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The effects of CoVID-19 diagnosis and national lockdown on hearing loss, tinnitus, vertigo and migraine: the outcome of a prospective cohort study.

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STRUCTURED ABSTRACT

Objectives:

To identify changes in hearing loss, tinnitus, vertigo, and migraine in individuals with Meniere's disease diagnosed with CoVID-19 and during the UK national lockdown.

Design

Cross-Sectional Observational study.

Main outcome measures

Patients were questioned regarding CoVID-19 status and how their symptoms of hearing loss, tinnitus, vertigo, and migraine changed as a consequence of the pandemic.

Results

411 participants were recruited into this study, of which 382 had a self-reported CoVID-19 status. Of those individuals with a positive CoVID-19 diagnosis, 43 (11.3%), were more likely to experience worsening symptoms of hearing loss and tinnitus. Worsening symptoms of hearing loss and tinnitus, but improved symptoms related to vertigo, were observed during the UK national lockdown.

Conclusion

A diagnosis of CoVID-19 and/or experiencing the consequences of a national lockdown potentially resulted in a worsening of hearing loss and tinnitus symptoms. Symptoms of vertigo were found to improve during the same time period.

Key Words:

Ménière's Disease, Vertigo, Dizziness, CoVID

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MAIN TEXT

Introduction

Hearing loss, tinnitus and vertigo are often hidden but devastating symptoms, that have a significant effect on an individual's ability to contribute to, and function within, society. In 2019, the UK Ménière's Society funded the development of a disease registry for individuals with Ménière's disease. In 2020, the world was subjected to nationally enforced lockdowns. The subsequent effects of isolation, changes to normal routines and an increase in reported mental health conditions, had the potential to adversely affect the symptoms of hearing loss, tinnitus, and vertigo in individuals with Ménière's disease. In view of this, the lead investigator for the Ménière's Disease Registry project identified a unique opportunity to supplement the main project questionnaires with further questions to prospectively investigate the impact of a positive CoVID diagnosis and national lockdown on the progression of audio-vestibular symptoms.

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Methods

In 2020, ethics approval was granted to invite patients diagnosed with Ménière's disease to have their clinical data entered into a bespoke study data collection platform (North West - Liverpool Central Research Ethics Committee, United Kingdom - IRAS ID:275749). Further details regarding the development of the Ménière's disease registry are available elsewhere.[1]

Patients with Ménière's disease were identified from eight hospital sites; four were NHS sites and four were independent sites. Table 1 lists the hospital sites from which patients were identified. Potential participants with a diagnosis of probable or definite unilateral or bilateral Ménière's disease as defined by the 2015 edition of the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) criteria[2] in their hospital records were identified at ENT secondary care and private clinics (including services provided by audio-vestibular medicine). All potential participants had received a diagnosis of Ménière's disease within the previous 10 years by a consultant ENT surgeon or audio-vestibular physician specialising in balance disorders or had received a new diagnosis during the recruitment window of the study. A full list of inclusion and exclusion criteria for participant recruitment is provided in Table 2.

For the purpose of this study, recruited individuals were asked whether they had contracted CoVID-19. All participants were asked to report whether their symptoms of hearing loss, tinnitus, vertigo and migraine improved, remained stable or worsened. The format of these questions in displayed in Table 3.

Data were securely collected and managed using REDCap electronic data capture tools hosted at the University of East Anglia. STROBE reporting guidelines for observational studies were followed where relevant.

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Statistical Methods

The sign test was used to test for a change in symptoms of hearing loss, tinnitus, vertigo, and migraine in individuals overall during the pandemic, regardless of their COVID-19 diagnosis. The Mann-Whitney U test was used to test for a difference between CoVID-19 positive and CoVID-19 negative individuals with respect to the change in symptoms of hearing loss, tinnitus, vertigo, and migraine. Statistical significance was set at the (two-sided) 5% level.

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Results

Recruitment to this study began in November 2020 and ended in September 2021. Over this ten-month recruitment period, 411 participants were recruited into this study. Of these, CoVID test information was self-reported by 382. A positive test for CoVID-19 was reported in 43 (11.3%) and 339 (88.7%) reported not testing positive for COVID-19, at the time of recruitment. This study was completed before the widespread introduction of vaccinations throughout the United Kingdom.

