



Did internet use protect older adults' mental health during the COVID-19 pandemic? It depends on their pre-pandemic social connectedness

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ABSTRACT

Many studies have addressed changes in mental health during the COVID-19 pandemic's early lockdown stage. Fewer studies have investigated the further developments in older adults' mental health throughout the pandemic's later stages. Research gaps particularly pertain to the role of how online information search behaviour and offline social network interact. Both provide important resources (e.g., information, support, services) that are essential for independence and well-being in later life. By investigating how they interact, we propose four theoretically derived mechanisms and test them using high-quality data.

Based on the Survey of Health, Ageing and Retirement in Europe's (SHARE) wave eight (2019) and second Corona survey (May–September 2021), we apply multinomial logistic regressions to predict stability and increase of depressive mood between the first and the second pandemic phases among 30,076 adults aged 50 years or older, observed in 27 countries. Results show that increased government information search online is associated with increased depressive mood. Pre-pandemic social connectedness moderates the associations between internet use and depressive mood positively, decreasing the risk of depressive mood among internet non-users and pointing to compensation of lacking online resources via offline social ties. Additionally, the negative effects of increased government information search were aggravated by deeper social connectedness, pointing to conflicts or disagreements over pandemic governance policy that may arise in close social networks.

1. Introduction

Much scholarship has examined how the COVID-19 pandemic affected mental health, including depression (Paccagnella & Pongiglione, 2022), anxiety (Hajek et al., 2022) and loneliness (author 1). Concerns about increasing mental health problems were already present before the pandemic (WHO, 2023). This trend was reinforced during the pandemic with its lockdown measures and their consequences on social isolation (National Institutes of Health (NIH), 2023). However, the high extents of nuance and multidimensionality in mental health during the COVID-19 pandemic (author 1) present several important angles that remain understudied, including the interaction of individual internet behavior and social networks (Penninx et al., 2022).

Firstly, the drivers of mental health risks and resilience during the pandemic seem to be different for adults in later life (Paccagnella and Pongiglione, 2020; Reppas-Rindlisbacher et al., 2021) than for children

and adolescents (Chavira et al., 2022; Valkenburg et al., 2022) or parents of minor children (Etheridge & Spantig, 2022). Secondly, while older adults' mental health concomitants of social distancing and contact restrictions are unanimous (Robb et al., 2021), the evidence pertaining to older adults' changes in internet use and their mental health consequences during the COVID-19 pandemic has been mixed (Kung & Steptoe, 2023a, 2023b; Vismara et al., 2021), but evidence suggests within-person fluctuation in older adults' internet use over time (König & Seifert, 2020). Thirdly, the pandemic's effects upon digitalization and need for digital participation are sustained, especially in digital channels that allow access to government and healthcare information and services. It is essential to study their longer-term changes' effects on mental health – for older adults who were or became "onliners" and for the potentially vulnerable populations less digitally connected (König & Seifert, 2020). Finally, social connectedness has been shown to promote well-being in later life and to buffer negative effects on well-being

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during personal and societal crises (Steuerink & Lindenberg, 2006; Zanjari et al., 2022).

At first, it thus appears plausible to assume that social connectedness with ties from before the pandemic positively moderates the pandemic experience, including the impacts of digital participation during the pandemic on mental health. On the other hand, scholarship has demonstrated potential negative implications from close or demanding social ties for well-being (Antonucci et al., 1998; Piquart & Sørensen, 2006). However, the majority of studies suggest positive mental health consequences of social connectedness. In the context of older adults' internet use, the moderation potential of social connectedness is not yet fully understood. The pandemic situation creates a unique opportunity for studying this research gap, because of the restrictions in accessing a large range of offline institutional and welfare services, and the restricted abilities to create new or strengthen existing offline social ties.

Our study makes a few notable contributions to the literature by addressing these lines of research. First, it traces changes in two types of internet use to self-reported changes in depressive mood occurring between the well-studied first (lockdown) stage of the COVID-19 pandemic and a later pandemic stage (spring to fall 2021), among Europeans aged 50 years or older. By studying the mental health changes beyond the first COVID-19 lockdown, our study contributes to a better understanding of the dynamics of well-being and mental health throughout the different stages of a public health crisis.

Second, we take a nuanced perspective by focusing on health information search and government information search. Moreover, we investigate two understudied internet applications which have few technological requirements but were particularly salient during COVID-19.

Third, by linking these online behaviors with pre-pandemic offline network resources, we investigate how social connectedness moderated the associations between internet use and mental health. Through doing so, we advance our understanding about the interplay of two important factors for independence and well-being in later life.

Finally, we make a theoretical contribution by theorizing the joint impact of online behavior and offline connectedness, integrating theoretical perspectives and formulating four mechanisms that consider both positive and negative consequences of online and offline resources. Filling the above-mentioned research gaps, we ask.

- 1) How are stability and change in internet use for obtaining health and government information during the pandemic associated with changes in depressive mood?
- 2) How do associations between internet use and mental health depend on social connectedness?

