

Self-reported hearing difficulties are associated with loneliness, depression and cognitive dysfunction during the COVID-19 pandemic

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Abstract:

Objective: To investigate whether hearing difficulties exacerbate the damaging effects of enforced social distancing due to the COVID-19 pandemic on isolation and loneliness, and lead to accelerated mental health issues and cognitive dysfunction.

Design: Rapid online survey. Participants completed a series of online questionnaires regarding hearing ability, socialisation (pre- and during-pandemic), loneliness, anxiety, depression and cognitive function.

Study Sample: 80 participants over the age of 70 with access to the internet.

Results: There was a significant reduction in socialisation levels from pre-pandemic in this population. Hearing difficulties were significantly associated with greater levels of loneliness, depression and self-perceived cognitive dysfunction after controlling for age, gender, and level of education. Additionally, compared to pre-pandemic, people with hearing difficulties had increased odds of reporting worsened anxiety, depression, and memory during the COVID-19 pandemic, although only the effect of hearing difficulties on the change in memory reached statistical significance after controlling for age, gender, and level of education.

Conclusions: The worse the self-reported hearing abilities are, the greater the negative impact of enforced social distancing on depression, loneliness and cognitive function.

Keywords: hearing difficulties; mental health; cognitive function; COVID-19; social distancing

1. Introduction

Hearing loss (HL) is one of the leading causes of disability in older adults and is commonly associated with increased rates of depression, social isolation, and risk of cognitive decline (Livingston et al., 2020; Mick, Kawachi, & Lin, 2014; Strawbridge, Wallhagen, Shema, & Kaplan, 2000). The mechanism of the hearing-cognitive decline relationship has yet to be elucidated, but one theory is an indirect association through the loneliness/social isolation pathway (Griffiths et al., 2020). People with HL are more likely to report feelings of loneliness and social isolation (Huang et al., 2020; Mick et al., 2014; Shukla et al., 2020) and these factors have been shown to increase the risk of developing dementia (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000; Wilson et al., 2007).

The COVID-19 respiratory disease was declared a worldwide pandemic in March 2020. In order to reduce the rapid transmission of the disease, social distancing was enforced and necessary. In the UK, a 'clinically vulnerable' list of people at risk of becoming seriously unwell if contracting the virus, were asked to shield from the public. People over the age of 70 were amongst the vulnerable shielding from March to August 2020, meaning they were confined to their households as much as possible.

Approximately 70% of people over the age of 70 (>8.3m people) have HL (WHO, 2020). Older people with HL may be selectively disadvantaged by the coronavirus pandemic for a number of reasons, including cancellation of medical appointments, the use of facemasks and the limitation in the use of technology.

Firstly, many routine face-to-face audiology appointments have been postponed, suspended or where possible, are being offered remotely (Saunders & Roughley, 2020). Therefore, people who need hearing tests or hearing aid maintenance have been put on a waiting list to be seen when clinical practices resume. This alone may have a profound impact on people with HL, as demonstrated in a recent survey in Scotland, which reported 60% of participants were more worried than usual if their hearing aids stopped working or of not being able to get batteries (Naylor, Burke, & Holman, 2020).

Secondly, the use of face masks, which act as a direct barrier to communication, are particularly problematic for people with HL. A large-scale online survey of the effects of face coverings has shown that face coverings negatively impact ability to hear, understand, engage

and connect during communication, for both the speaker and the listener regardless of hearing status, although people with HL were impacted more severely (Saunders et al., 2020).

Finally, enforced social distancing means that people should not communicate with those outside their households except via technology (telephone, email, video calls etc.). People with HL may not be able to benefit from these means of communication as readily due to degraded sound quality during digital transmission and decreased auditory processing abilities (Moore, Shaw, Griffiths, Stone, & Sherlock, 2019; Naylor et al., 2020). For our older population with HL, this may be further exacerbated as almost half of all people over the age of 70 live alone (Office for National Statistics, 2019) and thus will rely on these external connections for meaningful communication.

Therefore, there is a risk that social distancing due to the COVID-19 pandemic will have a detrimental impact on mental health and cognitive function in people over the age of 70, which may be further exacerbated by HL. The aim of this study was to investigate the effects of HL on loneliness and social isolation as well as anxiety, depression and cognitive function during the COVID-19 related restrictions. This will help us to understand if people with HL were particularly disadvantaged by the consequences of the pandemic and enforced social distancing.

