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REVIEW ARTICLE

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Otologic and vestibular symptoms in COVID-19: A scoping review

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Abstract

Background: Otologic and vestibular symptoms have been seen in patients confirmed to have COVID-19 disease. Further discussion of these symptoms may provide insight into short- and long-term management for these patients.

Objective: The aim of this review was to describe the otologic and vestibular symptoms that present in patients with COVID-19. The primary outcomes of this review were onset, duration and clinical outcomes of these symptoms.

Sources of Evidence: Pub Med, APAMed Central, Herdin, CINAHL, Scopus, Springer Link, ProQuest Coronavirus Research Database, and Google Scholar were searched for the articles to be included.

Eligibility Criteria: Studies included were those involving adult patients diagnosed with COVID-19 who experienced hearing loss, ear pain, ear discharge, otitis media, vertigo, or tinnitus. Studies were eligible for inclusion if there was a description of the otologic dysfunction, specifically onset, duration, or clinical outcomes.

Results: The majority of patients who experienced hearing loss (68%), tinnitus (88%), vertigo/dizziness (30%), ear pain (8%), and discharge (100%) did so within a month of experiencing the typical symptoms of COVID-19. A majority also experienced complete resolution of their symptoms within 2 weeks. Standard treatment for COVID-19 was usually provided but when specific diagnoses are made for these symptoms (e.g., sudden sensorineural hearing loss, otitis media, vestibular neuritis), they are treated in the same manner as one would for non-COVID-19 cases, in addition to the management for COVID-19. In certain cases, there may be a need for additional work-up to rule out other causes.

Conclusions: Otologic and vestibular symptoms were present in COVID-19 patients, majority as part of the systemic nature of the disease. The onset, duration, and course were consistent with the natural history of a systemic viral infection. COVID-19 should be considered in any patient with a new-onset hearing loss, tinnitus, or vertigo/dizziness, even in the absence of infectious or respiratory symptoms.

Abbreviations: HHIA, Hearing Handicap Inventory for Adults; SSNHL, sudden sensorineural hearing loss; THI, Tinnitus Handicap Index.

KEYWORDS
COVID-19, dizziness, hearing loss, tinnitus, vertigo

Key points

- Most reviews on the otologic and vestibular symptoms in COVID-19 patients aim to determine the pooled prevalence of these symptoms in COVID-19. This study described the onset, duration, and clinical outcomes of otologic and vestibular symptoms that presented in COVID-19 patients.
- Majority of patients who experienced hearing loss, tinnitus, vertigo/dizziness, ear pain, and discharge did so within a month of experiencing the typical symptoms of COVID-19. A majority also experienced complete resolution of their symptoms within 2 weeks.

INTRODUCTION

Coronavirus 2019, more commonly known as COVID-19, is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The most common presenting symptoms of this condition are fever, cough, and fatigue.[1] On the other hand, sore throat, headache, and smell affectations are the most common ear nose and throat (ENT) manifestations in patients with COVID-19.[2] However, there have been reports suggesting that the spectrum of clinical presentation may be wider than initially thought, to even include problems in hearing and other otologic conditions. Reviews by Almufarrij and Munro in 2021[3] and Maharaj, Alvarez, Mungul, and Hari in September 2020[4] showed that, though relatively rare, reports of otologic, audiologic, and vestibular symptoms have been seen in patients confirmed to have COVID-19, particularly, hearing loss, tinnitus, and vertigo. However, further discussion of these symptoms may provide insight into short- and long-term management for similar patients.

The aim of this review was to describe the otologic and vestibular symptoms that present in patients with COVID-19. The primary outcomes of this review were onset, duration, and clinical outcomes of these symptoms. Secondary outcome included was describing therapeutic management received by these patients.

MATERIALS AND METHODS

The preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) checklist was followed for this study.[5] This study was registered in the institution's Research Administration Office. As this study is a systematic review of published literature, institutional ethical committee approval and informed consent were not obtained.

