). *Green Paper on Ageing. Fostering solidarity and responsibility between generations*. https://ec.europa.eu/commission/priorities/deeper-and-fairer-economic-and-monetary-union/european-pillar-

European Commission. (2021b). *The 2021 Ageing Report*. https://ec.europa.eu/info/sites/default/files/economy-finance/ip148_en.pdf

European Commission. (2022). *European Declaration on Digital Rights and Principles for the Digital Decade*. https://digital-strategy.ec.europa.eu/en/library/declaration-european-digital-rights-and-principles

European Council. (2020). *Council conclusions on human rights, participation and well-being of older persons in the era of digitalisation*. https://data.consilium.europa.eu/doc/document/ST-11717-2020-REV-2/en/pdf

European Innovation Partnership on Active and Healthy Ageing. (2021). *Blueprint digital transformation of health and care for the ageing society*. https://digital-strategy.ec.europa.eu/en/library/blueprint-digital-transformation-health-and-care-ageing-society

Eurostat. (2019). Ageing Europe. *Looking at the Lives of Older People in the EU*. https://doi.org/10.2785/26745

Francis, J., Ball, C., Kadylak, T., & Cotten, S. R. (2019). Aging in the Digital Age: Conceptualizing Technology Adoption and Digital Inequalities. *Ageing and Digital Technology*. https://doi.org/10.1007/978-981-13-3693-5_3

Fundación Telefónica. (2019). *Sociedad Digital en España 2018*. https://www.fundaciontelefonica.com/cultura-digital/publicaciones/sociedad-digital-en-espana-2018/655/

Gaia, A., Sala, E., & Cerati, G. (2021). Social networking sites use and life satisfaction. A quantitative study on older people living in Europe. *European Societies, 23*(1), 98–118. https://doi.org/10.1080/14616696.2020.1762910

Glenn, N. (2009). Is the apparent U-shape of well-being over the life course a result of inappropriate use of control variables. A commentary on Blanchflower and Oswald (66: 8, 2008, 1733–1749). *Social Science and Medicine, 69*(4), 481–485. https://doi.org/10.1016/j.socscimed.2009.05.038

Gwozdz, W., & Sousa-Poza, A. (2010). Ageing, health and life satisfaction of the oldest old: An analysis for Germany. *Social Indicators Research, 97*(3), 397–417. https://doi.org/10.1007/s11205-009-9508-8

Halmdienst, N., Radhuber, M., & Winter-Ebmer, R. (2019). Attitudes of elderly Austrians towards new technologies: Communication and entertainment versus health and support use. *European Journal of Ageing, 16*(4), 513–523. https://doi.org/10.1007/s10433-019-00508-y

Hasan, H., & Linger, H. (2016). Enhancing the wellbeing of the elderly: Social use of digital technologies in aged care. *Educational Gerontology, 42*(11), 749–757. https://doi.org/10.1080/03601277.2016.1205425

Hellevik, O. (2017). The U-shaped age–happiness relationship: Real or methodological artifact? *Quality and Quantity, 51*(1), 177–197. https://doi.org/10.1007/s11135-015-0300-3

Helsper, E. (2021). *The digital disconnect: The social causes and consequences of digital inequalities*. SAGE Publications Ltd. https://doi.org/10.4135/9781526492982

Huxhold, O., Hees, E., & Webster, N. J. (2020). Towards bridging the grey digital divide: Changes in internet access and its predictors from 2002 to 2014 in Germany. *European Journal of Ageing, 17*(3), 271–280. https://doi.org/10.1007/s10433-020-00552-z

Johannes, N., Dienlin, T., Bakhshi, H., & Przybylski, A. K. (2022). No effect of different types of media on well-being. *Scientific Reports, 12*(1), 61. https://doi.org/10.1038/s41598-021-03218-7

Kavetsos, G., & Koutroumpis, P. (2011). Technological affluence and subjective well-being. *Journal of Economic Psychology, 32*(5), 742–753. https://doi.org/10.1016/j.joep.2011.05.004

Kratz, F., & Brüderl, J. (2021). The Age Trajectory of Happiness: How Lack of Causal Reasoning has Produced the Myth of a U-Shaped Age-Happiness Trajectory. *PsyArXiv*. https://doi.org/10.31234/osf.io/d8f2z

Kraut, R., Kiesler, S., Boneva, B., Cummings, J., Helgeson, V., & Crawford, A. (2002). Internet Paradox Revisited. *Journal of Social Issues, 58*(1), 49–74. https://doi.org/10.1111/1540-4560.00248

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., & Scherlis, W. (1998). Internet paradox. A social technology that reduces social involvement and psychological well-being? *The American Psychologist, 53*(9), 1017–1031.