Table 4 displays self-reported change in hearing loss, tinnitus, vertigo, and migraine in all 411 participants during the pandemic. These results indicate strong evidence that symptoms of tinnitus (frequency, duration, loudness, intrusiveness) and hearing were more likely to worsen than improve during the pandemic. To a lesser degree, there was evidence of an improvement in symptoms of vertigo (duration and severity) during the pandemic.

Table 5 displays how the symptoms of hearing loss, tinnitus, vertigo, and migraine in CoVID positive individuals compared with CoVID negative individuals. For the following symptoms: vertigo (frequency, duration, severity), tinnitus (frequency, duration), migraine (frequency, duration, severity), there was no evidence of a difference between CoVID groups in the symptom levels. However, for symptoms of tinnitus loudness and tinnitus intrusiveness, there is evidence of a difference between CoVID groups in the symptom levels: a greater number of those in the CoVID positive group, compared to the CoVID negative group, reported an increase in tinnitus loudness (35.0% versus 20.5%) and also an increase in tinnitus intrusiveness (32.5% versus 16.2%). There was strong evidence of a difference between CoVID groups in hearing levels. The CoVID positive group were more likely to report a worsening of hearing than the CoVID negative group (52.4% versus 27.4%).

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Discussion

CoVID-19 infection (SARS-CoV-2) is primarily a pulmonary condition but can lead to a wide range of non-pulmonary, sensory, and neural complications. In addition to this, the psychological and societal effects of CoVID have been broad, severe and are continuing to have a long-lasting and profound effect on the quality of life of most individuals around the globe. Many retrospective studies have been published regarding the progression of audio-vestibular symptoms during the pandemic; mostly individual cases or case series. The outcome of narrative and systematic reviews has largely been inconclusive.[3, 4, 5] We believe that this is the only study to have captured data from a defined clinical population to determine how CoVID-19 diagnosis and national lockdown impacted upon symptoms of hearing loss, tinnitus, vertigo, and migraine.

CoVID-19 diagnosis

Our study has found that CoVID-19 diagnosis has been associated with a statistically significant tendency for a worsening of tinnitus loudness and tinnitus intrusiveness. A CoVID-19 diagnosis was also associated with a statistically significant tendency for a worsening of hearing ability. Some of these findings are in keeping with other studies.[6] The effects of contracting CoVID-19 on individuals with pre-existing tinnitus has been investigated by Beukes[6] where it was found that the majority of individuals reported no change in their symptoms but that 40% of individuals reported a worsening of their tinnitus experience.[6] A number of potential mechanisms have been proposed to explain how CoVID-19 might cause a range of audio-vestibular symptoms; these mechanisms include: cochleitis or neuronitis[7], autoimmune mediated damage to the inner ear[7]; microvascular compromise[8] and the sequelae of immune-mediated disorders (such as the overzealous production of proinflammatory cytokines).[9]

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National lockdown

National lockdown has had a wide-ranging effect on public health. Onyeaka *et al.* have explored crucial aspects of daily life that have been affected by global lockdown, including: food security, global economics, education, tourism, hospitality, sports and leisure, gender relationships, domestic violence/abuse, mental health and environmental air pollution.[10] Our study in individuals with Ménière's disease has found that regardless of CoVID-19 diagnosis during UK lockdown, self-reported symptoms of tinnitus and hearing difficulty have had a tendency towards becoming worse, whereas symptoms of vertigo had a tendency towards improvement.

The worsening of tinnitus symptoms is perhaps not unexpected. The CoVID-19 pandemic has resulted in demonstrable increases in rates of stress, anxiety and depression.[11] In the United Kingdom, a large population-based cohort study using primary care records has identified a greater severity of mental illness and increasing incidence of non-fatal self-harm and suicide during 2020.[12] Anxiety during the pandemic has been identified as a risk factor for the deterioration of symptoms for other chronic conditions, for example in patients with severe asthma.[13] The link between adverse mental health and tinnitus severity has been long established.[14] Other studies have suggested that factors that were found to exacerbate an individual's tinnitus experience included: self-isolation, loneliness, poor sleep and reduced levels of exercise.[15] This work also highlighted how increased depression, anxiety, irritability and financial worries further significantly contributed to tinnitus being more bothersome during the pandemic period.[15]

Whilst a range of explanations could be proposed for the perceived deterioration in hearing ability for individuals during lockdown, a worsening of hearing ability overall is possibly due to an unfavourable hearing environment instigated by the use of facemasks. Poor or no access to hearing aid services will have been likely to exacerbate hearing difficulties for those members of society who rely on

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hearing aids for communication. This is particularly relevant as we observed a 30% deterioration overall, regardless of CoVID-19 diagnosis.

