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ARTICLE

Does internet use worsen old-age loneliness during pandemics? A gendered analysis of the SHARE data

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Abstract

Despite internet use potentially reducing loneliness among older adults during the Covid-19 pandemic, quantitative research in this area is limited. Our study addresses this gap by exploring how internet use affects loneliness worsening in old age across Europe from a gendered perspective. We adopt a comprehensive approach, considering individual and contextual factors. Using multi-level modelling, we analyse data from the Survey of Health, Ageing and Retirement in Europe (Wave 8 and Corona Survey 1), supplemented by the Oxford Covid-19 Government Response Tracker and the Eurostat Digital Agenda Scoreboard Key Indicators. The empirical analysis has revealed gender-specific differences in the relationship between internet use and the worsening of loneliness among older people during the pandemic, with internet use contributing to increased loneliness for older women, but not for men. In addition, our study indicates that while the contextual factors, namely the severity of the contingency measures and the quality of the internet connection, are not moderators of the relationship between internet use and loneliness worsening, the stringency index specifically exacerbates loneliness in women. These findings contribute to the development of more effective and targeted interventions to combat loneliness worsening and promote wellbeing among older women, particularly in the context of global health crises such as the Covid-19 pandemic.

Keywords: old-age loneliness; internet use; Covid-19; multi-level modelling; Europe; SHARE

Introduction

To contain the spread of the Covid-19 pandemic, the different European countries implemented a range of containment measures, the so-called social distancing restrictions, aimed at limiting/preventing in-person social contact. Although these measures proved effective in reducing the spread of the infection (Courtemanche *et al.*, 2020,

Ge, Zhang, Liu *et al.,* 2022; Ge, Zhang, Wu *et al.,* 2022; Sharma *et al.,* 2021), they also led to several side effects, as documented in many studies. Specifically, research has shown that Covid-19 and the related containment measures were associated with an increase in loneliness among the older population (*e.g.* Atzendorf and Gruber, 2021; Heidinger and Richter, 2020; Kotwal *et al.,* 2022; Luchetti *et al.,* 2020; Stolz *et al.,* 2021, 2022; van Tilburg *et al.,* 2021).

Loneliness, that is, the subjective feeling of isolation accompanied by the perception of a deficiency in the desired number or quality of social relations (Peplau and Perlman, 1982), is playing a key role in the current public health debate, also because of its detrimental impact on people's mental and physical health. There is solid evidence showing that loneliness is related to an increase in all-cause morbidity and mortality (Barnes *et al.,* 2022; Holt-Lunstad *et al.,* 2010; Luo *et al.,* 2012; Rico-Uribe *et al.,* 2018), especially for the older population. Because of its potential effects on older people's wellbeing and the health-care system in general, it is crucial to understand the conditions that lead to old-age loneliness and to identify the resources that may contribute to alleviating it, especially during pandemics.

In an increasingly digitalized society, the internet offers unprecedented opportunities to keep older people connected and engaged with society, especially when social distancing restrictions are in place: social media (*e.g.* Facebook, WhatsApp) provide additional opportunities for communication with family and friends; internet surfing allows for information search of online activities, boosting socialization; and online gaming is both a 'time killer' and a way of consolidating and establishing (new) relationships (*e.g.* Antonucci *et al.,* 2017, Melis *et al.,* 2021; Reis *et al.,* 2021). Thus, internet use is important for older people's wellbeing, especially for those with reduced mobility (Fang *et al.,* 2018; Nimrod, 2020); it can be one of the resources they employ to combat old-age loneliness. Indeed, there are many studies that have documented the positive impact of internet use on loneliness (for a recent review, see Rennoch *et al.,* 2023, 3).

Despite the potential role that internet use may have played in alleviating older people's loneliness during the Covid-19 outbreak, however, there is a shortage of (quantitative) research on this topic. This study contributes to addressing this gap by investigating the relationship between internet use and the worsening of old-age loneliness across Europe, focusing on both individual-level characteristics and contextual-level factors that may affect this relationship (*e.g.* older people's living arrangements as well as the stringency of the containment measures and the quality of the internet connection). In this work, we define older people as people aged 65 or over (European Union [EU], 2020). We adopt a gender perspective and use data from the Survey of Health, Ageing and Retirement in Europe (SHARE) augmented with country-level data from the Oxford Covid-19 Government Response Tracker (OxCGRT) (Hale *et al.,* 2021) and the Eurostat Digital Agenda Scoreboard Key Indicators (Eurostat, 2018). Findings from this study will contribute to the debate on internet use and old-age loneliness, documenting the complexity of this relationship for older men and women.

The empirical context

Despite the abundance of qualitative studies investigating older people's experiences of loneliness during the Covid-19 outbreak and documenting the role that internet use

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may have played in mitigating the social consequences of the containment measures (*e.g.* Cipolletta and Gris, 2021; Greenwood-Hickman *et al.,* 2021; Llorente-Barroso *et al.,* 2021; Melis *et al.,* 2021; Scarfe *et al.,* 2022), there is surprisingly a shortage of quantitative research on internet access/use and old-age loneliness during the Covid-19 pandemic.

We are aware of only one study on internet *access* and old-age loneliness. Focusing on a large representative sample of US Medicare beneficiaries aged 65 years or older, Holaday *et al.* (2022) found that older people with internet access were more likely to feel lonely compared to those without internet access. However, the authors have also shown that this finding was driven by differences in older people's living arrangements: the association between internet access and loneliness was significant only for older people living alone (for those who did not live alone, the authors found no association between internet access and loneliness).

