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Physical distancing is related to fewer electronic and in-person contacts and to increased loneliness during the COVID-19 pandemic among older Europeans

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Abstract

Purpose During the COVID-19 pandemic older adults are asked to maintain physical distancing, which can be linked to loneliness. While older people are encouraged to use electronic communication to stay socially connected, it remains an open question whether electronic contacts are related to lower loneliness during the pandemic. This study examined the associations of physical distancing during the pandemic with loneliness and the role of in-person and electronic contacts with children and non-kin as explaining these associations across European regions.

Methods The study used data from Survey of Health, Ageing and Retirement in Europe (SHARE), collected during the COVID-19 pandemic in 2020. Mediation and moderation analyses tested the direct and indirect associations between physical distancing, contact frequency and loneliness, as well as the differences across European regions.

Results The results indicate that adults who reported higher frequency of physical distancing also felt lonelier during the pandemic. This association was partly explained by social contacts—those who practiced physical distancing maintained less in-person contact with children and non-kin and less electronic contact with non-kin, which were related to feeling lonelier. Adults in Southern European countries felt lonelier and reported more frequent contacts. The moderation analyses showed that the link between physical distancing and loneliness was found in the northern region, but not in the southern and eastern regions of Europe.

Conclusion This study can indicate that attention should be paid to adults who may struggle to maintain social contacts in light of physical distancing guidelines.

Keywords Social contacts · Friends · Loneliness · Online · Phone

Introduction

The older population faces increased health risks resulting from the COVID-19 pandemic [1, 2]. In an attempt to shield older adults, they are encouraged to avoid social contacts outside of the home [3]. In particular adults are asked to maintain physical distancing to protect their health, including avoiding crowded places [4]. Thus, older adults are faced with difficult choices and can face a "double jeopardy" during the pandemic. On the one hand, maintaining physical distance can protect them from infections and potentially save their lives [5]. On the other hand, social contacts are a fundamental human need, with far-reaching effects on health and well-being [6–10], and prolonged social isolation increasing the risk of loneliness [11, 12]. Physical distancing guidelines may hamper the ability of older adults to maintain in-person contact with their loved ones, resulting in increased loneliness [13, 14].

Isolation can be especially detrimental for the older population because their often relatively poor digital literacy may put them at a disadvantage in using the internet to keep in touch [15]. Therefore, the effects of physical distancing on loneliness can depend on the ability of older adults to maintain social contacts. Consequently, during the pandemic adults have been encouraged to use electronic communication to stay connected, as a means to compensate for the lack

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of in-person contact [16]. However, it is unclear whether adults who adhere to physical distancing guidelines will indeed maintain more electronic contacts to keep in touch with loved ones. In "regular" times, social use of the internet is associated with decreased loneliness [17], which can improve quality of life [18], and electronic communication is considered as a useful means to maintain contact with physically remote people [19]. However, adults in "pre-COVID" studies were voluntarily using the internet and were often relatively educated and in a better cognitive status [20].

During the pandemic, on the other hand, some adults might be pushed to take up more electronic forms of communication. The diffusion model explains the spread of an innovation as a diffusion process, in which a new technology is introduced to a comparatively small homogenous group from which it then slowly spreads out [21]. Physical distancing can be related to higher prevalence of electronic communication around older individuals, leading to more use of such a communication mode. However, evidence to this extent is limited. Investigations of social contacts by older adults during the pandemic haven't differentiated between in-person and electronic contact [7, 22], and it is yet unclear whether electronic contact can be linked with lower loneliness of adults who maintain physical distancing guidelines during the pandemic.

When examining social contacts, it is necessary to distinguish between contact with children and non-kin, both of which constitute central types of social ties of adults [23, 24]. Contact with children is beneficial for well-being [24] and is related to lower loneliness among older adults [25]. During the COVID-19 pandemic, contact with children was found to be associated with lower social loneliness among Dutch older adults [7]. However, contact with children during the pandemic can also be shaped by normative obligation, possibly resulting in ambivalent and even conflictual communication [26]. Friends and other non-kin ties, on the other hand, can be more voluntary ties and more strongly linked to well-being [27] and reduced loneliness [25, 28]. Therefore, the current investigation will examine the links of physical distancing to contact with children and non-kin ties, as well as their associations with loneliness.