Lelkes, O. (2013). Happier and less isolated: Internet use in old age. *Journal of Poverty and Social Justice, 21*(1), 33–46. https://doi.org/10.1332/175982713X664047

Li, Y. B., & Perkins, A. (2007). The impact of technological developments on the daily life of the elderly. *Technology in Society., 29*(3), 361–368. https://doi.org/10.1016/J.TECHSOC.2007.04.004

Lifshitz, R., Nimrod, G., & Bachner, Y. G. (2018). Internet use and well-being in later life: A functional approach. *Aging & Mental Health, 22*(1), 85–91. https://doi.org/10.1080/13607863.2016.1232370

Lohmann, S. (2015). Information technologies and subjective well-being: Does the Internet raise material aspirations? *Oxford Economic Papers, 67*(3), 740–759. https://doi.org/10.1093/oep/gpv032

Loos, E., & Ivan, L. (2022). Not only people are getting old, the new media are too: Technology generations and the changes in new media use. *New Media & Society*, *26*(6). https://doi.org/10.1177/14614448221101783

López-Ulloa, B. F., Møller, V., & Sousa-Poza, A. (2013). How does subjective well-being evolve with age? A literature review. *Population Ageing, 6*, 227–246. https://doi.org/10.1007/s12062-013-9085-0

Lu, H., & Kandilov, I. T. (2021). Does mobile internet use affect the subjective well-being of older Chinese adults? An instrumental variable quantile analysis. *Journal of Happiness Studies, 22*(7), 3137–3156. https://doi.org/10.1007/s10902-021-00365-6

Lucas, R. E., & Donnellan, M. B. (2007). How stable is happiness? Using the STARTS model to estimate the stability of life satisfaction. *Journal of Research in Personality, 41*(5), 1091–1098. https://doi.org/10.1016/J.JRP.2006.11.005

Lucendo-Monedero, A. L., Ruiz-Rodríguez, F., & González-Relaño, R. (2019). Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe. *Telematics and Informatics, 41*, 197–217. https://doi.org/10.1016/J.TELE.2019.05.002

Ma, X., Zhang, X., Guo, X., Lai, K., & Vogel, D. (2021). Examining the role of ICT usage in loneliness perception and mental health of the elderly in China. *Technology in Society, 67*, 101718. https://doi.org/10.1016/J.TECHSOC.2021.101718

McDool, E., Powell, P., Roberts, J., & Taylor, K. B. (2021). Social media use and children's wellbeing. *SSRN Electronic Journal*. https://doi.org/10.2139/SSRN.2886783

Millward, P. (2003). The "grey digital divide": Perception, exclusion and barriers of access to the Internet for older people. *First Monday*. https://doi.org/10.5210/FM.V8I7.1066

Morgan, R., & O'Connor, K. J. (2017). Experienced life cycle satisfaction in Europe. *Review of Behavioral Economics, 4*(4), 371–396. https://doi.org/10.1561/105.00000070

Nakagomi, A., Shiba, K., Kawachi, I., Ide, K., Nagamine, Y., Kondo, N., Hanazato, M., & Kondo, K. (2022). Internet use and subsequent health and well-being in older adults: An outcome-wide analysis. *Computers in Human Behavior*, *130*. https://doi.org/10.1016/j.chb.2021.107156

Nie, P., Sousa-Poza, A., & Nimrod, G. (2017). Internet use and subjective well-being in China. *Social Indicators Research, 132*(1), 489–516. https://doi.org/10.1007/s11205-015-1227-8

OECD. (2013). A Good Life in Old Age? *OECD*. https://doi.org/10.1787/9789264194564-en