Although there is no evidence that internet access may alleviate old-age loneliness, a number of studies have documented that the *frequency* of internet use may play a key role in this regard. Analysing a large UK probability sample of middle-aged and older adults, Wallinheimo and Evans (2022) showed that frequent internet users aged 55–75 reported feeling less lonely than sporadic internet users. In addition, similar to Holaday *et al.* (2022), Wallinheimo and Evans (2022) documented that older people who live alone are more likely to be lonely, being less frequent information and communication technology (ICT) users. Also, studying a large probability sample of German older people, Hajek and König (2022) found that, compared to daily users, less-frequent users of the internet for contact with friends and relatives reported increased loneliness. Consistently with evidence from previous studies, they also showed that older people living alone were more likely to feel lonely than those living with a partner. When analysing the relationship between internet communication and social and family loneliness, Bertić and Telebuh (2020) obtained similar results. Focusing on a selected sample of 107 Croatian older people, they showed that people aged 65 and over who 'constantly' or 'occasionally' communicated using information technology during the Covid-19 pandemic showed lower levels of loneliness than those who never communicated using information technology.

There is also evidence documenting that both the use of *specific* communication applications and the *type* of internet use may counteract old-age loneliness. Based on a self-selected sample of older people living in Hong Kong, Yang *et al.* (2022) have demonstrated that for people aged 55 and over mobile app use for instant communication, video entertainment and information (out of the 14 mobile apps considered in their analysis) was associated with reduced emotional loneliness. Interestingly, the association between video entertainment app use and emotional loneliness became stronger with increasing age and education level. Also, in their cross-country study, Bonsaksen *et al.* (2021) examined the use of video-based communication and its association with social and emotional loneliness on a sample of 836 Norwegian, US, British and Australian older people, finding a marked age effect, with people aged 60–69 feeling less lonely (while no associations were observed for participants aged 70 or over). In addition, the already mentioned study by Wallinheimo and Evans (2022) showed that internet use for email communication is associated with being less lonely, whereas internet use for information search about health is related to higher levels of loneliness.

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It is worth noticing that Wallinheimo and Evans' (2022) work is the only study with a specific focus on gender differences when analysing the association between internet access/use and old-age loneliness. In their study, the authors found that older men reported using the internet for email communication more often than older women, while older women claimed to use the internet for health-related information searches more frequently than their male counterparts. Given that internet use for email communication is associated with being less lonely, this implies that older women using the internet may be more likely to feel lonely than older men. To conclude, the few studies on internet access/use have shown that internet *use* may constitute a protective factor against Covid-19 loneliness for specific groups of older people, that is, men, those who do not live alone, younger seniors (aged 60–69) and frequent internet users.

Despite the important role that internet use may have played in alleviating the old-age loneliness brought about by the Covid-19 containment measures, our literature review has documented the shortage of research on this topic. Specifically, there is very little cross-country research on internet access/use and old-age loneliness during the Covid-19 pandemic, preventing a better understanding of how the relationship between the two variables may be shaped by country-level factors, such as the stringency of the Covid-19 containment measures (Atzendorf and Gruber, 2021). Also, although we know that older women are less likely to be internet users than their male counterparts (Sala *et al.,* 2020), there is still very little knowledge on the gendered consequences of internet access/use on loneliness during the pandemic. Adopting a gendered perspective would allow us to understand *if* and *how* older men and women can dispose of an important resource to mitigate loneliness. In addition, in our literature review we have also documented the limitations of some of the studies we have considered to define the empirical context in which this work is set. Specifically, some studies are not based on probability samples of the old-age population, which hampers the generalizability of their research findings (*e.g.* the study conducted by Bertić and Telebuh [2020] is based on a sample of selected members of an old-age population).

Against this background, our study aims to explore the relationship between internet use and old-age loneliness worsening during the Covid-19 pandemic across Europe. In pursuing our aim, we draw on de Jong Gierveld and Tesch-Römer (2012) and consider loneliness as the result of the interplay of both individual-level characteristics and country-level features. The limited empirical evidence available on this topic does not allow us to state sound hypotheses to test. However, given that the association between internet use and old-age loneliness may vary by gender (*i.e.* internet use may constitute a protective factor against loneliness for older men while contributing to loneliness worsening for women), we shall adopt a gendered approach when pursuing our research aim. In addition, there is evidence documenting the role both of the stringency of the Covid-19 containment measures in increasing old-age loneliness (*e.g.* Atzendorf and Gruber, 2021; Caro *et al.,* 2022; Stolz *et al.,* 2021; Wester *et al.,* 2022) and of the quality of the internet connection in boosting internet use among older people (*e.g.* Mohan and Lyons, 2022; Sala *et al.,* 2020). Therefore, we believe that it is important to consider these country-level variables when investigating the relationship between internet use and old-age loneliness worsening during the Covid-19 pandemic. From a methodological point of view, we adopt a comparative approach, considering cross-country differences at the European level, analysing data from the

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probability-based SHARE survey. To our best knowledge, this is the first study that adopts a comprehensive and methodologically sound approach when investigating the relationship between internet use and older men's and women's loneliness worsening across Europe during the Covid-19 lockdown.

Materials and methods

To analyse the relationship between internet use and old-age loneliness worsening across Europe, we employ multilevel regression analysis using individual-level data from the Corona Survey 1 (CS1) of the Survey of Health, Ageing and Retirement in Europe (SHARE), augmented with data from Wave 8 (Börsch-Supan, 2022; Börsch-Supan *et al.,* 2013; Scherpenzeel *et al.,* 2020). We also use country-level data from the OxCGRT (Hale *et al.,* 2020, 2021) and from the Eurostat Digital Agenda Scoreboard Key Indicators (Eurostat, 2018).

Individual and country-level data

Individual data: SHARE Wave 8 and Corona Survey 1 (CS1)

SHARE is a large-scale longitudinal survey of the older population in Europe. It collects information on different aspects of a sample of individuals aged 50 or over living in all continental EU countries, plus Switzerland and Israel. Data are collected every two years, through face-to-face interviews. Wave 1 started in 2004. Wave 8 (face-to-face) fieldwork started in October 2019 and was suspended in March 2020 owing to the Covid-19 outbreak. Alongside older people's demographic, health and socio-economic characteristics, Wave 8 also collected detailed information on older people's social engagement (*e.g.* volunteering), social networks and internet use.