As the COVID-19 pandemic is experienced across Europe, the pandemic's effects on loneliness and social contacts may vary between European countries. These countries differ in their prevalent norms of family solidarity, which affect loneliness and social contacts [29, 30]. Such norms are often stronger in Eastern Europe and weaker in Western Europe [31]. A common finding in "pre-COVID" times is that Southern European countries show a high prevalence of loneliness, while loneliness among older adults is less common in Western and Northern Europe [32, 33].This trend can be explained by Johnson and Mullins' [34] concept of the "loneliness threshold"-people have their own minimal standards for social contacts, determined by the cultural value system in a society and the number of social contacts to which people are normally accustomed [35]. In more collectivist cultures (like Southern European countries), pressures and expectations of communality are likely to be higher than in a more individualist type of culture (Northern European countries) [36, 37]. Thus, we will inspect the associations of physical distancing, contacts and loneliness during the COVID-19 pandemic among European adults.

To sum, the current study will examine the associations of physical distancing during the COVID-19 outbreak with loneliness, and the role of in-person and electronic contacts with children and non-kin ties in these associations across European regions. Our investigation is guided by four hypotheses:

(1) Adults who maintain physical distancing are more likely to report loneliness.
(2) This association will be mediated by in-person contacts—physical distancing will be related to less in-person contact which will be related to more loneliness.
(3) This association will be mediated by electronic contacts—physical distancing will be related to more electronic contact which will be related to less loneliness.
(4) Adults in Southern European countries will report greater loneliness and more social contacts, and will present stronger associations between physical distancing and loneliness.

Methods

The present study is based on the Wave 8 COVID-19 data collected by the Survey of Health, Ageing and Retirement in Europe (SHARE) [38]. SHARE is a cross-national panel survey of European community-dwelling adults aged 50 and above and their partner of any age [39]. The COVID-19 special dataset is based on interviews of a sub-sample of SHARE's panel respondents via a Computer Assisted Telephone Interview (CATI). It collected data targeted to the COVID-19 situation of European adults people who are 50 years and older [38]. The COVID-19 wave of SHARE was reviewed and approved by the Ethics Council of the Max Planck Society. All participants provided informed consent.

The study sample focuses on 52,061 participants who took part in the COVID-19 survey. The main analyses were performed on the 42,246 participants who had supplied full information for all the study variables. Participants from the following 27 European countries took part in the COVID-19 survey and were thus included in the present study: Germany, Switzerland, Belgium, Poland, Luxembourg, Hungary, Romania, Spain, Italy, France, Greece, Israel, Portugal, Bulgaria, Cyprus, Malta, Czech Republic, Slovenia, Estonia, Croatia, Lithuania, Latvia, Slovakia, Sweden, Netherlands, Denmark, and Finland.

We compared these participants to those who were not included in the analysis due to missing information in the dependent variable—loneliness, using *t* tests or chi-square tests for continuous or categorical variables, respectively (Supplementary table 1). Participants with missing information were more likely to be female, older, to live alone, perceive their health as poorer, less likely to have electronic contact with children and non-kin, less likely to have in-person contact with non-kin and more likely to live in the eastern region in Europe.

Measures

Dependent variables

Loneliness

Loneliness was measured using a single item to assess loneliness. This item uses the question "How much of the time do you feel lonely?" with response options being (1) "Often", (2) "Some of the time", (3) "Hardly ever or never" [40]. Due to few responses of "Often" (7%), we converted it to a binary measure by merging the categories of "Often" and "Some of the time". A score of 0 indicated no loneliness and a 1 indicated some degree of loneliness.

Independent variable

Physical distancing. Respondents were asked whether they ever left their home since the outbreak. If they reported leaving their home, they were asked "Since the outbreak of Corona, how often have you done the following activities, as compared to before the outbreak?". One of the activities inquired about was "Meeting with more than 5 people from outside your household?". Response options ranged between 1 "Not any more" and 4 "More often". We also added a 0 category to indicate those who have not left their home since the outbreak. Next, we recoded these five responses such that a higher score indicated greater distancing (between 0 "More often" and 4 "Not left home").

Mediators

We used four indicators to assess the in-person and the electronic contacts of the participants with children and non-relatives such as friends and neighbours since the COVID-19 outbreak. In-person contact was tapped by inquiring "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?" Electronic contact was inquired with the question: "Since the outbreak of Corona, how often did you have contact by phone, email or any other electronic means with the following people from outside your home?" We focused on responses describing contact with children and "Other non-relatives like neighbours, friends, or colleagues". Each variable was measured on a 5-point Likert scale, ranging between 1 "Never" and 5 "Daily", with higher scores indicating more frequent contact.