2. Materials and Methods

2.1. Participants and data collection

Participants with mixed hearing abilities were recruited through online advertising between June and July 2020. People over the age of 70 were categorised as vulnerable and were expected to voluntarily shield from others to protect themselves from the virus. Shielding measures at this time advised individuals to stay in their homes and only leave the house once per day for exercise. They should have no visitors, except for support, care or nursing needs, and should ensure to keep two metres apart from others at all times. The inclusion criteria were broad. Participants were required to be over the age of 70 with access to the internet and fluent in written English language. Data were collected remotely from participants using the online Research Electronic Data Capture (REDCap) tool¹ (Harris et al., 2009), hosted by

¹ REDCap is a secure, web-based software platform designed to support data capture for research studies, providing: 1) an intuitive interface for validated data capture; 2) audit trails

The University of Manchester. The University of Manchester Research Ethics Committee (project ID 9894) approved the procedures and all participants gave informed consent through REDCap.

2.2. Instruments

Participants were asked to complete a series of online questionnaires including demographic information, such as: age (measured in years); gender; education (defined as education for less than or equal to O-level/GCSE or equivalent, to A-level or higher vocational qualification, or education to University level); and diagnoses of HL, anxiety, depression, or memory loss (measured by 'yes', 'no', 'don't know'). All participants completed additional questionnaires as listed below.

Hearing difficulties were measured using the Speech, Spatial and Qualities of Hearing scale (SSQ12) (Noble, Jensen, Naylor, Bhullar, & Akeroyd, 2013). Participants are given 12 scenarios and have to provide a response using a Likert scale ranging from 0 to 10, where higher scores reflect better subjective hearing abilities. Anxiety levels were measured using the Generalised Anxiety Disorder (GAD-7) questionnaire (Spitzer, Kroenke, Williams, & Lowe, 2006), which includes seven questions which are summed to a maximum of 21. Depression was measured using the Patient Health Questionnaire (PHQ-9), which includes nine questions to be summed to a maximum of 27 (Spitzer, Kroenke, & Williams, 1999). For both the GAD-7 and PHQ-9, higher scores are indicative of greater severity with ≥ 5 being the threshold for mild anxiety/depression and >10 requiring further clinical evaluation. Loneliness was assessed using the short form of the de Jong Gierveld Loneliness Scale (DJGLS) (De Jong Gierveld & Van Tilburg, 2010), which ranges from 0 to 6 with higher scores indicating greater loneliness. Cognitive function was established using the inbuilt PROMIS-v2 instrument (PROMIS Health Organization and Assessment CenterSM, www.nihpromis.org). This scale assesses self-perceived cognitive deficits in the domains of mental acuity, concentration, verbal and nonverbal memory, verbal fluency and perceived changes in these cognitive functions. Finally, a composite measure of socialisation scores was created by combining frequency of contact with means of communication and social activities, to a possible maximum of 138. The

for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

questionnaire is included as supplementary material and can be found at <http://tandfonline.com/doi/suppl>. Due to the time pressures to collect the data during the COVID-19 pandemic, best practice methodology, such as validation of this measure, was relaxed in the interest of speed, as were the case with other COVID-19 related research (Geldsetzer, 2020; Naylor et al., 2020; Saunders & Roughley, 2020). Participants were asked to complete the measure twice, as they would have ‘before lockdown’ as well as in their current situation.

In addition to this, participants were asked whether they felt the pandemic had caused a *change* in their depression, anxiety, and memory and were asked to respond with ‘no change’, ‘yes-worsened’ or ‘yes-improved’.

2.3. Data analysis

The study was pre-registered on the Open Science Framework repository (DOI: [10.17605/OSF.IO/8Q25W](https://doi.org/10.17605/OSF.IO/8Q25W)). This paper reports the early cross-sectional baseline data analyses of the scoping survey. In brief, a series of linear regression models were used to investigate the association between SSQ12 and socialisation, loneliness, anxiety, depression, and cognitive function, controlling for age, gender and education. Self-perceived pandemic change data were investigated using binary logistic regression, a deviation from methods outlined in the pre-registration, due to violation of the proportional odds assumption and lack of participants in the ‘yes-improved’ group. For this reason, the ‘no change’ and ‘yes-improved’ categories were combined into one category.