2. Theoretical background and previous research

2.1. Pandemic-era internet use among older adults

Optimistic voices at the outset of the pandemic speculated that digitalization would further spread, arriving to all societal groups and enabling a greener and more participative society (see, e.g., Mora et al., 2021). Yet, these anticipated trends have not been confirmed. Despite older adults being the population group with the fastest increasing rate in internet use already before the pandemic (McDonough, 2016) and in all European countries (Lee, 2023), evidence pertaining to within-person developments of internet use during the COVID-19 pandemic is mixed. Some studies find no evidence for a growing share of older internet users during the COVID-19 pandemic (Kung & Steptoe, 2023a). Others find that frequencies of internet usage among Europeans aged 65 or older have risen through time, but at a slower speed during than directly before the COVID-19 era (Lee, 2023). One study highlights fluctuations in older adults' internet use, as they transition from being "onliners" to being "offliners" and vice-versa (König & Seifert, 2020). Other scholars suggest that changes are specific to the type of internet

usage (Kung & Steptoe, 2023a, 2023b; Lee, 2023): in the UK while a seven-fold increase in use of video or voice calls and government-related internet information search was observed, health-related information search cut by about half between 2019 and 2020 (Kung & Steptoe, 2023a). The latter finding is perhaps surprising given the strong health concerns and the need for updated information during fast-changing pandemic conditions. Yet, such change might reflect older adults' avoidance of worrying news, as we will outline below.

Most studies on the association between older adults' pandemic-era internet use and mental health have focused on online communication – particularly: frequency of use, obstacles to use, and types of applications used (Kung & Steptoe, 2023a, 2023b; Lee, 2023). However, different types of internet use plausibly have different effects upon mental health (Lam et al., 2020), raising the need for alternative perspectives on older adults' internet use beyond digital communication with family members.

In this study, we focus on *two types of internet search* with few requirements (i.e., they can be executed from different digital devices using an internet browser), but high salience and importance during and after the pandemic, namely: health information search and government information search. In early stages of the pandemic, search for information – e.g., incidence number and lockdown regulations, but also health protection recommendations, testing and symptoms – to cope with the novel circumstances was widespread. In tandem, new digital information channels and services have been established by governments and providers of healthcare services (e.g., online appointment bookings, online appointments, information websites, application for income support, registration for vaccinations and COVID-testing, and online counselling).

We argue that the necessity and usage of these services have persisted beyond the initial pandemic phase with stricter lockdowns and no protection through vaccines. Many of these services (e-health services, e-government) were already available – but less widespread – before the pandemic, but the reliance on such online infrastructure increased sharply throughout the pandemic, resulting in an organizational shift away from offline services to online tools. This makes these two types of internet use particularly informative for studying the longer-term effects of digitalization on older adults' well-being and mental health, during a public health crises and beyond.

2.2. General hypotheses concerning internet use and mental health

Scholarship suggests that using digital applications may be consequential for mental health (Stefanone et al., 2012), but the evidence is inconclusive, offering support for both negative effects and positive effects on mental health. Concurring with the latter, online communication activity lessened depressive moods and increased life satisfaction (Kung & Steptoe, 2023b; Lee, 2023). During the early phase of the COVID-19 era, new forms of neighborhood-based support emerged, assisted by digital technologies (Carlsen et al., 2021; author2). Giving and receiving support during COVID-19 have been shown to promote the formation of social capital (author2), which is important for well-being beyond the pandemic (Chang, 2017; Rostila, 2011).

On the other hand, *negative effects of internet use* may be expected. Vismara et al. (2021) found that search for health-related information during the COVID-19 era could lead to stress, depression, and anxiety, and Bu et al. (2021) found that following news on the pandemic (via television, internet and social media) raised depressive symptoms. These findings are in line with earlier findings on adolescents' excessive internet use (Valkenburg et al., 2022). For many older adults, the health situation was perceived as threatening, and "doomscrolling" – i.e., the volitional exposure to negative and worrying internet content (Price et al., 2022; Ytre-Arne & Moe, 2021) – can increase depression and anxiety (Bu et al., 2021; Vismara et al., 2021). Avoidance of health information and COVID-19-related government news on the internet can thus be interpreted as a means of protecting mental health (Mannell &

Meese, 2022). Further, internet information search has heightened the risk of being exposed to false information that was not evidence based or conveyed COVID-skepticism (Balakrishnan et al., 2022), particularly during early stages of the pandemic. It has been shown that skepticism towards government and science has damaged close social ties, and that a considerable share of adult Germans report having lost social ties during the early stage of the COVID-19 pandemic (author2).

Based on these considerations, we formulate *two opposing hypotheses*. First, positive effects on mental health may arise from access to official and accurate information online, as well as from access to health and citizen services. We thus assume that *those with stable internet use (before and during the pandemic) and those who increased their internet searching are less likely to report (stable or increased) depressive mood during the pandemic than those who were stably offline or decreased their internet search behaviors (H1a)*.

On the other hand, exposure to worrying or alarming content (including “fake news”), and polarized opinions and debates, as well as doomscrolling may threaten well-being. However, this may particularly affect negative emotions if such behavior arose newly during the pandemic. We thus assume that *those who increased their internet search behavior are more likely to report (stable or increased) depressive mood than those who stably used the internet (before and during the pandemic), did not use it, or decreased their usage (H1b)*.

2.3. Social connectedness and mental health

On the other hand, we know from the general literature that offline social relations are a major factor for mental health and well-being. Two strands concerning the association between social connectedness and mental health can be identified from the literature. The first strand suggests that individuals with higher social connectedness are protected against mental health problems, generally and in later life. The second strand, which is less emphasized in the literature, suggests that network ties may pose a risk factor for mental health.

On the one hand, *protective effects of social connectedness for mental health* can be expected. Generally, health benefits arise from connectedness with network members who exhibit different characteristics and strengths of emotional ties (Granovetter, 1973; Steverink & Lindenberg, 2006), including close family members and friends, distant kin, and non-family ties. Stress process models emphasize the importance of relational resources to cope with stressors arising from exogenous shocks (such as the COVID-19 pandemic), which are originators of stressors that can negatively affect health and well-being (Pearlin et al., 1981). Network ties are particularly important for understanding the mental health consequences of such shocks, as they function as “coping resources” that buffer against the negative effects of these stressors, for instance, by providing information, advice, and support. A recent study suggests that offline contacts were protective of mental health during the COVID-19 pandemic (Vacchiano & Valente, 2023). Based on these concepts, we identify pre-pandemic social connectedness as a global measure of *individuals’ support potential*.