Covariates

Covariates were sex, age, household's financial status, perceived health status, living alone and regions of Europe. Age was defined as continuous measures. Sex was a dichotomous variable (0 = male, 1 = female). Self-assessed health was measured on a 5-point Likert scale, ranging from 1 "Poor" to 5 "Excellent", such that a higher score indicated better perceived health. Household's financial status was defined as the household's ability to make ends meet since the outbreak, measured with a Likert scale ranging between 1 "With great difficulty" and 4 "Easily". We also considered whether participants lived alone or not. Regions of Europe were clustered into four categories according to the division of Nielsen, Halling and Andersen-Ranberg [41]: Central-Western Europe (countries: Germany, Switzerland, Belgium, Poland, Luxembourg, Hungary, and Romania); Southern Europe (countries: Spain, Italy, France, Greece, Israel, Portugal, Bulgaria, Cyprus, and Malta); Eastern Europe (countries: Czech Republic, Slovenia, Estonia, Croatia, Lithuania, Latvia, Slovakia); and Northern Europe (countries: Sweden, Netherlands, Denmark, and Finland). In the multivariable analysis, the variable was divided into three dummy variables and Central-Western Europe was defined as the reference category.

Data analyses

Descriptive statistics were applied to the background and study variables. Next, associations between the independent variable, dependent variable, mediators, and covariates were examined using chi square tests and Pearson correlations (not all data shown).

Multivariable analysis was computed in which the four mediators (in-person contact frequency with children; electronic contact frequency with children; in-person contact frequency with non-kin; electronic contact frequency with non-kin) were entered simultaneously to test the components of the mediation model using the bootstrapping method for assessing the indirect effects of the mediation model in the PROCESS statistical program [42, 43]. Thus, the multiple meditation model was investigated by directly testing the significance of the indirect effect of physical distancing on loneliness through the four mediators described above. The indirect effects were quantified as the product of the effects of physical distancing on the mediators (path *a*) and the effect of the mediators on loneliness (path *b*), while controlling for covariates.

The total effect (*path c*, without mediators) was calculated using a regular logistic regression model, with loneliness as

a binary outcome—controlling for the covariates (data not shown). The direct effect (weight c', with mediators) and indirect effects ($a \times b$ weights) of physical distancing on loneliness, were calculated using the multiple mediator analysis which is based on a logistic regression model. Since the mediators are continuous, the coefficients (a) associated with the paths between physical distancing and the mediators were estimated using linear regression models. The indirect effects were calculated through bootstrapping set at 5000 samples. Bootstrapping is a non-parametric method based on resampling with replacement which is done many times. From each of these samples the indirect effect is computed and a sampling distribution can be empirically generated. Because the mean of the bootstrapped distribution will not exactly equal the indirect effect a correction for bias can be made. Confidence intervals were calculated using this method by sorting the lowest to highest of these 5000 samples of the original dataset, yielding a 95-percentile confidence interval (if the number 0 falls within the confidence intervals, the tested effect would be non-significant). Nagelkerke's statistic (pseudo R^2) shows the total variance accounted for in the model. To calculate the explained variance added by the mediators we obtained the Nagelkerke's pseudo R^2 from the model without the mediators and subtracted it from the model with the mediators. The difference in pseudo R^2 indicates the explained variance added by the inclusion of the mediators.

Finally, we carried out logistic regression analyses to test the effect of the interaction (physical distancing * regions in Europe) on loneliness, after controlling for the effects of covariates. Odds ratio and 95% confidence intervals indicate the effect of each of the interactions between physical distancing with the three dummy regions of Europe (northern, southern, and eastern vs. central-western) and whether it met statistical significance. Chi-square test indicate whether the set of independent variables in the model reliably predicts the outcome. All analyses were run using SPSS 25.0.