The tendency towards an improvement of vertigo symptoms is a little more difficult to explain than the observations for tinnitus and hearing loss, particularly as our findings are in contrast with other studies.[16, 17] In a study by Lovato *et al.* during the CoVID-19 pandemic, their patients reported a significantly higher number of vertigo attacks as compared with pre-CoVID numbers.[16] Yeo *et al.* have reported higher odds of vertigo in individuals with Ménière's disease and more severe symptoms during periods of greater stress.[17] The effects of national lockdown in the UK have notably been different for individuals suffering from vertigo. Depending on an individual's pre-CoVID activity levels, enforced 'limits' on exercise might reduce activity for some, whilst encourage activity for others. Similarly, an opportunity for fresh air for some individuals might have been considered to be a reward, whilst the idea of isolation for the majority of patients might have had the opposite effect. The enforced break from demanding work duties, and the benefits from less exposure to dizziness-triggering activities for those with associated Persistent Posturo-Perceptual Dizziness, are other factors worthy of consideration.

This study has benefitted from seeking data directly from patients. A unique opportunity was identified at the beginning of the pandemic which has allowed new insights into the symptoms of a 'primed' population who are particularly susceptible to the distress associated with hearing loss, tinnitus, vertigo, and migraine. Whilst changes have been reported for hearing loss, tinnitus and vertigo, no statistically significant changes in the severity of migraine overall were identified; this mirrors the literature studying chronic migraine during lockdown using comparable methodology.[18]

There are areas where this study has weaknesses. Firstly, the population studied might not represent individuals with hearing loss, tinnitus, vertigo and/or migraine, who do not have Ménière's disease,

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and therefore, their experiences with CoVID-19 and national lockdown might be different. Secondly, the relative proportion of individuals with a positive test for CoVID-19 was relatively small. This might be, in part, due to lower numbers of individuals with CoVID-19 in the UK at the time that the study ran, alternatively this might have been due to a group of individuals with CoVID-19 who never went ahead to have their CoVID-19 status tested. Thirdly, we have relied on patient reported diagnosis of CoVID-19, so an accurate confirmation of how a CoVID-19 was made or how many times a diagnosis was made was not possible. Fourthly, we have no data to consider how the reported changes in hearing loss, tinnitus, vertigo and/or migraine symptoms might have been observed in the absence of a national lockdown. Finally, whilst we broadly requested participants to report a change in their symptoms retrospectively, the data would be stronger had they been acquired pre-CoVID and post-CoVID, using a validated questionnaire and audiometric data. Again, this was not possible due to the unexpected manner by which CoVID-19 spread across the globe. Ménière's disease is a condition whereby symptoms fluctuate over time. In an ideal scenario, a comparison between our cohort of participants and a similarly selected historical cohort of participants could be compared. However, due to the nature of this current study, this comparison has not been possible.

SUMMARY

- Numerous reports have been produced since the beginning of the CoVID-19 pandemic regarding the impact of diagnosis and national lockdown on a broad range of audio-vestibular symptoms.

- We have set up a data collection platform to acquire a large and diverse range of clinical patient data for individuals diagnosed with Ménière's disease.

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- Data collection for this project was initiated at beginning of the CoVID-19 pandemic, providing a unique opportunity to consider the effect of CoVID-19 diagnosis on the symptoms of hearing loss, tinnitus, vertigo, and migraine in individuals diagnosed with Ménière's disease

- A diagnosis of CoVID-19 and/or experiencing the consequences of a national lockdown potentially resulted in a worsening of hearing loss and tinnitus symptoms.

- A diagnosis of CoVID-19 and/or experiencing the consequences of a national lockdown potentially resulted in an improvement of vertigo symptoms during the same time period.

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Conclusion

This study of individuals with Ménière's disease has provided new insights into the audio-vestibular effects of CoVID-19 diagnosis and national lockdown. A diagnosis of CoVID-19 and/or experiencing the consequences of a national lockdown was associated with a worsening of hearing loss and tinnitus symptoms in the population we studied. Symptoms of vertigo were observed to improve during the national lockdown.