The CS1 is part of Wave 8. The CS1 was carried out between May and August 2020 via computer-assisted telephone interview on a subsample of over 50,000 Wave 8 sample members to investigate the socio-economic and health consequences of the first wave of the Covid-19 pandemic on older Europeans. In addition, it includes information on changes (pre vs. during the Covid-19 outbreak) in older people's social interactions, mental health and wellbeing (anxiety, depression, difficulty in sleeping and loneliness) and active ageing (*e.g.* paid work, volunteering, care-giving). The CS1 questionnaire content covers the most important life domains.

In our analysis, we include the following 24 countries: Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Romania, Slovenia, Spain, Sweden and Switzerland. We exclude Austria, Portugal and Slovakia because of data availability (for Austria and Portugal, data on both Wave 8 and CS1 are not available, whereas for Slovakia, macro data from the OxCGRT are not available) and Israel owing to our focus on continental EU countries. Our analytical sample constitutes 20,698 older people (8,506 men and 12,192 women) aged 65 or over responding to both the Wave 8 and the CS1 surveys. Table 1 presents the main characteristics of the analytical sample. The average age is 75.0 years (SD = 6.9). Approximately one-third of respondents have achieved no higher than a lower secondary or second stage of basic education, representing 36.4 per cent of participants.

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Table 1. Sample descriptives

Variables	% Means (SD)
Change in loneliness level during the pandemic	
Less so or about the same	87.3
More so	12.7
Internet use	
No	51.4
Yes	48.6
Age	75.0 (6.9)
Gender	
Male	41.1
Female	58.9
Education	
Low	36.4
Medium	41.1
High	22.5
Household size	1.9 (0.8)
Households' ability to make ends meet since the pandemic	
Easily	8.1
Fairly easily	23.5
With some difficulty	35.4
With great difficulty	33.1
Health	
Poor/Fair	35.8
Good	44.8
Very good/Excellent	19.4
Extraversion	3.5 (0.9)
Agreeableness	3.7 (0.8)
Conscientiousness	4.1 (0.8)
Neuroticism	2.7 (1.0)
Openness	3.3 (0.9)
Cognitive functioning	4.3 (1.8)
Social contacts	
Never	10.0
Low	57.1
Medium or higher	32.9

(*Continued*)

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Table 1. (*Continued.*)

Variables	% Means (SD)
Area of residence	
Central	66.4
Peripheral	33.6
5G mobile broadband coverage	13.4 (25.4)
Stringency index	49.5 (11.2)

Notes: N = 20,698; %: percentage; standard deviation in parenthesis.

Meanwhile, a majority, 41.1 per cent, have attained a medium level of education. However, only about one-fifth, or 22.5 per cent, have obtained tertiary education. More than one-third of respondents report having poor or fair health (35.8%), while the majority report having good (44.8%) or very good/excellent (19.4%) health. The percentages of respondents living in central and peripheral areas are 66.4 per cent and 33.6 per cent, respectively.

Country-level data: the Oxford Covid-19 Government Response Tracker and the Eurostat Digital Agenda Scoreboard Key Indicators

The OxCGRT is a research programme developed by the University of Oxford. It provides 21 country-level indicators on 5 groups of policy measures governments adopted to limit the Covid-19 outbreak, namely, containment and closure policies, economic policies, health system policies, vaccination policies and miscellaneous policies. The 21 indicators are aggregated into four composite indices, namely, the containment and health index, the economic support index, the government response index and the stringency index. Although the OxCGRT collects information on 187+ countries, it does not gather data for Slovakia, which is excluded from the analysis, as previously explained (for more information, see Hale *et al.*, 2020, 2021).

The Eurostat Digital Agenda Scoreboard Key Indicators are developed by the European Union and provide detailed country-level information on the key dimensions of the European information society: telecom sector, broadband, mobile, internet usage, internet services, egovernment, ecommerce, ebusiness, ICT skills, and research and development (more information is available at https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/key-indicators/indicators).

Variables

Dependent variable: loneliness worsening

Our dependent variable, loneliness worsening, measures changes in loneliness compared to pre-pandemic levels. Following the methodology of Atzendorf and Gruber (2021), this variable is operationalized as a dummy variable, where '1' indicates an increase in feelings of loneliness and '0' represents either a decrease or no change in loneliness levels relative to before the outbreak. Consistent with Atzendorf and Gruber, respondents who reported not feeling lonely at all (comprising 69.3% of our sample) are coded as 0 to ensure their inclusion in the empirical analysis (otherwise, they would be missing). Additionally, missing values for our derived variable constitute 0.7 per cent of

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the sample. Loneliness worsening is derived from two questions in the CS1 survey. The first question asks 'How much of the time do you feel lonely?', with response options including 'hardly ever or never', 'some of the time' and 'often'. The second question seeks to gauge changes since the Covid-19 outbreak, asking 'Has that been more so, less so or about the same as before the Covid-19 outbreak?', with possible responses being 'less so', 'about the same' and 'more so'.

Independent variable: internet use

Internet use is a dummy variable, determined by the response to the question 'During the past 7 days, have you used the internet for emailing, searching for information, making purchases or any other purpose at least once?'. The category 'any other purpose' encompasses activities such as chatting, using social networks, skyping etc. This question was posed during Wave 8, prior to the implementation of any pandemic-related restriction measures. The prevalence of missing values for internet use is notably low, constituting only 0.1 per cent of the sample. Owing to the very low rate of missing data, we excluded cases from our analysis that are missing on either loneliness worsening or internet use.

Individual-level control variables: demographics, socio-economic characteristics, psychological characteristics and health conditions

The individual-level control variables in our analysis encompass demographics, socio-economic characteristics, psychological traits and health conditions of older individuals. Age is calculated at the time of data collection for CS1 in 2020. Educational attainment is categorized using the 1997 International Standard Classification of Education (United Nations Educational, Scientific and Cultural Organization (UNESCO) 2006, 19), with three levels: 'low level of education' (encompassing 'none', 'ISCED Level 1' and 'ISCED Level 2'), 'medium level of education' (including 'ISCED Level 3' and 'ISCED Level 4'), and 'high level of education' (comprising 'ISCED Level 5' and 'ISCED Level 6'). Household size is assessed by the total number of members ranging from 1 (living alone) to 9. Area of residence is divided into two categories: 'central area' (covering 'a big city', 'the suburbs or outskirts of a big city' and 'a large town') and 'peripheral area' (including 'a small town' and 'a rural area or village'). Social status is measured using a four-point Likert scale to assess households' financial ease in managing expenses since the onset of the Corona pandemic. The question posed is 'Thinking of your household's total monthly income since the outbreak of Corona, would you say that your household is able to make ends meet with great difficulty, with some difficulty, fairly easily, or easily?'. In this scale, a higher score corresponds to greater difficulty in making ends meet since the pandemic began.