Results

Table 1 shows the sample characteristics. About 29% of the participants reported feeling lonely and their average score on physical distancing was high, with an average of 2.7 (range: 0–4), indicating they met more than five people between "less often" and "not any more" since the outbreak. The respondents reported that since the outbreak they had in-person contact with their children "about once a week" (3, range: 1–5), while reporting electronic contact with their

Table 1 Descriptive statistics of the study variables ($N = 52061$)

Variables	*N* (%)	Mean (SD)	Valid range
Dependent variable			
Loneliness			
Not lonely	36668 (71.2)		
Lonely	14842 (28.8)		
Independent variable			
Physical distancing		2.7 (0.8)	0–4
Mediators			
In-person contact frequency with children		2.9 (1.4)	1–5
Electronic contact frequency with children		4.0 (1.1)	1–5
In-person contact frequency with non-kin		2.3 (1.2)	1–5
Electronic contact frequency with non-kin		2.8 (1.1)	1–5
Covariates			
Sex			
Women	30064 (57.7)		
Men	21997 (42.3)		
Age		70.5 (9.2)	50–103
Household financial status		2.8 (0.9)	1–4
Perceived health status		2.9 (0.9)	1–5
Household arrangement			
Lives alone	12637 (24.3)		
Lives with others	39423 (75.7)		
Regions of Europe			
Central-Western	15412 (30.1)		
Southern	15589 (30.4)		
Eastern	15414 (30.1)		
Northern	4820 (9.4)		

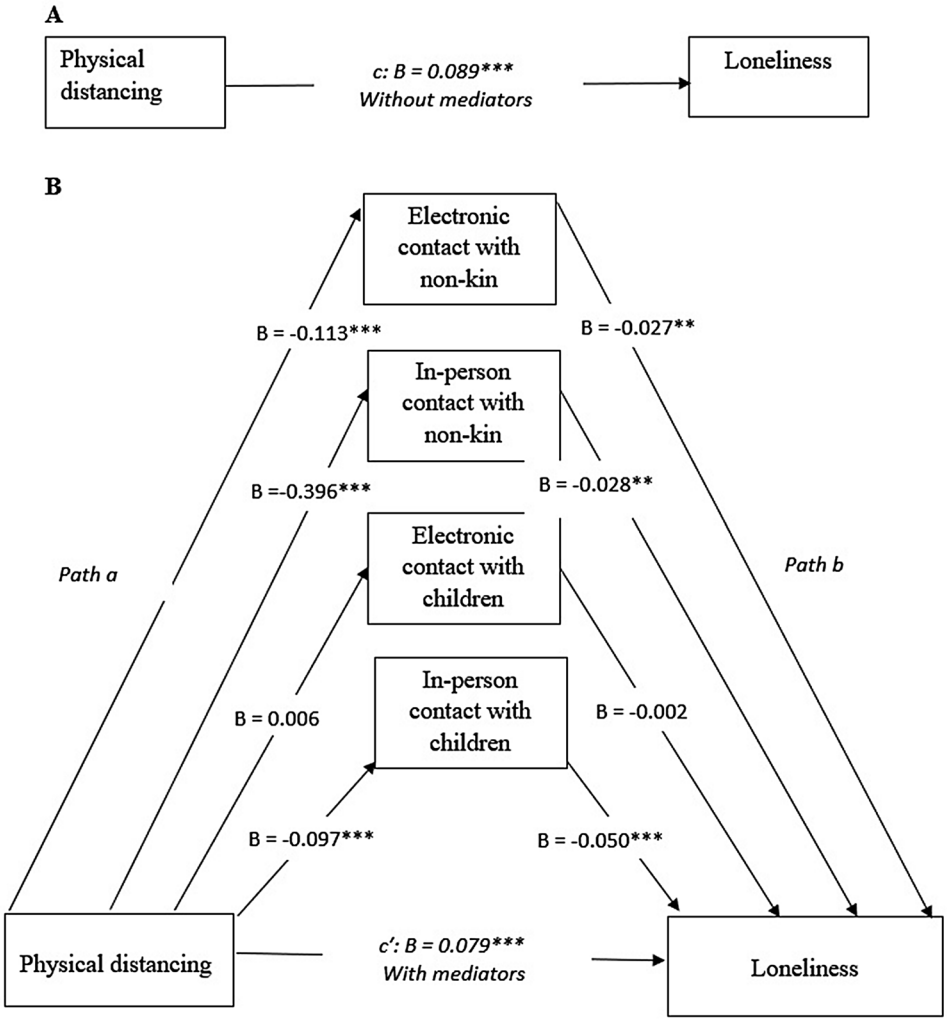

Fig. 1 Regular logistic regression depicting the beta coefficient of the direct effect (path *c*) without mediators (**A**); and a multiple mediator model—(**B**) depicting the beta coefficients of the direct effect with mediators (path *c*′) and the indirect effects (paths *a* and *b*) of physical distancing on loneliness via the four mediators (In-person contact with children; electronic contact with children; in-person contact with non-kin; Electronic contact with non-kin), controlling for covariates. $^{**}p < 0.01$, $^{***}p < 0.001$