Eligibility criteria

The population of interest was adult patients who were diagnosed with COVID-19 (SARS-CoV-2) using any diagnostic tool available for this disease (antigen test, antibody test, real-time polymerase chain reaction [RT-PCR]). The patients experienced or were diagnosed with the following: hearing loss, ear pain, ear discharge, otitis media, vertigo, or tinnitus. Studies were eligible for inclusion if there was a description of the otologic dysfunction, specifically onset, duration, or clinical outcomes. Randomized and nonrandomized controlled trials, cohort, case-control, cross-sectional, case series, and case reports were included. Studies involving the pediatric population were excluded. Studies were also excluded if the description of the specific dysfunction was inadequate, did not have a description on at least one of the primary outcomes, or there were no original case descriptions. Articles that were not in English were translated using Google Translate and were still included if they fulfilled the other criteria mentioned.

Information sources and search strategy

A broad, systematic literature search of Pub Med, APAMed Central, Herdin, CINAHL, Scopus, Springer Link, ProQuest Coronavirus Research Database, and Google Scholar from January 1, 2020 to February 6, 2021 was performed by two investigators (K. M. C. O. and T. L. G. C.). The following terms were used in the search "COVID-19" or "SARS-CoV-2" or "coronavirus," or "NCoV-19," and "hearing loss" or "ear pain" or "otalgia" or "ear discharge" or "otorrhea" or "otitis media" or "vertigo" or "tinnitus" or "otologic" or "neurotologic" or "audiologic" or "vestibular." Search strategies were adjusted to suit each database. Citations were screened for any additional relevant articles. We also considered other article types such as letters to the editor and brief communications or correspondence. Preprint articles were included to increase the sample size.

Selecting sources of evidence

Grossly irrelevant articles were removed. Retrieved references were checked for duplications and thus removed. The full text of the remaining studies was screened independently by both authors using the eligibility criteria as discussed above. Any disagreement regarding eligibility was resolved through a discussion.

Quality assessment of studies

Quality assessment of the included studies was evaluated by two investigators (K. M. C. O. and T. L. G. C.) using the Murad tool.[6] We considered poor, fair, and good quality if the average rating for each study was less than 3, less than 5, or 5 and above, respectively. Any disagreement was resolved by the investigators through a discussion.

Data collection and analysis

The following data were extracted from the full text of the articles: author and year, study design, setting, number of patients of interest, age/age range, sex, otologic/vestibular signs and symptoms, and other relevant clinical information on patients (comorbidities, onset of symptoms, duration of symptoms, treatment for the otologic/vestibular dysfunction, clinical outcome).

Categorical variables were pooled as frequencies and percentages while continuous variables were summarized using means or medians with standard deviation or ranges when deemed possible.

RESULTS

Selection of sources of evidence

The systematic literature search strategy performed on February 6, 2021, yielded a total of 1409 studies. We excluded 1270 for lack of relevance, 55 articles were found to be duplicates. Of the remaining 84 studies whose abstracts were screened, 52 did not contain information on the primary outcome of interest. Another seven articles were excluded either because the full text could not be found, or the article was on the pediatric population. Only 25 articles fulfilled the eligibility criteria. An additional six articles were added after doing an updated search on April 11, 2021. Eleven articles were also included after looking through citations. Figure 1 shows the flow diagram, including the reasons for the exclusion of articles.

Characteristics of sources of evidence

A total of 42 studies were included. Studies retrieved composed of 2 noncomparative cohort studies, 11 cross-sectional studies, and 29 case reports and case series. Table 1 shows the list of included studies. There were 23 studies that reported on hearing loss, 18 studies on tinnitus, 17 studies on dizziness or vertigo, 12 studies on ear pain, and 3 studies on ear discharge. Table 1 shows the list of included studies. Most of the cross-sectional or cohort studies included delved into determining various ENT and non-ENT symptoms, and so the authors extracted data from the relevant subset of patients in these studies.