The variable 'social contacts' quantifies the frequency of interactions with children, parents, other relatives and non-relatives. This derived variable is categorized into three levels: no contact, low level of social contact and medium/high level of social contact. It utilizes a summary scale based on responses to the question posed four times (to collect information on social interactions with children, parents, etc.): 'Since the outbreak of Corona, how often did you have personal contact, that is, face to face, with the following people from outside your home? Was it daily, several times a week, about once a week, less often, or never?'. Physical health is measured with the following five-point

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Likert scale: 'Before the outbreak of Corona, would you say your health was excellent, very good, good, fair or poor?', where a higher score indicates better physical health. The variable is coded into the following three categories: 'poor/fair', 'good/very good' and 'very good/excellent'. Psychological characteristics are measured using the 'Big Five' personality dimensions, derived from the 10-item Big Five Inventory (BFI-10) as documented by Levinsky *et al.* (2019). This inventory measures five key personality dimensions: agreeableness, conscientiousness, extraversion, neuroticism and openness. Each dimension is scored (and included separately in the models) on a scale from 1 to 5, where a score of 5 represents the highest expression of the respective personality trait. Cognitive functioning is assessed using the ten-words recall test, which was administered twice during the interview process, following the methodology described by Harris and Dowson (1982). The derived variable represents the average number of words the respondent can recall across the two tests, with possible scores ranging from 0 to 10.

Country-level control variables: government response severity and internet connection

We use two country-level variables measuring the government response severity to the pandemic outbreak and the quality of the internet connection across European countries. As an indicator of the stringency of the containment measures adopted by the European governments, we use the OxCGRT stringency index at the time of the CS1 interview, which is the simple average of nine country-level indicators, namely, school closing, workplace closing, cancel public events, restrictions on gathering size, close public transport, stay-at-home requirements, restrictions on internal movement, restrictions on international movement, and public info campaign. The stringency index ranges from 0 to 100 (with 100 being the highest degree of intensity of the government response to the pandemic outbreak).

As an indicator of the quality of the internet connection, we use the fiveg indicator from the Mobile thematic group indicators of the Eurostat Digital Agenda Scoreboard Key Indicators. Fiveg indicates the percentage of households living in areas covered by fifth generation (5G) mobile broadband and ranges from 0 to 89.2, with 89.2 being the highest 5G mobile broadband coverage.

Analytical strategy

Given the hierarchical nature of the data, with individuals nested within countries, we employ multilevel regression models to assess the effect of older people's individual characteristics and contextual features on loneliness worsening during the pandemic. Specifically, to take account of the characteristics of our dependent variable, that is, a dichotomous variable, we employ multi-level mixed-effects logistic regression that includes both fixed and random effects (Rabe-Hesketh and Skrondal, 2022). For the two levels employed in our analysis, the model can be formalized as follows:

$$\Pr\left(y_{ij} = 1 | x_{ij}, u_j\right) = H\left(x_{ij}\beta + z_{ij}u_j\right)$$

where

$\Pr(y_{ij} = 1|x_{ij},u_j)$ is the probability that the binary outcome y_{ij} is 1 for individual i in group j; x_{ij} are the fixed effects predictors for individual i in group j; z_{ij} are the

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random effects predictors for individual i in group j; u_j is the vector of random effects for group j; β is the vector of fixed effects coefficients; and $H(\cdot)$ is the logistic cumulative distribution function, which maps the linear predictor to the probability of a success ($y_{ij} = 1$) with $H(\mathrm{v}) = \exp(\mathrm{v})/\{1 + \exp(\mathrm{v})\}$.

To investigate the relationship between internet use and old-age loneliness worsening during the Covid-19 pandemic, we implemented the following analytical strategy. Initially, we estimate an unconditional mean model (M0), which includes no independent variables. This model is used to explore whether the grouping variable at Level 2, that is, countries, significantly affects the mean (intercept) of the dependent variable, that is, loneliness worsening, at Level 1. Additionally, it computes the intra-class correlation (ICC, or variance partition coefficient). This coefficient indicates the proportion of variability in the outcome that can be ascribed to each level of analysis and it serves as an initial indicator of the geographical distribution of loneliness worsening across countries.

Progressing to the second model (M1), a random intercept logit model, we introduce internet use as a Level 1 independent variable to assess its impact on loneliness worsening. By examining changes in the estimate of between-country variance, this model allows us to evaluate whether the distribution of internet use is consistent across countries. Building on this, the third model (M2) extends the analysis by incorporating additional individual-level predictors, including demographics, socio-economic characteristics, health conditions and psychological traits, as detailed in the individual-level control variables section. This model enables a more comprehensive analysis, providing deeper insights into the factors that contribute to the worsening of loneliness among older people during the pandemic.

The fourth model (M3) explores the variability of the internet use's effect across different countries, often referred to as the 'slope effect' in multilevel modelling. By employing a random slope logit model, this approach allows both the intercept and the coefficient of the independent predictor – internet use – to vary randomly across countries. This model aims to determine whether the influence of internet use on loneliness is consistent or varies significantly between countries. Advancing to the fifth model (M4), we introduce two Level 2 explanatory variables in M2. These variables are the severity of the government response to the pandemic outbreak and the quality of the internet connection. The inclusion of these Level 2 predictors aims to assess whether country-level characteristics contribute to the worsening of loneliness independently of individual factors, including internet use.