On the other hand, social connectedness may be negatively associated with mental health and well-being, as emphasized in another, less prominent strand of literature. Close social relations – often family relations – have been found to create distress or burden, for instance, when they demand comprehensive support or care (Antonucci et al., 1998; Pinguart & Sørensen, 2006, pp. P33–P45). This is not in contradiction to the social production function theory. Following Steverink et al. (2011, p. 22), stress arises even from functional social ties when they do not meet the need for affection. This may be the case if helping relationships become mentally straining or – during COVID-19 – when diverging opinions about containment measures (Prosser et al., 2020) may cause ambivalence within families, lowering well-being (Segel-Karpas & Ayalon, 2022).

2.4. Hypotheses regarding the moderating role of social connectedness

Since theoretically, both positive and negative associations of internet use and social connectedness with mental health are conceivable, four combinations in how online and offline resources may interact need to be discussed (Table 1).

Departing from a *positive main effect of internet use* (H1a), one could assume that the disadvantages from internet non-use may be moderated positively by social connectedness. Offline ties provide access to information and services and may **compensate** for the lack of online resources (H2). Yet, online resources have their own benefits, that may extend on offline support (Bouchillon, 2019; Stefanone, 2012). Conversely, assuming a negative moderation of social connectedness, one may assume that the lower well-being in internet non-users may be further reinforced, particularly if the lack of online resources and the reliance on offline support may result in **dependency and strain** (H3).

Likewise, departing from a *negative main effect of internet use* (H1b), the risks of internet use (such as mental health problems due to worrying and false information, including through doomscrolling) may be moderated by the presence of offline ties. A positive moderation via offline social connectedness might **alleviate worries or concerns** among internet users arising from exposure to false beliefs and worrying news (H4). Similarly, internet non-users relying on information from their offline network should benefit from greater social connectedness. Thus we assume that the greater the connectedness with one’s social networks, the lower the risk of depressive mood among both internet users and non-users.

Contrarily, assuming a negative moderation of social connectedness, internet users with higher social connectedness may experience **conflicts with or estrangement from** their pre-pandemic offline network ties. Such conflicts or estrangement may result from disagreements about pandemic policies, or from differences in perceptions of the overwhelming and worrying, and partly false, information obtained from the internet (H5).

3. Methods

We use data from two waves of the Survey of Health, Ageing and Retirement in Europe (SHARE). Changes in depressive mood and internet use come from the second wave of the SHARE Corona Survey (SHARE-ERIC, 2024); collected between June and August 2021. The first SHARE Corona Survey (could not be used because it lacked variables

Table 1
Hypotheses.

Main effect: Internet as protective for mental health (H1a)	... risk for mental health (H1b)
Internet use	Offline ☺	Online ☺
Networks: protective for mental health ☺	H2: Internet non-users exhibit lower risk of depressive mood the higher the connectedness with one’s pre-pandemic networks (compensation of resources)	H4: Internet users exhibit lower risk of depressive mood the higher the connectedness with one’s pre-pandemic networks (alleviating worries and concerns)
Networks: risk for mental health ☹	H3: Internet non-users exhibit higher risk of depressive mood the higher the connectedness with one’s pre-pandemic networks (dependency)	H5: Internet users exhibit higher risk of depressive mood the higher the connectedness with one’s pre-pandemic networks (conflict/estrangement)

Own conceptualization. ☺ denotes an assumed positive main effect on mental health. ☹ denotes an assumed negative main effect on mental health.

Note: “online” includes those who are stable internet users (no change in frequency) and those who recently increased their usage. As “offline”, we conceptualize those respondents who report not using the internet for government or health information search purposes before and during the pandemic or having decreased their use since the onset of the pandemic.

concerning respondents' internet use. For pre-pandemic information, we rely on information collected during the regular panel wave 8 (2019) for respondents' sociodemographic and socioeconomic control variables and the social networks module to measure connectedness.¹

3.1. Sample

We use information from respondents in 27 European countries who participated in wave 8 and the SHARE Corona Survey 2. Among the $n = 31,712$ respondents who took part in both waves and had valid interviews, $n = 31,534$ qualify for our analytical sample, as they were at least 50 years of age at the second wave of the SHARE Corona Survey (hereby referred to as the "valid sample"). After listwise deletion of cases with missing information on the outcome variable, the explanatory and control variables, we have $n = 30,076$ observations (95.4 % of the valid sample).

3.2. Variables

Our dependent variable denotes self-reported changes in depressive mood and was collected with the respective questions: "In the last month, have you been sad or depressed?", which could be answered with either "yes" or "no". All respondents who answered "yes" were subsequently asked, "Was that less so, about the same, or more so than during the first wave [SHARE Corona Survey 1]?". This allows us to create an outcome distinguishing between three categories denoting distinct trajectories of depressive mood: "No depressive mood" (about 70 %, the base category), "Stable depressive mood" (about 16 %) and "Increased depressive mood" (about 13 %) (for frequencies, see [Figure A.1](#) in the Supplementary Materials). The small group of those reporting a decrease in depressive mood (<3 per cent) was combined with those without depressive mood, and for robustness checks (see [Table A.4](#)), was excluded from the analysis.