3. Results

3.1. Participants

A total of 80 participants completed the full set of questionnaires (Table 1). Participant ages ranged between 70-91 (Mean = 76.01, SD= 5.46) The majority of participants were female (66%) and 14% were educated to O-level/GCSE or equivalent, 38% to A-level or higher vocational qualification level, and 48% to University degree level or above. Self-reported hearing difficulties varied considerably throughout the group, with mean SSQ12 scores ranging from 1.5 to 10 (Mean= 5.66, SD= 2.35) on the 10-point scale. In keeping with this, 65% of participants self-reported a diagnosis of HL.

3.2. Socialisation and loneliness

The results of composite socialisation scores pre-pandemic (Mean=45.77, SD=12.13) and during-pandemic (Mean=38.58, SD=12.04) indicate that socialisation decreased during the pandemic. The mean difference of 7.19 points was significant, $t(78) = 6.646$, $p < .001$. Hearing difficulties were associated with socialisation levels: a decrease of one unit on the SSQ12 led to a decrease in socialisation levels of 1.15. However, this effect only approached statistical significance at $p = 0.057$ (Table 2).

Varying levels of loneliness were observed during the pandemic. Participants' scores on the DJGLS ranged from 0 to 6, with higher values indicating greater loneliness (to a maximum of 6). After controlling for age, gender and education levels, higher levels of loneliness were significantly associated with lower mean SSQ12 scores ($R^2 = .275$; Table 2), suggesting that hearing difficulties are associated with increased loneliness.

3.3. Anxiety and depression

Participants' GAD-7 scores ranged between 0 and 17 (Mean=2.65, SD=3.77), with higher values indicating greater anxiety, and 10.1% reported an anxiety diagnosis. For the majority of participants (62.0%) anxiety levels were unchanged during the pandemic, but 35.4% reported increased anxiety levels and only 2.5% reported a reduction in anxiety. After controlling for age, gender, and education, SSQ12 scores were not significantly associated with GAD-7 scores during the pandemic (Table 2).

Participants' PHQ-9 scores ranged between 0 and 17 (Mean=4.54, SD=4.54), with higher values indicating greater depression (where scores ≥ 5 indicate depression, of various levels of severity). Only 8.9% had a diagnosis of depression. For most, mood did not change during the pandemic (67.1%). Almost 30% reported depression worsening and only 3.8% reported mood improving during the pandemic. Hearing difficulties were significantly associated with greater PHQ-9 scores after controlling for age, gender, and education ($R^2 = .347$; Table 2).

Figures 1A and 1B demonstrate that, on average, people with poorer hearing (lower SSQ12 scores) reported a negative change in anxiety and depression compared with people with higher SSQ12 scores, who mostly reported no change or an improvement. For each 1-point decrease in the mean SSQ12, the odds of anxiety increasing during the pandemic increased

by a factor of 1.23 and the odds of depression increasing during the pandemic increased by a factor of 1.25, although these were not statistically significant at the $p < .05$ level (Table 3) after controlling for age, gender, and education: anxiety ($b = .206$, Wald $\chi^2(1) = 3.50$, $p = .061$); depression ($b = .224$, Wald $\chi^2(1) = 3.68$, $p = .055$).

3.4. Cognitive function

Cognitive function PROMIS-v2 scores ranged between 20.10 and 68.90 ($M = 54.10$, $SD = 10.06$), with higher values indicating better cognitive function. The majority of participants (74.7%) reported no diagnosis of memory dysfunction, with 15.2% reporting a diagnosis and 10.1% reporting they were unsure. The pandemic did not cause any change in memory difficulties for the majority of participants (81%). Only 17.7% reported that their memory was worse, and 1.3% felt it was better.

Hearing difficulties were significantly associated with cognitive dysfunction after controlling for age, gender, and education ($F(5, 69) = 5.112$, $p < .001$; Table 2). Participants' self-reported cognitive function increased by 2.10 points with each 1-point increase on the SSQ12. In keeping with this, as shown in Figure 1C, lower SSQ12 scores were significantly associated with a self-reported negative change in memory during the pandemic ($b = .411$, Wald $\chi^2(1) = 6.614$, $p = .010$); a 1-point decrease in mean SSQ12 was associated with 1.51 times the odds of worsened memory (Table 3).