Quality assessment of sources of evidence

Table 1 shows the quality assessment of the studies included. The studies were assessed as fair to good in quality.

Results

Hearing loss

Details of hearing loss were present in 23 published reports, comprised of 199 patients.[7,9,11,13,17,21–23,25–28,30–32,34–37,39,41,43,45] Almost 68% of these patients began experiencing hearing loss within a month from the onset of typical symptoms or from COVID-19 diagnosis. Only three patients (1.5%) experienced hearing loss with no other symptom and were tested for COVID-19 sometime later.[11,30,37] One patient did not report hearing loss as a symptom but with significant audiometry findings. Three patients (1.5%) experienced hearing loss more than a month after being diagnosed with COVID-19, ranging from 40 to 117 days.[7,41,45] The remaining 28.6% did not provide any details regarding onset.

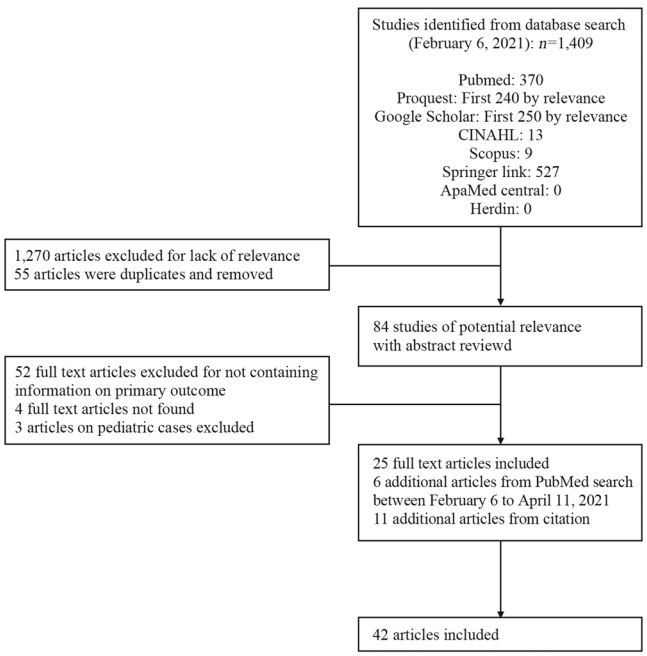

FIGURE 1 Flow diagram for study selection

TABLE 1 Summary of studies included in the review

Author and year	Symptoms reported	Quality assessment	Author and year	Symptoms reported	Quality assessment
Brzycki et al. (2021)[7]	HL	Fair	Liang et al. (2020)[8]	T	Good
Beckers et al. (2021)[9]	HL	Fair	Liu et al. (2020)[10]	V	Good
Chern et al. (2021)[11]	HL, V	Good	Mady et al. (2020)[12]	EP	Good
Chirakkal et al. (2021)[13]	HL, T	Fair	Maharaj and Hari (2020)[14]	V, T	Fair
Cui et al. (2020)[15]	EP, T	Fair	Malayala and Raza (2020)[16]	V	Good
Degen et al. (2020)[17]	HL, T	Good	Malayala et al. (2021)[18]	D, V	Good
Fadakar et al. (2020)[19]	V	Good	Miri and Ajalloueyan (2020)[20]	EP	Fair
Fidan (2020)[21]	HL, EP, T	Fair	Mohan et al. (2021)[22]	HL, EP, ED	Good
Fidan et al. (2021)[23]	HL	Fair	Moradian et al. (2020)[24]	EP, D	Good
Freni et al. (2020)[25]	EP, HL, T	Good	Munro et al. (2020)[26]	HL, T	Fair
Gallus et al. (2021)[27]	D, V, T, HL	Good	Perret et al. (2021)[28]	V, HL	Good
Garcia-Romo et al. (2021)[29]	D	Good	Raad et al. (2021)[30]	HL, EP, ED	Good
Guigou et al. (2021)[31]	HL	Fair	Rhman and Wahid (2020)[32]	HL, T	Good
Han et al. (2020)[33]	V	Fair	Salepci et al. (2021)[34]	EP, D/V, HL	Fair
Jacob et al. (2020)[35]	HL	Good	Savtale et al. (2021)[36]	HL, T	Good
Kilic et al. (2020)[37]	HL	Good	Sia (2020)[38]	D	Fair
Korkmaz et al. (2020)[39]	D, V, T, HL	Good	Stavem et al. (2021)[40]	EP	Good
Koumpa et al. (2020)[41]	HL, T	Fair	Vanaparthy et al. (2020)[42]	V	Good
Lamounier et al. (2020)[43]	HL, T	Good	Viola et al. (2020)[44]	D, V, T	Good
Lang et al. (2020)[45]	HL, T	Good	Wanna et al. (2020)[46]	EP, ED	Fair
Lechien et al. (2020)[47]	EP, V	Fair	Ye and Xianyang (2020)[48]	EP	Good