Internet use is measured with self-reported changes in two types of internet use: searching for information on health-related issues and obtaining information about government services (for example, for benefits, taxes, or passports). The question was phrased as follows (separately for the two types of internet use): "Nowadays, many things can be done online, that is, via the Internet. Since the outbreak of Corona, have you used the Internet ... for the following online activities?", followed by four answer categories: "More often", "About the same", "Less often" and "Not at all" (for distributions, see [Table A.1](#) in the Supplementary Materials). Notably, such information is not available in the SHARE Corona Survey 1, thus a comparison with changes between pre-pandemic and the lockdown period is not possible.

Pre-pandemic social connectedness is computed according to [Litwin and Stoeckel \(2016\)](#), as an additive unweighted index of several items from the SHARE wave 8 network module. This index ranges from 0 to 20 and includes: a) the number of close social contacts cited, among which: b) the number living within 25 km, c) the number with at least weekly contact, d) the number who are very or extremely emotionally close, and e) the number of different types of relationships (i.e., close and distant kin, different types of non-kin). Pre-pandemic social connectedness was highly important, as it provided stability and resources to cope with the sudden shock.

¹ Wave 8 was collected in two field-phases: before the outbreak of the COVID-19 pandemic (regular panel interview) and during spring and summer 2020 (SHARE Corona 1-interview). We use data from the pre-pandemic regular interview, as it contains the social network module. Overall, 27 countries participated in the regular wave 8 panel interview, including Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Romania, Spain, Sweden, Switzerland, Slovakia, and Slovenia. Of these 27 countries.

3.3. Control variables

Finally, we include a number of control variables measured pre-pandemic, which potentially confound the relationships of social connectedness and internet use with mental health. Socio-demographic controls include gender (ref. = men), age in groups (less than 60 (ref.), 60s, 70s, 80s+), marital/relationship status (married and living together with spouse (ref.), registered partnership, married but living separated from spouse, never married, divorced, widowed), number of living children (none (ref.), 1, 2, 3–5, 6 or more), and number of grandchildren (none (ref.), 1–2, 3–5, 6 or more). We also control for the extent of functional health limitations (measured with four categories).²

Socio-economic characteristics include highest educational level (below upper secondary, at most upper secondary, tertiary), quintiles of household income (computed separately within each country and studied as categorical), and changes in employment between pre-pandemic (wave 8) and the SHARE Corona Survey 2 ("not working in either wave (ref.)", "entered work", "exited work", "worked both waves"), which has been associated with increased mental health problems (author 1). Corresponding changes in marital/relationship status could not be studied as the SHARE Corona Survey 2 did not include variables on marital/relationship status. Finally, social context is captured with area of residence (living in an urban area vs. living in a rural area or village) and country of residence.

3.4. Analytical strategy

Our analyses are based on a cross-sectional dataset comprising one observation per respondent. Nevertheless, information on the outcome variable and pre-pandemic networks stem from different periods, and internet use represents changes across the studied period (from pre-pandemic to a later stage of the pandemic), we are able to minimize problems of endogeneity. We apply multinomial logistic regression models, predicting self-reported stable prevalence of and increase in depressive mood as compared to the absence of depressive mood (the base category). Changes in depressive mood are explained with self-reported changes in online health and government information search (included simultaneously), adjusting for the control variables.

In the second step, we include interaction terms between social connectedness and the two types of internet use (simultaneously). To test for our second (compensation of resources) and third (dependency) hypotheses, which are predicated on internet use being protective for mental health, we estimate the model including interaction terms using stable internet users as the reference category. The rationale behind this selection is that we expected a deviation of non-users (stable non-users or decreased users) from this group, who should exhibit higher risk of depressive mood, which might then be positively (H2) or negatively (H3) moderated by social connectedness. To test for the fourth (alleviation worries) and fifth (conflict and estrangement) hypotheses, which are based on internet use being a risk for mental health, we use stable internet non-users (i.e., individuals who report not having used the internet before the pandemic and not having taken up internet use) as the reference category, as we expect internet users to deviate from this group and exhibit higher risk of depressive mood, which might then be positively (H4) or negatively (H5) moderated by network connectedness. Finally, we test for independence of irrelevant alternatives (IIA) using the Hausman test. This assumption states that a respondent's choice between two answer categories will not be affected by the

² Reported numbers of limitations in activities of daily living, instrumental activities of daily living, and mobility restrictions were combined into a sum score. We standardized the sum score separately for men and women and created a categorical variable denoting 0 = no limitations (ref.), 1 = up to the mean, 2 = max. 1 standard deviation (SD) above the mean, and 3 = more than 1 SD above the mean.

presence of a third, unrelated option. The test statistics confirm that the assumption is not violated ($p > 0.7$).

Findings are presented graphically, as predictive margins (Figs. 1 and 2), and in tabular form, as relative risk ratios (RRRs) (Table 2). These predictive margins employ an earlier fit model to estimate the average values of the outcome at specific values of one or more covariates, while controlling for imbalances based in the remaining covariates (Graubard & Korn, 1999). The precise calculations involved are explained in Graubard and Korn (1999).

All models were weighed with the SHARE Corona Survey 2 calibrated cross-sectional weights, to adjust for differential probabilities of selection into the sample and of non-response. Standard errors were robustly adjusted for and clustered at the household level. All analyses were conducted with the Stata 16 statistical software package.

4. Results

4.1. Associations between internet use and depressive mood

Fig. 1 shows the multivariate associations between changes in internet use and changes in (self-reported) depressive mood since the outbreak of the COVID-19 pandemic separately for the two types of internet use. Associations are presented as predicted probabilities, developed through predictive margins, at the mean of social connectedness. RRRs can be obtained from Table 2, the upper section.