Finally, the last model (M5) refines the analysis by challenging a key assumption made in Model 4 – that the contextual effects are uniform across all individuals. In M5, we introduce cross-level interactions between internet use and country-specific characteristics into the model. This approach allows us to explore how the relationship between individual internet use and loneliness worsening may vary depending on broader country-level factors.

All models are estimated separately for men and women to account for potential gender-specific differences. To evaluate the fit of our models, we employ the likelihood ratio test (LR-test), which compares the 'log likelihood' of two models to determine if there are significant differences between them. This method, which utilizes the

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deviance statistic to compare model goodness of fit, is applicable under specific criteria outlined by Singer and Willett (2003). Further, we perform robustness checks to assess the stability of our key findings across different age groups, specifically for individuals aged 75 or over and 85 or over. Statistical analyses are conducted using Stata version 18 (StataCorp, 2023a). We specifically utilize the 'melogit' command, which is designed to fit mixed-effects logistic regression models for binary and binomial responses (StataCorp, 2023b). The response variable, given the random effects, is modelled using a Bernoulli distribution, with the success probability determined by the logistic cumulative distribution function.

Results

Approximately 13 per cent of older Europeans have reported a worsening in loneliness levels compared to pre-pandemic times. However, a majority of 69.3 per cent did not report any feelings of loneliness and 17.2 per cent felt about the same as before. Notably, a small fraction (0.7%) of respondents reported feeling less lonely than before the pandemic outbreak (see Table 1S in the Supplementary Materials).

As shown in Table 2, there is a statistically significant association between internet use and old-age loneliness worsening across Europe ($\chi^2 = 32.2$, $p = 0.000$). Specifically, older internet users are less likely to have experienced a worsening in loneliness level than non-internet users (11.3% vs. 13.9%). This association holds true when considering older men and women separately ($p = 0.000$ for men; $p = 0.041$ for women). In detail, 6.9 per cent of male and 14.9 per cent of female internet users reported feeling lonelier, compared to 10.2 per cent and 16.2 per cent of non-internet users. Key findings from the multilevel regression analysis are presented in Tables 3 and 4, with the complete models for both older men and older women detailed in Tables 2–6S of the Supplementary Material.

Initially, we examine the unconditional means model (M0), which assesses the proportion of variance in loneliness worsening explained by different countries. For both older men and older women, only a small proportion of the total variance in loneliness worsening is attributed to between-level differences, namely differences between

Table 2. Relative frequency distribution of loneliness worsening by internet use among European older adults in 2020

	Internet use					
	Men		Women		Total	
Loneliness level compared to pre-pandemic times	No	Yes	No	Yes	No	Yes
Decrease or no change in loneliness level	89.8	93.1	83.8	85.1	86.0	88.7
Increased loneliness level	10.2	6.9	16.2	14.9	13.9	11.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
N	4,013	4,493	6,629	5,563	10,642	10,056

Notes: Total: N = 20,698 ($\chi^2 = 32.24$, df = 2, p = 0.000); Male: N = 8,506 ($\chi^2 = 29.25$, p = 0.000); Female: N = 12,192 ($\chi^2 = 4{,}17$, p = 0.041).

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Table 3. Multi-level mixed-effects logistic regression: Loneliness worsening among European older adults in 2020 – odds ratios, significance levels and fit statistics

	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
ORs			0.680***	0.917	1.044	1.250**	0.964	1.232*	1.043	1.250**	0.844	1.265
LRT			24.42*** (M0 in M1)	8.17** (M0 in M1)	1377.59*** (M1 in M2)	2157.28*** (M1 in M2)	3.50 (M2 in M3)	1.75 (M2 in M3)	0.46 (M4 in M2)	4.98 (M4 in M2)	0.73 (M5 in M2)	4.99 (M5 in M2)
ICC (CI in brackets)	0.081 (0.043–0.148)	0.050 (0.027–0.089)	0.082 (0.044–0.148)	0.052 (0.029–0.092)	0.081 (0.041–0.153)	0.067 (0.036–0.118)	0.065 (0.064–0.065)	0.059 (0.059–0.059)	0.075 (0.035–0.150)	0.056 (0.030–0.104)	0.075 (0.027–0.151)	0.056 (0.030–0.104)
N	10,549	13,951	10,542	13,945	8,506	12,192	8,506	12,192	8,506	12,192	8,506	12,192
Controls												
Level 1					✓	✓	✓	✓	✓	✓	✓	✓
Random slope effect							✓	✓				
Level 2									✓	✓	✓	✓
CLI											✓	✓

Notes: Models are estimated using the STATA's melogit command. Level 1 predictors are age, household size, education, household's ability to make ends meet, social contacts, area of residence, health conditions, psychological characteristics and cognitive functioning. Level 2 predictors are 5G mobile coverage broadband and stringency index.
Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. ORs: odds ratios for internet use; LRT: likelihood ratio-test; ICC: intra-class correlation coefficient; CI: confidence interval; CLI: cross-level interaction between internet use and the stringency index.

Table 4. Random intercept logit model with Level 1 controls (Model 2): Loneliness worsening among European older adults in 2020 – odds ratios, standard errors and fit statistics