Abbreviations: D, dizziness; ED, ear discharge; EP, ear pain; HL, hearing loss; T, tinnitus; V, vertigo.

Twelve patients from case reports provided details of their audiometry. All three patients diagnosed with otitis media presented with unilateral hearing loss—two had mild conductive hearing loss, while one had moderate mixed hearing loss.[21,22,30] Nine patients were diagnosed with sensorineural hearing loss—five bilateral, four unilateral—with varying severity. Two of these cases presented with low-frequency hearing loss,[13,37] while the rest ranged from moderate to profound hearing loss.[9,11,17,31,32,43,45] A study by Gallus et al.[27] compared the pure tone thresholds of the patients with COVID-19 compared to matched controls, but while a statistically significant difference was noted in the 250, 2000, and 4000 Hz, the differences were minimal and did not appear to be clinically significant as the thresholds were all within the normal range.

One hundred and twenty-eight of the 199 patients had details regarding their recovery. Almost 56% of patients completely recovered or were able to achieve their baseline hearing thresholds. Ninety percent of them recovered within 2 weeks, while the rest recovered within a month. Five patients (2.5%) reported having partial recovery of their hearing.[9,22,32,41,43] The study by Freni et al.[25] measured hearing loss using the Hearing Handicap Inventory for Adults (HHIA) showing significant improvement in scores from the active phase of COVID-19 disease to 15 days after having RT-PCR negative result. The HHIA score with a mean (SD) of 13.2 (14.9) was seen in the 20 patients who reported the appearance of or worsening hearing loss during the active phase, while a mean (SD) HHIA score of 4.24 (5.55) was reported by the nine patients who continued to have hearing loss. Twelve patients (6%) continued to have persistent symptoms at the time of assessment.[11,13,25,45] Timing of assessment were varied with two patients followed up until 3 and 8 weeks after onset of hearing loss,[11,45] and a study that performed assessment 15 days after having a negative PCR.[25] One of these was a case of intralabyrinthine hemorrhage, that presented with sudden sensorineural hearing loss (SSNHL), unresponsive to oral and intratympanic steroids.[11] One was described as having "progressive clinical recovery."[28] The remaining 35.2% did not provide any details regarding duration.

Given the temporal relationship with the patients' COVID-19 diagnosis, almost all these cases of hearing loss were attributed to the SARS-CoV-2 virus, except for one case that incidentally also tested

positive for syphilis and meningitis.[31] Forty-six patients (23.1%) presented as SSNHL, while nine patients (4.5%) were diagnosed with otitis media.

Except for those diagnosed with otitis media, nearly all case studies reported performing an MRI study to rule out retrocochlear and brain abnormalities. Only three of the nine patients with otitis media were reported to have undergone computed tomography scan of the temporal bone, one of which was complicated by unilateral facial palsy. COVID-19 treatment that was considered standard for each country was given to most patients. Corticosteroids, whether oral, intratympanic, or both, have been given as therapy to most cases of SSNHL. One case of hearing loss in Germany prompted urgent cochlear implantation after MRI showed inflammation in the cochlea.[17] Myringotomy was performed in some of the cases of otitis media.