children "several times a week" (4, range: 1–5). The participants reported in-person contact frequency with non-kin was "less often" than once a week (2, range: 1–5), while electronic contact with non-kin was more frequent, "about once a week" (3, range: 1–5). Table 1 also shows that the sample consisted of a majority of women, at an average age of 71. Almost a quarter of the respondents lived alone. About 30% lived in the central-western region in Europe, 30% in the southern region, 30% in the eastern region and 9% in the northern region.

Mediation effects: direct and indirect effects

We first tested the direct effect by logistic regression analysis—whether physical distancing was associated with loneliness, while controlling for covariates (see Fig. 1A). The results indicated a significant total direct effect of physical distancing on loneliness [B = 0.089, se = 0.013, $p < 0.001$, *Nagelkerke* (R^2) = 0.14]. That is, greater physical distancing was linked with a high probability of feeling lonely, regardless of the effects of covariates and mediators.

We then examined whether the direct effect was mediated by the four mediators (in-person contact frequency with children; electronic contact frequency with children; in-person contact frequency with non-kin; electronic contact frequency with non-kin), while controlling for the covariates (see Fig. 1B). After adding the four mediators, the direct effect of physical distancing on loneliness decreased, albeit remaining significant [B = 0.079, se = 0.015, $p < 0.001$, 95% CI = 0.050, 0.108, *Nagelkerke* (R^2) = 0.19]. In other words, the beta coefficient of the link between physical distancing and loneliness declines from B = 0.089 (without mediators) to B = 0.079 (with mediators) which indicates partial mediation via the mediators.

The beta coefficients of the indirect effects (see Fig. 1B, and Table 2) were significant for three of the mediators, except electronic contacts with children, indicating that physical distancing was related to lower in-person contact

Table 2 Direct effects of physical distancing on loneliness since the COVID-19 outbreak and indirect effects through in-person contact and electronic contact frequency with children and with non-kin ($N = 42246$)

Direct effects of physical distancing on loneliness since the COVID-19 outbreak—with mediators and covariates					*Nagelkerke* (pseudo R^2) (*p* value)
	B	95% CI		*p* value	
Constant	0.452	0.159	0.745	< 0.001	0.19 (< 0.001)
Independent variable					
Physical distancing	0.079	0.050	0.108	< 0.001	
Mediators					
In-person contact frequency with children	− 0.050	− 0.067	− 0.033	< 0.001	
Electronic contact frequency with children	− 0.002	− 0.025	0.020	= 0.846	
In-person contact frequency with non-kin	− 0.028	− 0.049	− 0.007	< 0.010	
Electronic contact frequency with non-kin	− 0.027	− 0.049	− 0.005	< 0.010	
Covariates					
Sex	0.431	0.381	0.481	< 0.001	
Age	0.009	0.006	0.012	< 0.001	
Household's financial status	− 0.306	− 0.333	− 0.280	< 0.001	
Perceived health status	− 0.321	− 0.348	− 0.294	< 0.001	
Household arrangement	− 1.308	− 1.362	− 1.254	< 0.001	
Southern Europe	0.256	0.194	0.319	< 0.001	
Eastern Europe	− 0.127	− 0.188	− 0.066	< 0.001	
Northern Europe	− 0.218	− 0.314	− 0.122	< 0.001	
Indirect effect of physical distancing on loneliness since the COVID-19 outbreak via *the four mediators*					
	B	95% CI			
In-person contact with children	0.004	0.003	0.006		
Electronic contact with children	0.000	− 0.000	0.000		
In-person contact with non-kin	0.011	0.003	0.019		
Electronic contact with non-kin	0.003	0.001	0.005		

Value labels of categorical variables: Loneliness (0 = not lonely, 1 = Lonely); Sex (0 = male, 1 = female); Perceived health status (1 = poor to 5 = excellent); Household arrangement (0 = lives alone, 1 = lives with others); Household's financial status (1 = With great difficulty to 4 = easily); Northern Europe (0 = Central-Western, 1 = Northern Europe); Southern Europe (0 = Central-Western Europe, 1 = Southern Europe); Eastern Europe (0 = Central-Western, 1 = Eastern Europe)

frequency with children and non-kin, as well as to lower electronic contact frequency with non-kin, and these in turn, were linked to a higher likelihood of feeling lonely. Adding these mediators contributed 5% to the explained variance in loneliness, after the contribution of the covariates (see Table 2 and Fig. 1). This indicated that taking into account these mediators explained an additional 5% of variance in the feeling of loneliness, via indirect paths, beyond the 14% of variance that was found without mediators.