	Model 2	
Variable	Men	Women
Internet use: *No*		
Yes	1.044 (0.109)	1.250** (0.084)
Age	1.014* (0.007)	1.004 (0.004)
Household size	0.503*** (0.036)	0.608*** (0.025)
Education: *Low (ISCED 1–2)*		
Medium (ISCED 3–4)	0.947 (0.099)	0.922 (0.061)
High (ISCED 5–6)	1.123 (0.140)	0.949 (0.080)
Households' ability to make ends meet since the pandemic: *With great difficulty*		
With some difficulty	0.782 (0.114)	0.633*** (0.057)
Fairly easily	0.607** (0.096)	0.492*** (0.048)
Easily	0.519*** (0.091)	0.408*** (0.044)
Health: *Poor/Fair*		
Good	0.608*** (0.057)	0.757*** (0.046)
Very good/Excellent	0.495*** (0.066)	0.601*** (0.053)
Extraversion	0.936 (0.044)	0.951 (0.029)
Agreeableness	1.100 (0.059)	0.995 (0.034)
Conscientiousness	1.029 (0.056)	0.984 (0.034)
Neuroticism	1.221*** (0.055)	1.193*** (0.032)
Openness	0.959 (0.046)	1.043 (0.031)
Cognitive functioning	0.943* (0.026)	0.955** (0.017)
Social contacts: *Never*		
Low	1.019 (0.142)	0.958 (0.083)
Medium-low or higher	0.642** (0.099)	0.713*** (0.068)
Area of residence: *Central*		
Peripheral	0.837 (0.079)	0.790*** (0.048)
Constant	0.169* (0.119)	0.652 (0.309)
Likelihood ratio test (LRT)	LR chi2 (18) = 1377.59	LR chi2 (19) = 2157.11
Model 1 nested in Model 2	Prob > chi2 = 0.000	Prob > chi2 = 0.000
Sample size	8,506	12,192

Notes: Model 2 is estimated using STATA's melogit command.
Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

countries (ICCs are 8 per cent for older men and 5 per cent for older women). Most of the variance is owing to differences between individuals, accounting for 92 per cent for older men and 95 per cent for older women. Figures 1 and 2 illustrate the empirical

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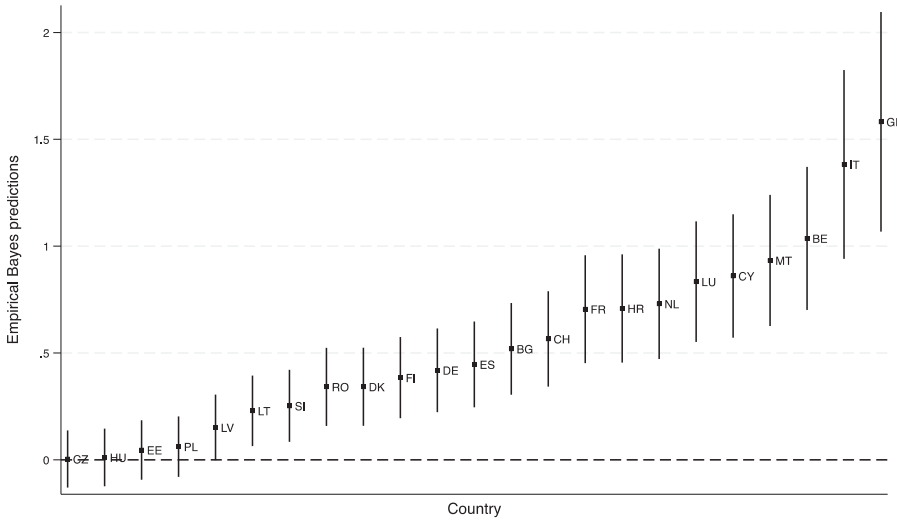

Figure 1. Empirical Bayes predictions and 95 per cent confidence intervals of old-age loneliness worsening among men by European countries.
Note: BE = Belgium; BG = Bulgaria; CH = Switzerland; CY = Cyprus; CZ = Czech Republic; DE = Germany; DK = Denmark; EE = Estonia; ES = Spain; FI = Finland; FR = France; GR = Greece; HR = Croatia; HU = Hungary; IT = Italy; LT = Lithuania; LU = Luxembourg; LV = Latvia; MT = Malta; NL = The Netherlands; PL = Poland; RO = Romania; SE = Sweden; SI = Slovenia.

Bayes predictions from M0 for older men and older women, respectively. These predictions adjust each group's estimate based on both its specific data and the overall trend, thereby reducing the influence of outliers and stabilizing estimates for groups with smaller or noisier data samples. The graphs depict the pattern of old-age loneliness worsening during the pandemic across various European countries. A clear finding stands out from the analysis of the estimated predictions: in most European countries, older men are more likely to experience a worsening of loneliness compared to the pre-pandemic period than are older women. Specifically, the loneliness of older men worsened during the pandemic in most European countries; in contrast, this was observed among older women in only two countries, Italy and Greece.

We next consider results from the random intercept logit model (M1), which estimates the effect of internet use on the worsening of loneliness. The comparison of the ORs for the male and female samples reveals clear gender differences in the association between internet use and loneliness worsening among older people. For older men, this association is statistically significant (OR = 0.680, $p < 0.001$), indicating that internet use reduces loneliness compared to non-use. In contrast, for older women, internet use is not statistically associated with loneliness worsening (OR = 0.917; $p = 0.096$). The LR-test analysis suggests that M1 provides a better fit compared to the previous model, with significant improvements ($p < 0.001$ for men; $p = 0.004$ for women). However, the introduction of the independent variable, internet use, does not affect the variance in the outcome, as the ICCs in Model 0 and Model 1 remain substantially unchanged.

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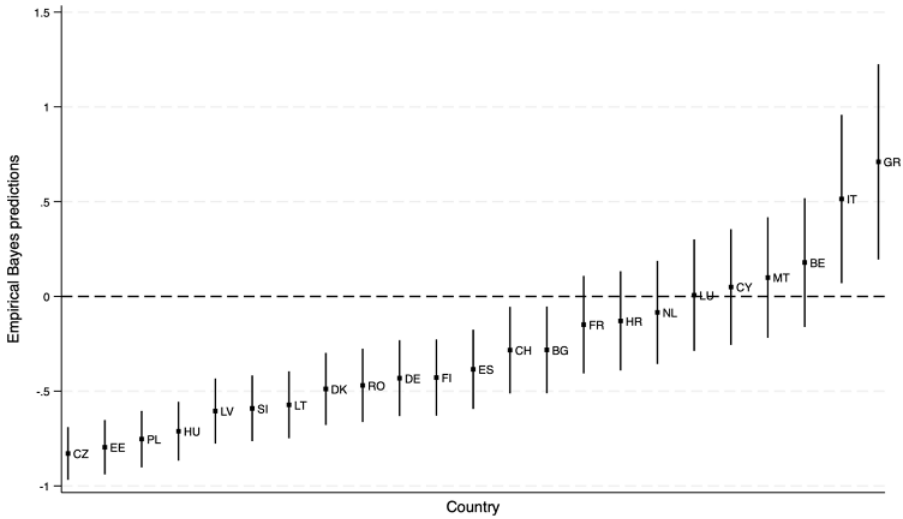