We find a significant positive association between an increase in government information search and an increase in depressive mood (relative risk ratio (RRR) = 1.618*), represented by the light grey diamonds on the right-hand panel in Fig. 1. A similar trend is also found for stable depressive mood among those who increased their government information search (1.335) and increased depressive mood among those who increased their health information search (RRR = 1.402); yet these differences are not statistically significant at conventional levels. These findings are in line with our hypothesis H1b. Evidence for protective effects of internet use (H1a), however, are the findings that those

who increased their health information search on the internet showed a decreased risk of stable depressive mood (0.642**), while those who did not engage in government information search exhibited the highest levels of stable depressive mood (1.514*). Both of these latter effects reached statistical significance.

4.2. Assessing the moderating role of social connectedness

Next, we turn to the interaction between internet use and social connectedness. Results are presented graphically, as predicted probabilities (the y-axes in Figs. 2 and 3) of experiencing depressive mood across varying levels of network connectedness (the x-axes). We start with a discussion of the results for health information search (Fig. 2), followed by government information search (Fig. 3). The figures are arranged in four panels, distinguishing between experiencing stable or increased depressive mood as an outcome (paired left and right), for internet users (the two panels on the left side) and non-users (the two panels on the right side). The lower part of Table 2 presents RRRs of the interaction terms, indicating the deviance of increased and decreased internet use as compared to stable non-use and stable use (both serving as reference categories, depending on the hypothesis tested).

Regarding health information search (Fig. 2), we start with the assumption of protective effects of internet use (H1a), and the positive or negative moderation potentials of network connectedness (H2 and H3). We find that higher social connectedness mostly decreases the risk of depressive mood among internet users and non-users, as the majority of the slopes in Fig. 2 point downwards. This is also reflected in the RRR-coefficients (Table 2, column 1) where the main effect for network connectedness (RRR = 0.848, n.s.) is slightly negative for stable internet users' (the reference) likelihood of having a stable depressive mood. However, as the main and interaction coefficients for health information search in Table 2, columns 1 and 2, suggest, none of these trends are statistically significantly different from one another. What remains statistically significant is the overall difference between stable users and increased users (RRR = 0.633**) with regard to their risk of

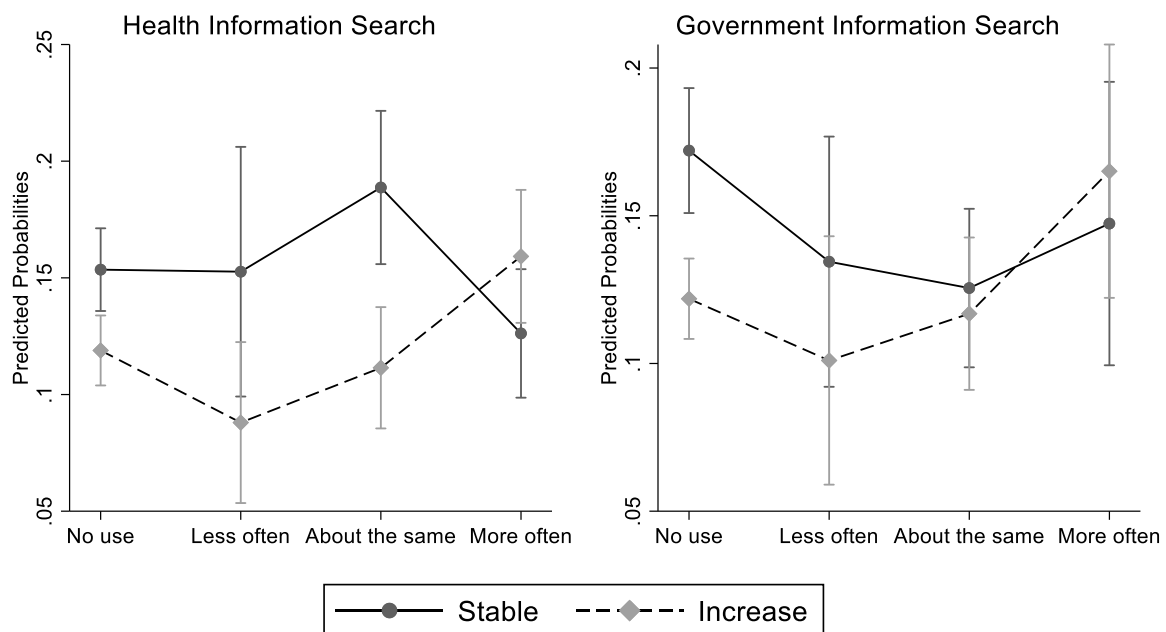


Fig. 1. Associations between Internet use and Changes in Depressive Mood. Source: SHARE Wave 8 pre-pandemic regular panel interview (collected 2019/2020) and Corona 2-survey (collected in June–September 2021). Analytical sample: $n = 30,076$ persons. Estimates (predicted probabilities) of stable and increased mental health problems, at the mean of social connectedness (pre-pandemic), weighted results from multinomial logistic regression models. For RRRs, see the upper part of Table 2.