Table 3 presents the direct effects of regions in Europe (with the central-western region as the reference category) on the four mediators, while controlling for the covariates. The results showed the in-person contact with children was more frequent in the southern region of Europe and less frequent in the northern region compared with the central-western region. It was also found that electronic contact with children was more frequent in the southern and eastern regions compared with the central-western region while being less frequent in the northern region of Europe. In-person contact with non-kin was less frequent in the southern and eastern regions than the central region, but was more frequent in the northern region. In addition, electronic contact with non-kin was more frequent in the southern and eastern regions than the central-western region.

Moderation effects

Logistic regression analysis was conducted to explore the effect of the interaction (physical distancing * regions in Europe) on loneliness, controlling for covariates. The interaction model was significant [χ^2 (3, 15) = 7255.87, $p < 0.001$]. This result indicated that the probability of

Table 3 Direct effects of regions in Europe on the four mediators—in-person and electronic contact frequency with children and with non-kin ($N = 42246$)

Regions in Europe	In-person contact with children			Electronic contact with children			In-person contact with non-kin			Electronic contact with non-kin		
	B	95% CI	*p* value	*B*	95% CI	*p* value	*B*	95% CI	*p* value	*B*	95% CI	*p* value
Southern Europe	0.15	0.11 0.19	0.001	0.49	0.46 0.52	0.001	− 0.07	− 0.10 − 0.04	0.001	0.37	0.34 0.39	0.001
Eastern Europe	− 0.01	− 0.03 0.03	0.860	0.07	0.05 0.10	0.001	− 0.12	− 0.15 − 0.09	0.001	0.18	0.15 0.20	0.001
Northern Europe	− 0.15	− 0.19 − 0.12	0.001	− 0.14	− 0.18 − 0.11	0.001	0.06	0.02 0.10	0.001	− 0.01	− 0.05 0.02	0.386

Regions in Europe: Southern Europe (0 = Central-Western Europe, 1 = Southern Europe); Eastern Europe (0 = Central-Western, 1 = Eastern Europe); Northern Europe (0 = Central-Western, 1 = Northern Europe); The models controlled for the covariates

feeling lonely increased when the degree of physical distancing increased in the northern region [$B = 0.15$, $P = 0.001$, 95%CI: 1.04–1.30, OR = 1.16], but not in the southern and eastern regions, compared with central-western region (data not shown).

Discussion

To sum, the current investigation showed that during the COVID-19 pandemic, European adults that maintained physical distancing were more likely to feel lonely, in accordance with our first hypothesis. This effect was mediated by in-person contact, confirming our second hypothesis. Specifically, maintaining physical distancing was associated with less in-person contacts with children and non-kin, which were in turn associated with greater loneliness. The effect of physical distancing was also mediated by electronic contact with non-kin, but in the opposite direction to our hypothesis. That is, adults who maintained physical distancing reported less electronic contact with non-kin, and this was related to increased loneliness. Finally, adults in southern European countries reported greater loneliness, while reporting more contact with children, more electronic contact with non-kin and less in-person contact with non-kin, compared to central-western European countries. In the northern region, physical distancing was more strongly associated with loneliness compared to central-western European countries when accounting for the interaction term between physical distancing and regions. This partially confirmed our fourth hypothesis.

This study showed that adults who adhered to physical distancing guidelines and reduced encounters with more than five people felt lonelier compared to those who reported lower adherence to these guidelines. This suggests that even tough physical distancing guidelines can decrease the risk of COVID-19 infections for older adults, they may place them at risk of greater loneliness [3]. Overall, there are indications that older adults as a group have not necessarily suffered from increased loneliness during the pandemic [44, 45]. However, our results could suggest that attention should be directed towards adults who maintained more physical distancing, as they face a greater risk of loneliness. These results can also help explain previous findings of less loneliness among older compared to younger adults during the pandemic [44]—older adults could be less likely to attend crowded places (e.g. a workplace) and less likely to feel lonely when kept away from such venues. However, adults who are used to crowded places (such as community centres) can feel lonelier when decreasing their attendance of such venues.