Figure 2. Empirical Bayes predictions and 95 per cent confidence intervals of old-age loneliness worsening among women by European countries.
Note: BE = Belgium; BG = Bulgaria; CH = Switzerland; CY = Cyprus; CZ = Czech Republic; DE = Germany; DK = Denmark; EE = Estonia; ES = Spain; FI = Finland; FR = France; GR = Greece; HR = Croatia; HU = Hungary; IT = Italy; LT = Lithuania; LU = Luxembourg; LV = Latvia; MT = Malta; NL = The Netherlands; PL = Poland; RO = Romania; SE = Sweden; SI = Slovenia.

This indicates that the distribution of internet use is similar across countries for both older men and women.

As a third step, in Model 2 (M2), we introduce Level 1 predictors, namely, demographics, socio-economic characteristics, psychological traits and health conditions (see Table 4 for the full model). Interestingly, controlling for individual characteristics, the direction of the relationship between internet use and old-age loneliness worsening changes. Specifically, for older men the association between the two variables cancels out (OR = 1.044, $p = 0.697$), while for older women, internet use becomes positively associated with loneliness worsening (OR = 1.250, $p < 0.01$), suggesting that internet use exacerbated loneliness among women during the pandemic. Also, the introduction of individual-level predictors further improves the fit of the model for both genders ($p < 0.001$).

In Models 3–5, we further investigate the role of country-level variables in the association between old-age internet use and loneliness worsening, using Model 2 as the reference model for assessing model fitness. After introducing the second-level covariates in Models 3–5, the ICC decreases slightly compared to the models without these covariates. This indicates that, while the contribution of contextual factors to the already limited between-country variability is small, it is not negligible. The remaining heterogeneity between countries likely reflects other contextual variables not included in the models. In the random slope model (M3), we evaluate if the impact of internet use on loneliness worsening varies across European countries by allowing both the

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intercept and the slope of the internet use parameter to vary randomly across countries: M3 does not improve the fit of the model compared to M2 ($p = 0.174$ for older men and $p = 0.417$ for older women), indicating that the impact of internet use on loneliness worsening is consistent across countries. Additionally, the relationship between internet use and loneliness worsening observed in M2 remains substantially unchanged (OR for men: 0.964, $p = 0.720$; OR for women: 1.232, $p = 0.003$).

In Model 4 (M4), we introduce Level 2 predictors, specifically the quality of the internet connection and the severity of the government response to the pandemic. Similar to Model 3, the introduction of Level 2 predictors does not affect the relationship between internet use and loneliness worsening (OR for men: 1.043, $p = 0.709$; OR for women: 1.250, $p = 0.001$). Interestingly, the effects of these Level 2 predictors differ between genders. Independently from internet use, for older men loneliness worsening is not associated with these country characteristics. In contrast, for older women, loneliness worsening correlates with the severity of the government response to the pandemic, but not with the quality of the internet connection (see Table 5S in the Supplementary Material). For both men and women, the LR-test shows that Model 4 does not improve the fit of the model compared to Model 2 (LR-test for men: 0.46, $p = 0.794$; LR-test for women: 4.98, $p = 0.083$).

In Model 5 (M5), we introduce a cross-level interaction to assess whether the severity of government responses to the pandemic (a Level 2 predictor) moderates the effect of internet use on loneliness worsening. This approach allows us to examine if the impact of internet use on loneliness worsening varies with cross-country differences in the severity of the government response. With the introduction of this interaction, the main effects of internet use, as well as the cross-level interaction parameters, are not statistically significant for either older men or older women. It is important to note that the loss of statistical significance in the internet use coefficient for the female sample can be attributed to increased standard errors associated with the cross-level interaction model. Additionally, the inclusion of the cross-level interaction does not enhance the model's predictive power, confirming the goodness of fit established by M2 (LR-test for men: 0.73, $p = 0.867$; LR-test for women: 4.99, $p = 0.173$, as shown in Table 6S of the Supplementary Material). We conclude that the severity of the government response to the pandemic did not significantly affect the relationship between internet use and loneliness worsening. To account for the heterogeneity of the ageing population, we conducted additional robustness checks on subsets of the population aged 75 or over and 85 or over. The findings from these additional analyses are consistent with those from the initial sample of individuals aged 65 or over.[1]

Discussion

The containment measures adopted to control the spread of the Covid-19 pandemic have led to an urgent reflection on their social consequences, also because of the risk of new pandemic outbreaks in the near future (Talenti *et al.*, 2021). Specifically, the strict social distancing restrictions implemented during the early stages of the Covid-19 pandemic brought about an increase in old-age loneliness, with detrimental effects on specific groups of the old-age population, namely, those lacking the skills to act and

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interact in an increasingly digitalized society. Indeed, many studies have documented that internet use may have played a key role in counteracting old-age loneliness, for example by facilitating social contacts. Adopting an innovative approach that considers individual- and country-level characteristics as possible drivers of loneliness, this study investigates the relationship between internet use and old-age loneliness worsening across Europe during the first Covid-19 lockdown from a gender perspective by analysing the Wave 8 and the CS1 SHARE data, augmented with country-level variables, namely, the stringency index and the 5G mobile broadband coverage.