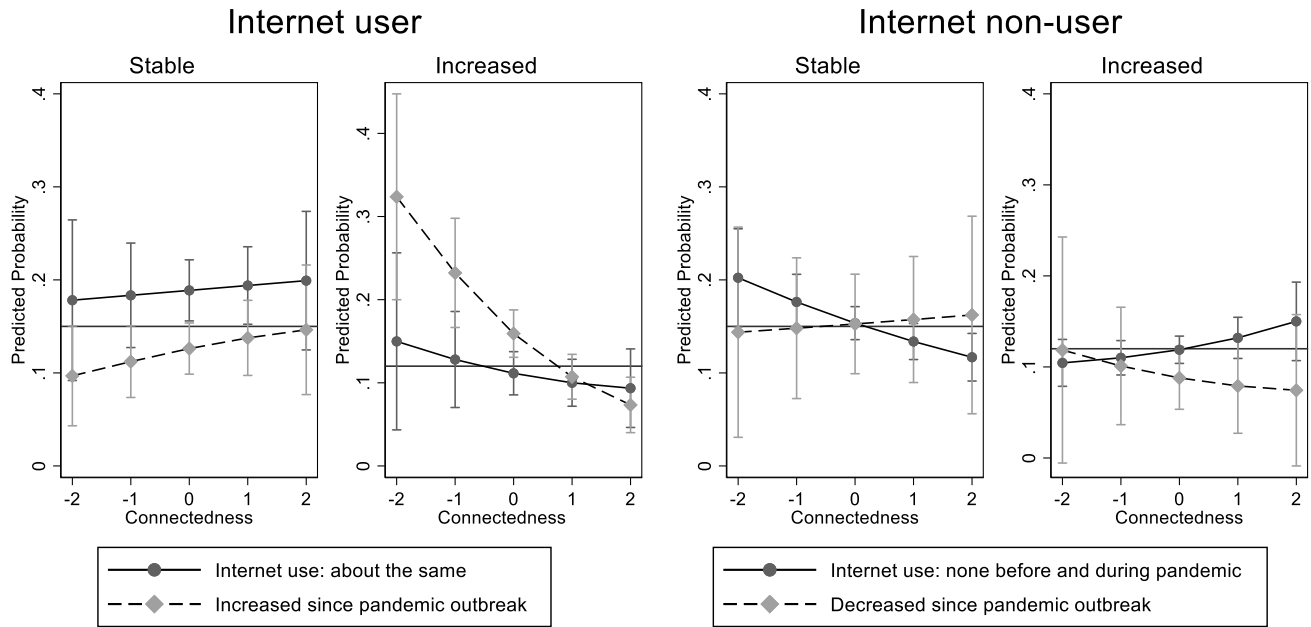


Fig. 2. Health-Related Internet Search and Depressive Mood Conditional on Social Connectedness. Data Source: SHARE waves 8 and Corona Survey 2. Predicted Probabilities derived from multinomial logistic regressions including all control variables (n = 30,076). Reference lines represent population averages (15 % stable, 12 % increased depressive mood).

Table 2
Main effects and interaction terms between internet use and networks (relative risk ratios).

	(1)	(2)	(3)	(4)
No Depressive mood vs.	Stable	Increase	Stable	Increase
<i>Main Effects</i>				
Health Information Search: none	0.751	0.990	(ref.)	(ref.)
Decrease	0.761	0.701	1.014	0.708
Stable use	(ref.)	(ref.)	1.332	1.010
Increase	0.633**	1.399	0.844	1.413*
Government Information Search: none	1.427	1.157	(ref.)	(ref.)
Decrease	0.964	0.868	0.676	0.750
Stable use	(ref.)	(ref.)	0.701	0.864
Increase	1.252	1.594*	0.877	1.377
Social connectedness	0.848	1.243	0.885*	0.937
<i>Interaction Relative Risk Ratios</i>				
Health Search: none * Social connectedness	0.827	1.233	(ref.)	(ref.)
Decrease * Social connectedness	0.888	0.981	1.074	0.795
Stable use * Social connectedness	(ref.)	(ref.)	1.209	0.811
Increase * Social connectedness	0.980	0.697	1.185	0.565**
Government Search: none * Social connectedness	1.262	0.611*	(ref.)	(ref.)
Decrease * Social connectedness	1.017	1.272	0.806	2.082*
Stable use * Social connectedness	(ref.)	(ref.)	0.793	1.637*
Increase * Social connectedness	1.195	0.665	0.947	1.088
Observations	30076	30076	30076	30076

Data Source: SHARE Wave 8 (October 2019–February 2020) and Corona 2-survey (May–October 2021). Multinomial logistic regression models, control variables included, weighted results. Robust standard errors clustered at the household level. All interaction terms were estimated simultaneously. Models (1) and (2) use stable internet use as the reference category (testing H2 and H3). Models (3) and (4) utilize stable internet non-use as the reference category (testing H4 and H5).

experiencing stable depression (as illustrated in the two nearly parallel slopes in the leftmost panel in Fig. 2).

Yet, when we turn to the assumption of a negative effect of health-

related internet use (H1b, Table 2, columns 3 and 4), we find that social connectedness significantly reduces stable depression (RRR = 0.885*) for stable non-users as compared to stable users. Moreover, higher network connectedness significantly **positively moderates** the previously found higher risk of increased depressive mood (main effect: RRR = 1.413*) among recent or increased users for health information search. Specifically, the deeper the pre-pandemic network connectedness, the smaller the risk of increased depressive mood among members of this group (interaction RRR = 0.565**). This finding is reflected in the steep downward pointing light grey slope in the second-to-left panel and supports our fourth hypothesis (H4) which was based on the mechanism that concerns arising from exposure to **worrying content or false information can be alleviated** by offline support and contact with social ties.

Turning to government information search (Fig. 3), we find evidence for both positive and negative moderation. Starting from H1a assuming benefits of internet use (columns 1 and 2 in Table 2), we found that higher connectedness reduces the risk of increased depressive mood among those who are stable non-users (interaction RRR = 0.611*), whose main effect (at means of social connectedness) was slightly, albeit not significantly, positive (RRR = 1.157, n.s.). This finding is reflected in the downward-pointing light grey slope in the rightmost panel in Fig. 3, indicating a reduction in (self-reported) depressive mood the higher the network connectedness among internet non-users. This association supports our second mechanism that posits that social connectedness may **compensate for a lack of resources** stemming from internet non-use (H2). However, negative moderation is found for those who decreased their internet use for government internet use. While the RRR's for main effect imply slightly lower, albeit non-significant, risks for stable (RRR = 0.676, n.s.) and increased depression (RRR = 0.750, n.s.), this lower risk is offset among those who heavily rely on offline social ties, creating **dependency** and resulting in higher risks of increased depressive mood (RRR = 2.082*, see Table 2, column 4). This finding is thus in line with our third hypothesis (H3).