We also examined the mediating pathways that can explain the effect of physical distancing. Adults who adhered

to the guidelines reported less frequent in-person contacts with their children and non-kin, and these were related to increased loneliness. However, we also hypothesized that adults who report physical distancing will cope with their reduced in-person contacts by increasing their electronic interactions. This hypothesis was not supported by our results. Adults who maintained physical distancing also reported less electronic contact with non-kin, which was related to increased loneliness. These results indicate that older adults may not necessarily increase their use of alternative means of contact in order to cope with physical distancing guidelines, but rather that adhering to these guidelines could be related to lower overall contact with others. A potential explanation is that adults who avoided crowded places are those who were used to attending social settings for older adults, such as community centres [46], and it was more difficult to them to maintain electronic contact with the people from these venues. Another related explanation is that the connections with non-kin are usually based on face-to-face meetings [47]. Such meetings are difficult to carry out during the pandemic and not all older adults can bridge the technological gap and transfer these contacts to the electronic sphere [48]. Thus, adults who refrain to a larger degree from crowded places seem to face a greater risk of both physical and electronic isolation. These findings may indicate that adults could benefit from interventions to improve their digital literacy [20] and foster online social activities [49] in order to combat loneliness.

Interestingly, electronic contact with children was not related to loneliness, unlike the association to electronic contact with non-kin. This finding is supported by previous literature which indicated that contact with friends is more strongly associated with loneliness compared to contact with children [25, 28]. Contact with children is more obligatory [50], while the connection with non-kin is voluntary and leans on value, mutual interests, equality, respect and love [27]. During the pandemic, electronic contact with children may entail ambivalent contacts [26], for example when children express excessive concern for their parents and argue with their behaviour choices. This study demonstrates the need to differentiate between in-person and electronic contacts, especially during the current pandemic.

Older adults from southern European countries reported higher loneliness [32]. Adults in southern European countries also reported more contact with children, perhaps in accordance with the more collectivist culture in these countries. They also reported more electronic contact with non-kin, thus they enjoy most sources of contacts that are related to lower loneliness. It is possible they feel lonelier despite their social contacts because the COVID-19 pandemic and the physical distancing increased their need and expectations for social contacts, which were not adequately met. Interestingly, and contrary to our predictions, in the northern region there were stronger associations between physical distancing and loneliness. This trend calls for a more careful examination of the effects of physical distancing measures on social contacts and loneliness in different European regions.

This study has several strengths, including a large, representative European sample and a mediation model. It is limited in that due to complexity of data collection, the sample is cross-sectional and we therefore can't determine the temporal order between physical distancing and loneliness. For instance, it's possible that adults who are lonelier in the first place are more likely to physically distance and avoid crowded settings. Furthermore, there are indications that cross-sectional estimates of mediation can generate biased estimates of longitudinal mediation parameters [51]. We thus emphasize that future studies should examine these results using longitudinal data. However, we prefer to use the available cross-sectional data while taking this limitation into account, due to the timely nature of this study and the long time it will take until longitudinal COVID-19 SHARE data will be available. We also note that we did not use survey weights since, to our knowledge, it is not possible to use them in the Process statistical program. We controlled for socio-demographic and health factors which could adjust for some of the effects of not using weights.

To sum, the current study showed that during the COVID-19 pandemic, older adults who maintain physical distancing guidelines also have less in-person and electronic contacts, which is associated with a greater risk of loneliness. These results can guide policy, services, and intervention programs. Particular attention should be paid to adults who may struggle to maintain social contacts in light of physical distancing guidelines. Interventions such as digital courses can improve their digital literacy and alleviate some of their social isolation. It is also noteworthy that some adults may face difficulties in creating electronic ties. Therefore, interventions should also foster electronic contacts, for example via online group activities, for adults who may find it difficult to do so themselves.

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Data availability Our study is a secondary analysis of existing data. Data files and documentation are for public use and available at www.share-project.org.

Code availability Not applicable.

Declarations

Conflict of interest The authors have no conflict of interest to disclose.

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