4. Discussion

In this cross-sectional analysis, we observed a significant association between greater self-reported hearing difficulties, measured using the SSQ12, and increased self-reported depression, loneliness and cognitive dysfunction. Similarly, on average, greater hearing difficulties were associated with an increase in self-report of negative change in anxiety, depression and memory loss during the pandemic, although only the latter relation reached statistical significance. Hence, people with hearing difficulties may be particularly vulnerable to the negative consequences of the pandemic.

Prior studies have shown that HL is associated with increased social isolation and loneliness (Huang et al., 2020; Mick et al., 2014; Shukla et al., 2020). In keeping with this, our study found that lower mean SSQ12 scores were significantly associated with higher DJGLS scores,

indicating that poorer hearing was associated with higher levels of loneliness during the pandemic. As predicted, socialisation scores significantly reduced in lockdown compared to pre-pandemic. However, although a trend was found where hearing difficulties were associated with lower levels of socialisation, this did not reach statistical significance, which may be due to the lack of statistical power due to either the relatively limited sample size, or the method for collecting socialisation scores. There is also the possibility of recall bias in the sample, as measurement of pre-lockdown socialisation was collected retrospectively. It may be that participants were influenced by their current circumstances and responses may have been different had they been collected pre-pandemic. Anxiety levels measured using GAD-7 were not significantly associated with SSQ12 scores. This is in keeping with results from a recent survey that demonstrated that during the pandemic, almost 70% of people with worse hearing felt relief not to be obliged to attend social gatherings (Naylor et al., 2020). Therefore, for some people with HL who may struggle with group conversations, the enforced distancing has meant a reduction in anxiety regarding attending social gatherings and communication in noisy public areas.

However, in keeping with the previous literature, hearing difficulties were associated with increased depression scores (Mener, Betz, Genther, Chen, & Lin, 2013) and increased reports of cognitive dysfunction (Amieva et al., 2015). Importantly, people with hearing difficulties had significantly increased odds of reporting a negative change in memory during the pandemic, although due to the cross-sectional nature of the analysis, causality cannot be inferred. Furthermore, a possibility that cannot be ruled out is that the associations are due to mood or another bias, such as underlying illness status that may affect the use of scales. For example, people with a low mood or cognitive dysfunction may tend to have a negative view of their abilities and characteristics on a number of dimensions that could include how they self-report on other measures such as hearing difficulties.

Further limitations to this work are the use of a self-reported measure of hearing difficulties rather than laboratory hearing tests (such as speech-in-noise tests). However, past research has demonstrated that self-reported hearing abilities may be a better predictor of subjective hearing-related outcomes than audiometric testing (Hornsby & Kipp, 2016). It should be noted that the prevalence of self-reported diagnosis of HL in the sample (65%) is comparable with prior studies of the same age range (Mener et al., 2013).

Another limitation is the potential for selection bias as this study was advertised online and only applicable for participants with access to the internet. Although internet use is widespread, older adults without internet access may be systematically different to those who do use the internet, in terms of social capital and health status (Choi & Dinitto, 2013). Further to this, most people were highly educated. Therefore, this study cannot draw any conclusions regarding the effects of the pandemic on people under the age of 70 or people who are not computer literate or with lower levels of educational attainment.

Other COVID-19 research to understand public perceptions in the UK during the lockdown period reported that most participants described the enforced social distancing/isolation to have had a negative impact on their mental health and wellbeing (Williams, Armitage, Tampe, & Dienes, 2020). Our study supports these findings and suggests that the impact of social restrictions may be worse for people with HL, which increases according to the severity of hearing difficulties.

To conclude, this cross-sectional analysis has demonstrated that hearing difficulties measured using the SSQ12 are associated with increased self-reported depression, loneliness and cognitive dysfunction during the COVID-19 pandemic, supported by the self-reported change variable of worsening memory in people with HL. The effects of the pandemic appear to have a greater negative impact on depression, loneliness and cognitive function the worse their hearing is. This may be due to increased levels of loneliness brought on by the enforced social distancing. Although we hope the social distancing measures to be temporary, they have been ongoing for many months, and many elements including the use of face-coverings and limited group meetings may remain for a longer period of time, and so further work into the longer-term collateral effects of the pandemic need to be investigated. Data collection is ongoing for this purpose. Due to the HL-mental health-cognitive function relationship, it is possible that the pandemic has had a detrimental impact on people with HL in terms of increasing the risk for developing dementia.