Finally, we turn to the assumption of a negative effect of internet use (H1b) and the test of H4 (alleviating worries) and H5 (conflict and

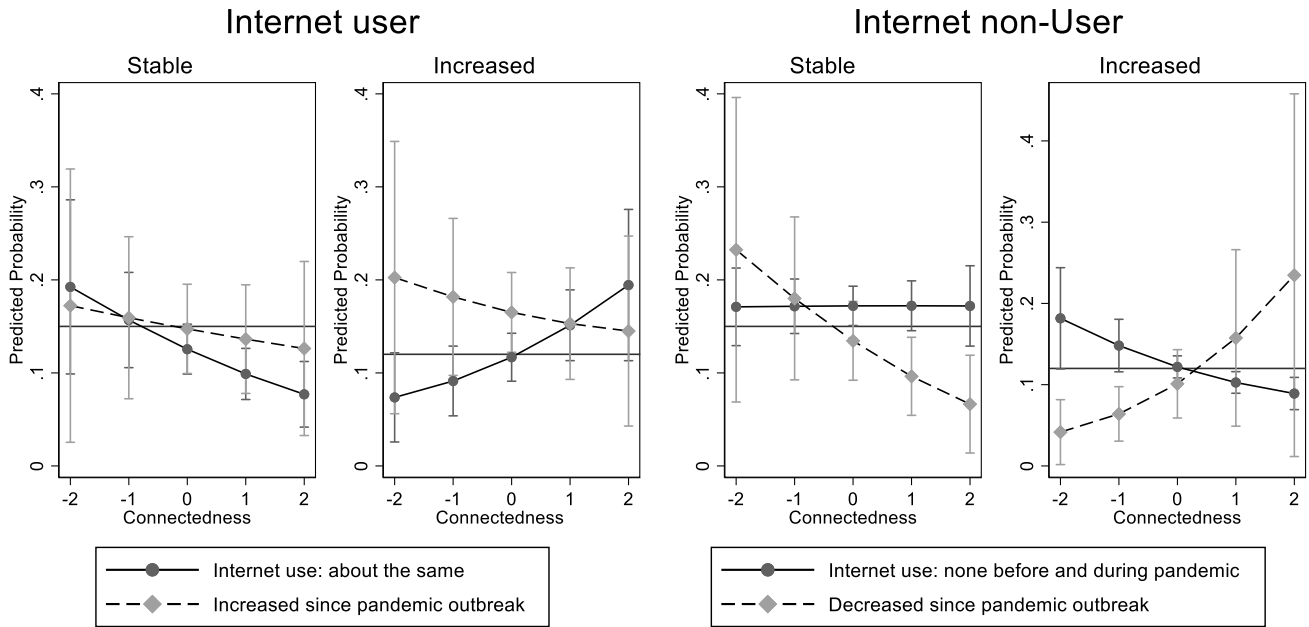


Fig. 3. Government-Related Internet Search and Depressive Mood Conditional on Social Connectedness. Data Source: SHARE waves 8 and Corona Survey 2. Predicted Probabilities derived from multinomial logistic regressions including all control variables (n = 30,076). Reference lines represent population averages (15 % stable, 12 % increased depressive mood).

estrangement), as displayed in columns 3 and 4 in Table 2. We also find evidence for negative moderation. Specifically, the deeper one’s social connectedness, the higher the risk of increased depressive mood among those stably using the internet for government information search (RRR = 1.637*). This finding supports our fifth hypothesis (H5), assuming that **disagreements or conflicts** over pandemic governance measures (such as vaccinations or masking) may lead to estrangement from close social ties and ultimately suppress well-being. The higher risk of increased depression among those increasing their internet use (Main effect: RRR = 1.594*), is reduced by higher network connectedness (RRR = 0.665), although this moderation is not significant.

4.3. Robustness tests

To test for the robustness of our results, we conducted a number of sensitivity analyses.

First, we removed the category “decreased in depressive mood” from the outcome variable as its prevalence was below 3 per cent. These findings are reported in the supplementary files, Table A.4, and are stable.

Second, countries may differ with regard to their degree of digitalization, both in general and with regard to their older populations. This has implications for internet use among older populations (see Figure A.2 in the supplementary files for distributions of health and government information search). We thus re-estimated our models replacing the countries with indicators on the internet infrastructure, use and skills of internet in the older population and general population internet access (see Table A.5 in the supplementary files), using Digital Economy and Society Index (DESI) indicators from the European Commission (2024).

Our associations between individual internet use and depressive mood remain stable upon inclusion of these indicators. When including information in internet skills and weekly internet use among older adults, or overall internet access in the population (in the household, broadband mobile), the positive association between increasing health information search and increasing depressive mood becomes significant

(p < 0.05). Moreover, the degree of digitalization in a country is independently associated with (self-reported) depressive mood. We find that in countries with more developed digital infrastructure (measured with a composite index, see European Commission, 2024), and in countries where a larger share of the population between 55 and 74 years of age has at least basic internet skills, the risk of increasing depressive mood between the pandemic stages is smaller than in countries with less infrastructure or fewer skills in that age group. Moreover, we also find that in countries where the share of weekly internet users among those aged 55–74 is higher, the risk of increasing depressive mood between the pandemic stages is larger. The latter suggests the possibility of increased doomscrolling heightening the risk of raised depressive mood. No significant associations were found with access to internet across households, or mobile broadband internet use. For full details, see Table A.5 in the Appendix.