OECD. (2019a). Going Digital: Shaping Policies, Improving Lives. In *Going Digital: Shaping Policies, Improving Lives*. https://doi.org/10.1787/9789264312012-en

OECD. (2019b). *How's life in the digital age? : opportunities and risks of the digital transformation for people's well-being*. https://doi.org/10.1787/9789264311800-en

OECD. (2021). *Addressing Digital Gender Divides - OECD Ministerial Council Meeting*. https://www.oecd.org/digital/agenda-addressing-digital-gender-divides.pdf

Orben, A., Przybylski, A. K., Blakemore, S. J., & Kievit, R. A. (2022). Windows of developmental sensitivity to social media. *Nature Communications*, *13*, 1649. https://doi.org/10.1038/s41467-022-29296-3

European Parliament. (2021). *Old continent growing older - possibilities and challenges related to ageing policy post 2020*. https://www.europarl.europa.eu/doceo/document/A-9-2021-0194_EN.html

Pénard, T., Poussing, N., & Suire, R. (2013). Does the Internet make people happier? *The Journal of Socio-Economics, 46*, 105–116. https://doi.org/10.1016/J.SOCEC.2013.08.004

Rice, R. E., & Katz, J. E. (2003). Comparing internet and mobile phone usage: Digital divides of usage, adoption, and dropouts. *Telecommunications Policy, 27*(8–9), 597–623. https://doi.org/10.1016/S0308-5961(03)00068-5

Roodman, D. (2011). Fitting fully observed recursive mixed-process models with cmp. *The Stata Journal, 11*(2), 159–206.

Schmiedeberg, C., & Schröder, J. (2017). Leisure activities and life satisfaction: An analysis with German panel data. *Applied Research in Quality of Life, 12*(1), 137–151. https://doi.org/10.1007/s11482-016-9458-7

Sen, K., Prybutok, G., & Prybutok, V. (2022). The use of digital technology for social wellbeing reduces social isolation in older adults: A systematic review. *SSM - Population Health, 17*, 101020. https://doi.org/10.1016/J.SSMPH.2021.101020

Stockwell, S., Stubbs, B., Jackson, S. E., Fisher, A., Yang, L., & Smith, L. (2021). Internet use, social isolation and loneliness in older adults. *Ageing and Society, 41*(12), 2723–2746. https://doi.org/10.1017/S0144686X20000550

Suárez Álvarez, A., & Vicente, M. R. (2023). Going "beyond the GDP" in the digital economy: Exploring the relationship between internet use and well-being in Spain. *Humanities and Social Sciences Communications, 10*(1), 582. https://doi.org/10.1057/s41599-023-02110-1

Szabo, A., Allen, J., Stephens, C., & Alpass, F. (2019). Longitudinal analysis of the relationship between purposes of internet use and well-being among older adults. *The Gerontologist, 59*(1), 58–68. https://doi.org/10.1093/geront/gny036

Tirado-Morueta, R., Rodríguez-Martín, A., Álvarez-Arregui, E., Ortíz-Sobrino, M. Á., & Aguaded-Gómez, J. I. (2021). Understanding internet appropriation among older people through institutional supports in Spain. *Technology in Society, 64*, 101505. https://doi.org/10.1016/J.TECHSOC.2020.101505

United Nations. (2017). *World Population Ageing 2017 highlights*. https://www.un.org/en/development/desa/population/theme/ageing/WPA2017.asp

United Nations. (2020). *World Population Ageing 2020 Highlights*. https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Sep/un_pop_2020_pf_ageing_10_key_messages.pdf

van Dijk, J. (2020). *The digital divide*. Wiley.

Vicente, M. R. (2022). ICT for healthy and active aging: The elderly as first and last movers. *Telecommunications Policy*, *46*(3). https://doi.org/10.1016/j.telpol.2021.102262

Watts, G. (2020). COVID-19 and the digital divide in the UK. *The Lancet. Digital Health, 2*(8), e395–e396. https://doi.org/10.1016/S2589-7500(20)30169-2

Zheng, H., Ma, W., Li, J., & Botero, J. (2023). Relationship between internet use and negative affect. *Applied Research in Quality of Life, 18*(4), 1693–1713. https://doi.org/10.1007/s11482-023-10158-z