This study makes an important contribution to the advancement of the current knowledge in this field, documenting the need to adopt a gender-sensitive approach when assessing the impact of internet use on loneliness worsening among older Europeans. Indeed, the empirical analysis has revealed gender-specific differences in the relationship between internet use and the worsening of loneliness among older people during the pandemic, with internet use contributing to increased loneliness for older women, but not for men. In addition, our study indicates that while the contextual factors, namely, the severity of the contingency measures and the quality of the internet connection, are not moderators of the relationship between internet use and loneliness worsening, the stringency index specifically exacerbates loneliness in women. We speculate that these differences may be owing to the different ways in which older men and older women use the internet. Previous research suggests that older women are more likely to engage in health-related information-seeking online, rather than using the internet for communication, such as through emails; this type of internet use could potentially heighten feelings of loneliness (Stockwell *et al.,* 2021; Wallinheimo and Evans, 2022; Wilding *et al.,* 2022). Consequently, this distinctive pattern of internet use may have made older women more susceptible to loneliness worsening during the pandemic. Furthermore, there is evidence indicating that older men are more actively engaged with social networking sites (SNS) compared to older women, deriving benefits from the social contact, interactions and support these platforms offer (Jeon *et al.,* 2020; Vošner *et al.,* 2016; Zhou, 2018, 2019). Under stringent containment measures, this propensity allows men to maintain their social connections through virtual relationships. In contrast, older women, who typically engage less with these digital platforms, may not experience the same protective effects against loneliness. This disparity can lead to increased feelings of isolation among older women during periods of enforced social distancing. Unfortunately, owing to the lack of data on older men's and older women's specific internet and SNS use, we were not able to empirically explore these hypotheses.

This study reveals gender-specific impacts of internet use on the exacerbation of loneliness among older Europeans, diverging from prior research that often neglected such differentiation. While existing literature, including studies by Bonsaksen *et al.* (2021) and Yang *et al.* (2022), generally underscores the beneficial role of internet use in mitigating old-age loneliness, our findings indicate a contrasting scenario for older women. Specifically, our analysis suggests that internet use may actually correlate with increased loneliness during pandemic conditions. Owing to the limited quantitative evidence specific to gender differences in the relationship between internet use and the worsening of old-age loneliness during pandemics, a direct comparison with earlier studies remains challenging. Nevertheless, our results align with the observation

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of Wallinheimo and Evans (2022) that older female internet users might experience heightened feelings of loneliness compared to their male counterparts.

The results from this present study challenge simplistic views on the impact of internet use on loneliness in older people during pandemics, underscoring the necessity for a more differentiated approach that acknowledges gender-specific differences and the influence of contextual conditions. These insights carry significant practical implications for policy makers, health-care providers and community organizers dedicated to mitigating loneliness worsening within older women. Our research underscores the critical importance of developing targeted digital literacy programmes specifically designed for older women. These programmes should extend beyond teaching basic skills to promoting meaningful online interactions that could supplement or even enhance real-world social connections, which are vital for alleviating feelings of loneliness. For example, the emphasis could be placed on training in the use of video calling and social networking platforms, rather than solely on information-seeking activities, which often do not offer the same level of social engagement. Furthermore, health-care providers need to be aware of the varied impacts of internet use on loneliness across different demographic groups. It is advisable for them to guide older women towards online communities and social networks known for fostering positive interactions and reducing feelings of isolation. Health-care professionals also have a pivotal role in educating older women about the potential benefits of balanced internet use. Additionally, community centres and local government initiatives should establish programmes that encourage older women to engage more actively with the internet. These could take the form of social media clubs or group internet sessions facilitated by volunteers, providing a supportive environment for learning. Moreover, these initiatives could integrate online interactions with offline activities, such as organizing live virtual events that connect to community gatherings.

Despite the relevance of the study findings, there are several limitations that need to be considered. Our analysis is based on a poor operationalization of the concepts of internet use and change in loneliness levels. Specifically, internet use is operationalized with a single yes/no question, measuring internet use (for emailing, searching for information, making purchases, etc.) during the past seven days before the interview. Therefore, we were unable to disentangle the specific effects of the *frequency* and the *purposes* of internet use on old-age loneliness worsening and estimate *their impact* for older men and older women. Additionally, the data on internet use, collected during Wave 8 between October 2019 and March 2020, may not accurately reflect the actual internet usage patterns in late 2020, when the CS1 survey was conducted. This time lag could lead to an underestimation of older people's internet use, which could also impact the research findings. Also, change in loneliness level is operationalized using two questions, asked during the CS1 interview, measuring whether respondents felt more/less lonely or about the same compared to the pre-pandemic situation. For a more accurate measurement, it would have been beneficial to employ validated scales, such as the UCLA Loneliness Scale, consistently before, during and after the lockdown periods. The reliance on self-reported data for assessing loneliness also introduces potential biases, as responses may be influenced by individual perceptions and characteristics. To conclude, we cannot exclude that a better operationalization/measurement of the concepts of internet use and change in loneliness levels could have led to different results.

The country-level variables we utilized introduce several additional considerations. Both the stringency index and the quality of internet connections are available only at the national level, despite potential variations within countries. For instance, Covid-19 restrictions in some countries were applied at the local or regional level. Incorporating local-level contextual variables could enhance our understanding of how these factors might influence the relationship between internet use and loneliness among older people. Addressing these limitations in future studies will not only refine our understanding of how internet use impacts loneliness worsening among older people during pandemics but also inform more targeted interventions designed to mitigate these effects. Such research is essential for developing strategies that effectively support older women during times of crisis.

Conclusions

Our study offers nuanced insights into the complex relationship between internet use and loneliness worsening among older adults in Europe during the Covid-19 pandemic. Our findings underscore the importance of adopting a gender-sensitive lens when examining this relationship, revealing distinct patterns for older men and women. These gender-specific nuances highlight the need for tailored interventions and strategies to address the diverse needs and preferences of older people. Moving forward, researchers should focus on elucidating the specific mechanisms underlying these gender differences in internet use and its impact on loneliness worsening, leveraging longitudinal designs and more comprehensive measures of the different purposes of internet use. By addressing these gaps and building on the empirical insights generated by our study, researchers and practitioners can develop more effective and targeted interventions to combat loneliness worsening and promote wellbeing among older people, particularly in the context of global health crises such as the Covid-19 pandemic.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0144686X2500011X.

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Competing interests. The authors declare no competing interests.

Note

1. The robustness check analysis is available from the authors upon request.

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