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Table 1: Hospital recruitment sites

NHS centres
Norfolk and Norwich University Hospitals NHS Foundation Trust, Norwich
Leicester Royal Infirmary, University Hospitals of Leicester, Leicester
Charing Cross Hospital, London
Guy's Hospital and St Thomas' Hospital, London
Private centres
Spire Norwich Hospital, Norwich
The London Road Clinic, Leicester
London Hearing and Balance Centre, London
The London Clinic, London

Table 2: Eligibility criteria

Inclusion criteria
- Individuals aged 18 years or over
- Definite or probable diagnosis of unilateral or bilateral Ménière's disease as defined by the 2015 edition of the American Academy of Otolaryngology–Head and Neck Surgery (Goebel 2016)
- Potential participants must have received a diagnosis of Ménière's Disease within the previous 10 years or have received a new diagnosis during the recruitment window of the study.
- Willingness to provide consent for data from health records to be used for research purposes.
Exclusion criteria
- Unable to provide consent
- Unable/unwilling to complete questionnaires.

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Table 3: Dataset provided by the participant.

Questions posed to trial participants regarding changes to **a.** hearing, **b.** tinnitus, **c.** vertigo and **d.** migraine symptoms.

a. Since the beginning of the CoVID pandemic, has your hearing changed?

Symptom	Response options
Hearing	Hearing worsened / Hearing improved / About the same overall

b. Since the beginning of the CoVID pandemic, has your tinnitus changed?

Symptom	Response options
Tinnitus frequency	More frequent / Less frequent / About the same overall
Tinnitus duration	Longer duration / Shorter duration / About the same overall
Tinnitus volume	Increased volume / Reduced volume / About the same overall
Tinnitus intrusiveness	Increased intrusiveness / Reduced intrusiveness / About the same overall

c. Since the beginning of the CoVID pandemic, has your vertigo changed?

Symptom	Response options
Vertigo frequency	More frequent / Less frequent / About the same overall
Vertigo duration	Longer duration / Shorter duration / About the same overall
Vertigo severity	Increased severity / Reduced severity / About the same overall

d. Since the beginning of the CoVID pandemic, has your migraine symptoms changed?

Symptom	Response options
Migraine frequency	More frequent / Less frequent / About the same overall
Migraine duration	Longer duration / Shorter duration / About the same overall
Migraine severity	Increased severity / Reduced severity / About the same overall

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Table 4: Change in audio-vestibular symptoms since the beginning of the pandemic for all consented participants

	Consented participants N = 411	Sign test M-statistic	p-value
Since the beginning of the pandemic, have the following symptoms changed:			
Vertigo frequency		-8.5	0.107
- More frequent	41 (12.0%)		
- Same overall	243 (71.1%)		
- Less frequent	58 (17.0%)		
Missing	69		
Vertigo duration		-10.0	0.029
- Longer duration	28 (8.5%)		
- Same overall	255 (77.0%)		
- Shorter duration	48 (14.5%)		
Missing	80		
Vertigo severity		-11.5	0.018
- Increased severity	32 (9.6%)		
- Same overall	245 (73.8%)		
- Reduced severity	55 (16.6%)		
Missing	79		
Tinnitus frequency		19.5	<0.001
- More frequent	61 (16.9%)		
- Same overall	277 (76.9%)		
- Less frequent	22 (6.1%)		
Missing	51		
Tinnitus duration		19.0	<0.001
- Longer duration	58 (16.1%)		
- Same overall	283 (78.4%)		
- Shorter duration	20 (5.5%)		
Missing	50		
Tinnitus loudness		34.0	<0.001
- Increased loudness	81 (22.5%)		
- Same overall	266 (73.9%)		
- Reduced loudness	13 (3.6%)		
Missing	51		
Tinnitus intrusiveness		25.5	<0.001
- Increased intrusiveness	64 (17.9%)		
- Same overall	281 (78.5%)		
- Reduced intrusiveness	13 (3.6%)		
Missing	53		
Hearing		50.5	<0.001
- Hearing improved	10 (2.7%)		
- Same overall	249 (67.3%)		
- Hearing worsened	111 (30.0%)		
Missing	41		

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Migraine frequency		-0.5	1.000
- More frequent	25 (8.8%)		
- Same overall	233 (82.0%)		
- Less frequent	26 (9.2%)		
Missing	127		
Migraine duration		2.0	0.636
- Longer duration	22 (8.1%)		
- Same overall	233 (85.4%)		
- Shorter duration	18 (6.6%)		
Missing	138		
Migraine severity		1.0	0.871
- Increased severity	20 (7.3%)		
- Same overall	235 (86.1%)		
- Reduced severity	18 (6.6%)		
Missing	138		

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Table 5: Change in audio-vestibular symptoms since the beginning of the pandemic, for those that are, versus those that are not, suspected/diagnosed with COVID.