Tinnitus

There were 18 reports on tinnitus, with a total of 214 patients.[8,14,15,17,18,21,25–27,32,36,39,41,43–45,47] Eighty-eight percent of these patients experienced tinnitus within a month from the onset of typical symptoms or from COVID-19 diagnosis. Two patients (<1%) reported tinnitus occurring 40–50 days after the COVID-19 diagnosis.[41,45] Both these patients also experienced hearing loss. Three patients (1.4%) had tinnitus as one of the presenting symptoms, accompanied by either ear pain or dizziness, and were diagnosed with COVID-19 later on.[14,18,21] Almost 10% of the patients (21/214) had no further details on tinnitus onset.

There was limited explicitly mentioned data in terms of tinnitus recovery. Eighty percent of patients did not have sufficient details regarding recovery. This was largely due to the study by Savtale et al.[36] that had 120 patients. Fifteen percent of patients reported complete recovery from tinnitus,[8,15,18,25–27,39] while around 4% reported persistence in symptoms at the time of assessment.[7,25,27,43,45] Timing of assessment were varied with two patients followed up 3 and 7 weeks after onset of tinnitus,[43,45] while two studies performed assessments around 2 weeks after a negative PCR.[25,27] Half of the patients who recovered completely did so within 2 weeks.[8,39] One case reported by Malayala et al.[18] had reported symptoms that resolved within 2 weeks but redeveloped after 6 days and then lasted for a month.[18] Meanwhile, the patients in the study by Freni et al.[25] did not specify the exact duration of tinnitus symptom experienced but noted whether tinnitus was present or absent by the 15th day after a negative PCR. In addition, the study used Tinnitus Handicap Index (THI) to estimate severity. A significant improvement was seen in THI scores reported by five patients who still had tinnitus on the 15th day after a negative PCR with a mean (SD) score of 1.14 (3.2) compared to the 10 patients who reported the symptom during the active phase (THI score 6.6 [12.1]) ($P < 0.001$).[25]

Similar to hearing loss, nearly all cases of tinnitus were attributed to the SARS-CoV-2 virus, except for two patients. One of these cases was already previously diagnosed with Meniere disease,[15] while the other was later on assessed to have a congenital inner ear abnormality.[14]

Vertigo/dizziness

There were 17 reports on vertigo or dizziness, with a total of 133 patients.[10,11,14,15,18,19,24,26–29,33,34,38,39,44,47] Almost 58% of them had no information regarding onset of dizziness but 35.3% reported experiencing the symptom after first experiencing the typical symptoms of COVID-19. Most of the patients began experiencing vertigo or dizziness within a month of the typical COVID-19 symptom and only one patient experienced vertigo 3 months after initial symptoms.[18] On the other hand, there were six patients (4.5%) in whom vertigo, dizziness, or imbalance was the presenting symptom, whieventually followed by the typical symptoms of COVID-19,[10,18,27,38] and another three patients (2.3%) with no other COVID-19 symptom except for vertigo.[11,14,18]

Ninety of the 133 patients had details regarding the recovery of their vertigo or dizziness symptoms. The majority of the patients experienced complete resolution of symptoms (57.8%), while six patients (4.5%) experienced partial recovery with varying degrees of improvement.[11,19,28,29,33,38] Two thirds of those who underwent complete recovery reported resolution within 14 days. Malayala et al.[18] report two cases that were resolved after more than a month. Dizziness can occur as long as 4 months as reported by Garcia-Romo et al.[29]. Symptoms were persistent in seven patients (5.3%).[24,27] The rest of the patients (32%) did not have sufficient details regarding their recovery.

Nearly all cases were potentially associated by their corresponding investigators to COVID-19 disease with perhaps the exception of two cases—Meniere Disease[15] and congenital inner ear abnormality.[14] Some of the causes of vertigo identified in the case reports were vestibular neuritis, labyrinthitis, cerebellitis, and intralabyrinthine hemorrhage. COVID-19 treatment that was considered standard for each country was given to most patients, with the addition of steroids, antiemetics, antivertigo medication such as meclizine, benzodiazepine, and betahistine, and vestibular rehabilitation.