5. Discussion

5.1. Summary

In this study, we aimed to uncover whether internet use during the pandemic was associated with changes in mental health between pandemic periods, and how these associations depend on social connectedness. We exemplarily focused on two applications of internet use which have few technical and skill requirements but were highly salient during the exceptional pandemic situation: namely health and government information search. In line with earlier studies, we found both negative associations between increase in internet use and mental health (Lam et al., 2022; Price et al., 2022) and protective consequences of internet use (Kung & Steptoe, 2023b; Lee, 2023). Moreover, our findings depend on the type of internet use. While use for health information is protective against depressive mood during the pandemic, increased search for government information is associated with higher risk of depressive mood, and so is abstention from search for government information. Thus, our findings are in line with previous research (Kung & Steptoe, 2023b; Vismara et al., 2021) about the mixed nature and

concomitants of internet use in an infodemic (Balakrishnan et al., 2022).

However, our findings extend earlier research by highlighting the plurivalent nature of how this association depends on individuals' previous social resources. Specifically, our findings point to social connectedness' moderation potentials in both directions. On the one hand, we found a protective moderation of higher social connectedness, which reduces the mental health risks of disadvantages arising from internet non-use. Such **compensation for a lack of online resources** was found for non-users of the internet for government information search. Thus, our second hypothesis (H2) is supported. Moreover, we found support for **alleviation of worries and concerns** (H4) among internet users for health information search with deeper pre-pandemic networks. Hence, positive moderation may occur pertaining to both negative aspects of internet use (such as doomscrolling and exposure to worrying content) and negative aspects of internet non-use (such as lack of access to information and services).

Negative moderation was found for both internet users and non-users also, but only with regard to government information search. On the one hand, we found that lacking access to online information and services, and the resulting reliance on offline social contacts to be aggravated in contexts with deeper networks. This may create **dependency on offline support** among internet non-users and strain social ties and well-being, thus supporting H3. Finally, we found that increased online information search may also be negatively related to well-being and reinforced by deeper social networks, supporting H5. Particularly in the context of the COVID-19 pandemic, **disagreements and conflicts** over pandemic governance, regulations, and appropriate behaviors may arise and lead to estrangement and subsequent loss of social ties (author 2).

Taken together, these findings imply that mental health may be shaped by an interplay of online and offline resources (Peng et al., 2018), and that both internet use (e.g., Bu et al., 2021; Kung & Steptoe, 2023b; Lee, 2023; Vismara et al., 2021) and social connectedness (e.g., Antonucci et al., 1998; Granovetter, 1973; Steverink & Lindenberg, 2006) may work in protective or challenging ways for mental health. The predominant patterns that arose, however, suggested a risk for depressive mood among those who recently increased their internet use, and positive moderation by deeper social connectedness among internet non-users. Our findings applied to government information search and – to a lesser degree – health information search and held for both stable and increased depressive mood. These findings suggest that mental health observed in later stages of the COVID-19 pandemic are more than a continuation of the exogenous shock experienced in its initial lockdown period, and document the dynamics of mental health and well-being throughout stages of a public health crisis.

5.2. Limitations and avenues for future research

This paper comes with a number of limitations that we would like to critically discuss. First, while longitudinal data are preferable to estimate causal effects, we have to rely on cross-sectional data containing self-reported changes in internet use and mental health because – during COVID-19 – the SHARE captured mental health and internet use with different instruments than in the regular panel waves and referring to various time periods. Hence, for each individual, we observe only one point in time. This prevents estimation of longitudinal models for repeated data offering the opportunity of adjusting for unobserved heterogeneity and reducing endogeneity.

Second, we relied on two types of internet search. Despite their few requirements and high salience, and potentially an increased need for them during the pandemic, we cannot generalize our findings to other internet applications. Future research should extend our analysis to other types of internet use (e.g., online banking, commercial applications, video calls), which are means of staying independent and covering one's needs in the light of health decline – regardless of a pandemic situation.

Third, networks carry many aspects that affect mental health. The

pre-pandemic measure in SHARE wave 8 only comprised respondent-reported quantitative and structural network features, and support potential. Our findings regarding connectedness were mixed, exhibiting both protective and straining moderation potentials. It is likely that the specific natures of the social ties may explain these findings. Future research could concentrate on eliciting the mechanisms behind positive and negative moderations of internet use.

6. Conclusions

Despite these limitations, we are confident that our approach offers conceptual value, by theorizing about different moderating potentials of social connectedness in the light of the ambiguous mental health consequences of internet use. Moreover, our study adds empirical value to the extant literature on older adults' internet use, the pandemic's effects on mental health, and the interactions of different types of resources for later life well-being. One particular advantage of this study is that the pandemic situation has exerted a sudden, exogenous shock and affected almost all older adults in a similar fashion across institutional contexts (Paccagnella & Pongiglione, 2022).

Furthermore, the COVID-19 pandemic has revealed the need for societal preparedness for future broadscale health, financial, or environmental crises, during which no one should be left behind (United Nations, 2023). Despite a return to "normal" in most societies, our findings yield some insights which are relevant beyond the COVID-19 pandemic, and informative for dealing with future crises. Our study thus contributes to general debates and developments with its insights and suggestions concerning how to strengthen civil societies' resilience and improve their inclusiveness in ageing societies and uncertain times.

CRedit authorship contribution statement

Jason Settels: Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ariane Bertogg:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chbr.2025.100659>.

Data availability

The authors do not have permission to share data.

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