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Table 1. Sample Characteristics of the 80 participants

	N	Percentage (%)
Male/Female	27/53	34/66
Age (SD)*	76.01 (5.46)	
<i>Highest education level:</i>		
O-level/GCSE	11	14
A-level/higher vocational	30	38
University degree	38	48
<i>Diagnosis (self-reported):</i>		
Hearing loss	52	65
Depression	8	10
Anxiety	9	11
Memory loss	12	15

*Age is reported as mean number of years, with standard deviation (SD) in brackets.

Table 2. Relation of measures for 1-point increase in mean SSQ12 (associated with better hearing abilities)

	B	95% CI	p-value
Socialisation	1.15	-.034, 2.33	.057
Loneliness	-.189	-.377, -.001	.049*
Anxiety	-.321	-.690, .048	.087
Depression	-.600	-1.04, -.166	.007*
Cognitive function	2.10	1.19, 3.01	<.001*

All measures adjusted for age, gender and education level. *=significant at $p < .05$

Table 3. Associated odds ratios for 1-point *decrease* in SSQ12 (associated with worse hearing abilities)

	Odds ratio	95% CI	p-value
Anxiety	1.23	.989, 1.52	.061
Depression	1.25	.994, 1.57	.055
Memory	1.52	1.10, 2.07	.010*

All measures adjusted for age, gender and education level. *=significant at $p < .05$

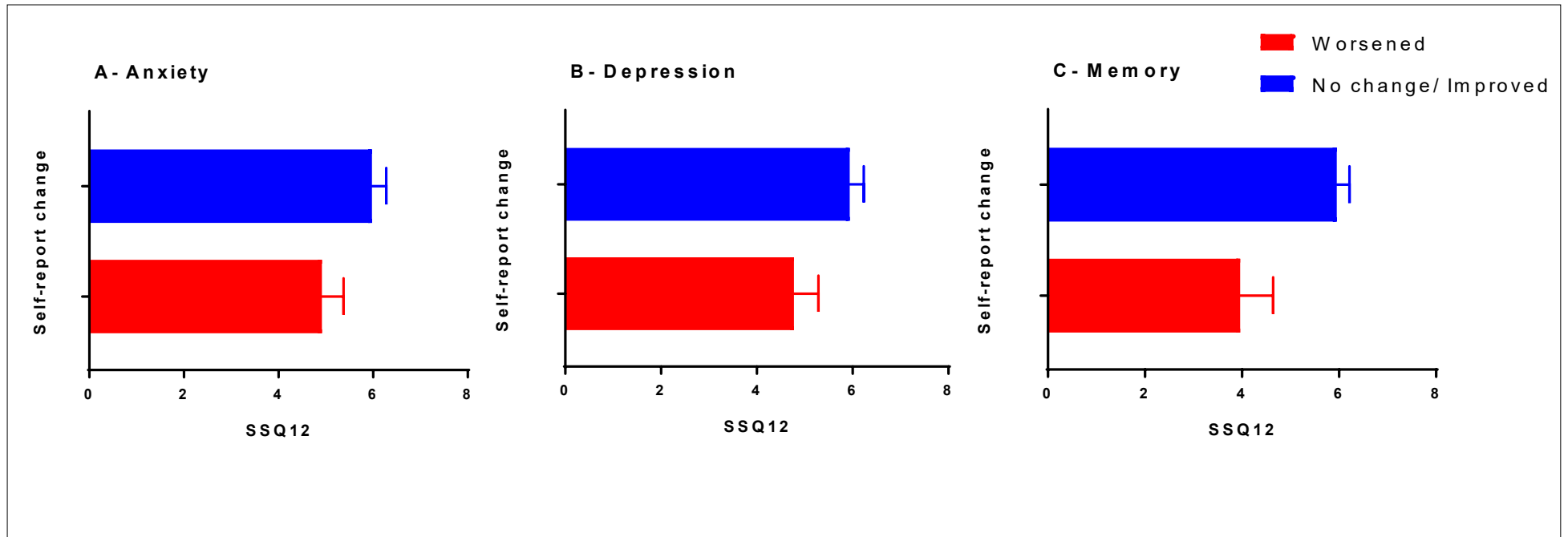


Figure 1. Mean SSQ12 scores and associated self-report change in (A) anxiety, (B) depression and (C) memory during the pandemic.

NB. Error bars represent Standard Error of the Mean. Blue bars represent mean scores for respondents who reported 'No change or better' and red bars represent mean scores for respondents who reported 'Worse'.