Ear pain

There were only 12 studies reporting on ear pain, with a total of 477 patients.[12,15,20–22,24,30,34,40,46–48] The largest study was by Lechien et al.[47] who reported 358 patients with ear pain.[47] Only 9% of all patients had any detail regarding onset where almost all patients experienced ear pain within a month from the onset of typical symptoms of COVID-19 or from COVID-19 diagnosis.[12,22,30,46] On the other hand, 90% had details regarding recovery, where 78.6% experienced complete resolution. The duration of the symptoms ranged from a few days to a few weeks. Eleven percent

experienced persistent ear pain. The timing of the assessment ranged from at least a week from the resolution of general symptoms to as long as 6 months.[24,40,47] The remaining 10% had insufficient details.[12,21]

The two most common diagnoses for ear pain were acute otitis externa and otitis media, with nearly all cases attributed to the COVID-19 diagnosis. Limited information was mentioned regarding otologic-specific management in most cases, but in those that provided some information, systemic antibiotic and antiviral medication,[21,22] mupirocin,[15] myringotomy with or without insertion of ventilation tube,[22,30] and antibiotic otic drops[22] were given to address these. One patient was a previously diagnosed case of cholesteatoma who underwent canal wall down mastoidectomy, and was managed with antibiotic otic drops and subsequent debridement of the mastoid cavity.[46]

Ear discharge

Ear discharge was reported in only three case reports.[22,30,46] All three patients experienced ear pain along with their discharge, and these symptoms occurred within 1 or 2 weeks after the onset of typical symptoms of COVID-19. All cases were diagnosed as otitis media (two acute, one chronic) and achieved complete resolution.

Table 2 shows a summary of the description of symptom onset and recovery.

DISCUSSION

COVID-19 has been established to be primarily a respiratory disease.[49] However, being a systemic viral infection, it has manifestations in other systems of the human body. The otologic/hearing and vestibular systems have been reported and theorized to bear the adverse effects of viral infections. Hearing loss, ear pain, ear discharge, and tinnitus may occur in acute otitis media directly caused by viral infections of the middle ear or secondary to viral upper respiratory tract infections. Hearing loss is the primary feature of SSNHL, with or without tinnitus. The definite etiology of SSNHL has not been established, but viral infections are one of the more common presumed etiologies. The following are the current theories in the mechanism of viral-induced SSNHL: first, direct viral invasion of the cochlea and its associated structures; second, reactivation of latent virus within tissues of the inner ear; and third, an indirect route wherein a systemic or distant viral infection triggers an antibody response that cross-reacts with an inner ear antigen or that triggers a circulating ligand, causing pathologic activation of cellular stress pathways within the cochlea.[50] Thus, mechanisms involved in the causation of hearing impairment by different viruses vary greatly,

TABLE 2 Description of symptom onset and recovery

Symptom	Hearing loss	Tinnitus	Vertigo/dizziness	Ear pain	Ear discharge
Number of studies	23	18	17	12	3
Cases (*n*)	199	214	133	477	3
Onset					
After the onset of typical symptoms of COVID-19 or from COVID-19 diagnosis	138 (69.3%)	190 (88.8%)	47 (35.3%)	38 (8%)	3 (100%)
Within a month from the onset of typical symptoms of COVID-19 or from COVID-19 diagnosis	135 (67.8%)	188 (88%)	40 (30%) 6 (4.5%)—at least a week after diagnosis	38 (8%)	3 (100%)
More than a month from the onset of typical symptoms of COVID-19 or from COVID-19 diagnosis	3 (1.5%)	2 (<1%)	1 (<1%)	-	0
Presenting symptom					
Preceding other symptoms or COVID-19 diagnosis	-	3 (1.4%)	6 (4.5%)	3 (<1%)	0
No other symptom, preceding COVID-19 diagnosis	3 (1.5%)	-	3 (2.3%)	2 (<1%)	0
No further details given	57 (28.6%)	21 (10%)	77 (58%)	434 (91%)	0
Recovery					
Complete resolution	111 (55.8%)	32 (15%)	77 (57.8%)	375 (78.6%)	3 (100%)
Partial recovery	5 (2.5%)	1 (<1%)	6 (4.5%)	-	0
Persistent	12 (6%)	9 (4%)	7 (5.3%)	55 (11.5%)	0
No further details given	70 (35.2%)	172 (80%)	43 (32%)	48 (10.1%)	0