				Mann-Whitney U test	
	Suspected/ diagnosed COVID N = 43	No suspected/ diagnosed COVID N = 339	Overall N = 382	U statistic	p-value
Since the beginning of the pandemic, have the following symptoms changed:					
Vertigo frequency				6946.5	0.519
- More frequent	6 (15.4%)	34 (11.3%)	40 (11.8%)		
- Same overall	27 (69.2%)	215 (71.4%)	242 (71.2%)		
- Less frequent	6 (15.4%)	52 (17.3%)	58 (17.1%)		
Missing	4	38	42		
Vertigo duration				6535.5	0.877
- Longer duration	3 (7.5%)	24 (8.3%)	27 (8.2%)		
- Same overall	31 (77.5%)	223 (77.2%)	254 (77.2%)		
- Shorter duration	6 (15.0%)	42 (14.5%)	48 (14.6%)		
Missing	3	50	53		
Vertigo severity				6029.5	0.175
- Increased severity	2 (5.0%)	29 (10.0%)	31 (9.4%)		
- Same overall	29 (72.5%)	215 (74.1%)	244 (73.9%)		
- Reduced severity	9 (22.5%)	46 (15.9%)	55 (16.7%)		
Missing	3	49	52		
Tinnitus frequency				7794.5	0.344
- More frequent	10 (24.4%)	51 (16.1%)	61 (17.0%)		
- Same overall	28 (68.3%)	247 (77.9%)	275 (76.8%)		
- Less frequent	3 (7.3%)	19 (6.0%)	22 (6.2%)		
Missing	2	22	24		
Tinnitus duration				7303.0	0.782
- Longer duration	7 (17.5%)	51 (16.0%)	58 (16.2%)		
- Same overall	31 (77.5%)	249 (78.3%)	280 (78.2%)		
- Shorter duration	2 (5.0%)	18 (5.7%)	20 (5.6%)		
Missing	3	21	24		
Tinnitus loudness				8109.0	0.043
- Increased loudness	14 (35.0%)	65 (20.5%)	79 (22.1%)		
- Same overall	25 (62.5%)	240 (75.7%)	265 (74.2%)		
- Reduced loudness	1 (2.5%)	12 (3.8%)	13 (3.6%)		
Missing	3	22	25		
Tinnitus intrusiveness				8018.5	0.040
- Increased intrusiveness	13 (32.5%)	51 (16.2%)	64 (18.0%)		
- Same overall	25 (62.5%)	254 (80.6%)	279 (78.6%)		
- Reduced intrusiveness	2 (5.0%)	10 (3.2%)	12 (3.4%)		
Missing	3	24	27		
Hearing				9406.0	0.002
- Hearing improved	1 (2.4%)	9 (2.8%)	10 (2.7%)		
- Same overall	19 (45.2%)	227 (69.9%)	246 (67.0%)		
- Hearing worsened	22 (52.4%)	89 (27.4%)	111 (30.3%)		
Missing	1	14	15		

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Migraine frequency				4857.0	0.711
- More frequent	3 (8.6%)	22 (8.9%)	25 (8.8%)		
- Same overall	28 (80.0%)	204 (82.3%)	232 (82.0%)		
- Less frequent	4 (11.4%)	22 (8.9%)	26 (9.2%)		
Missing	8	91	99		
Migraine duration				4575.0	0.804
- Longer duration	1 (2.9%)	21 (8.8%)	22 (8.1%)		
- Same overall	32 (94.1%)	200 (84.0%)	232 (85.3%)		
- Shorter duration	1 (2.9%)	17 (7.1%)	18 (6.6%)		
Missing	9	101			
Migraine severity				4357.0	0.273
- Increased severity	2 (5.9%)	18 (7.6%)	20 (7.4%)		
- Same overall	28 (82.4%)	206 (86.6%)	234 (86.0%)		
- Reduced severity	4 (11.8%)	14 (5.9%)	18 (6.6%)		
Missing	9	101	110		

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