Note: Values shown as frequency and percentage.

ranging from inflammation of auditory structures, to direct damage to inner ear structures, including inner ear hair cells and organ of Corti, to induction of host immune-mediated damage.[51] Dizziness or vertigo may be due to vestibular neuronitis, which is considered to be an inflammation of the vestibular portion of the eighth cranial nerve. The cause is presumed to be of viral origin, specifically the reactivation of latent HSV infection, but other causes have been proposed, such as vascular and immunologic,[52] similar to SSNHL, have been proposed. The link between viral infections and otologic and vestibular systems is not a new concept. Therefore it is relevant to explore the characteristics of this link in the setting of the present viral pandemic.

Otologic and vestibular symptoms have been identified in patients with COVID-19, a disease caused by the coronavirus SARS-CoV-2. Almufarrij and Munro[3] reviewed available studies to determine a pooled estimated prevalence of 7.6% (95% CI: 2.5–15.1), 14.8% (95% CI: 6.3–26.1), and 7.2% (95% CI: 0.01–26.4) for hearing loss, tinnitus, and rotatory vertigo, respectively. Although these are not common in occurrence when compared to fever and cough,[1] these can still be significant concerns for the patients, and will need appropriate management. Our current study was a review of available literature aimed to describe COVID-19 associated otologic and vestibular symptoms in terms of onset, duration, and recovery, to provide insight on how best to manage these patients.

Hearing loss, when it occurred, had an onset within a month from the initial typical symptoms of COVID-19 for 68% of the patients. Ninety percent of the patients who fully recovered did so within 2 weeks of the onset. Hearing loss was considered as an associated symptom of COVID-19 for most of the cases and did not receive any specific treatment. The onset and duration of hearing loss, when considered as a component of COVID-19, was consistent with the more than half-a-century old concept that the general natural history of a respiratory viral infection is that symptoms resolve within 2 weeks from the onset.[53] In cases where the hearing loss was rendered a specific diagnosis rather than just being a part COVID-19, SSNHL, and otitis media were the most common distinct otologic diagnosis made and given appropriate management. Sensorineural hearing affectation appeared to be more common and tended to be more severe than conductive hearing loss in patients with COVID-19. Affected frequencies in the pure tone audiometry of these patients were varied with low-frequency, high-frequency, and global hearing loss patterns seen. A study by Mustafa[54] on asymptomatic patients that tested COVID-19 positive, however, showed that high-frequency thresholds were significantly lower than a control group of normal-hearing patients.

Tinnitus, when it occurred, had an onset within a month in 88% of the patients. The majority of the tinnitus cases were considered part of COVID-19 and although detailed information was not available, it is significant to note that half of the patients with complete recovery also did so within 2 weeks, just like hearing loss.

Information on the onset of vertigo and dizziness in COVID-19 was scarce. When available, it also occurred within a month after the onset of the initial typical symptoms. It is important to note that, although relatively uncommon, these can be the presenting symptom (4.5%), or the only symptom (2.3%) in COVID-19 patients. This impacts the index of suspicion for COVID-19 when dealing with new-onset dizziness or vertigo, even in the absence of infectious and respiratory symptoms. The majority of patients had complete resolution of these symptoms, and did so within 2 weeks, reflecting the association of the symptom with the viral infection, instead of being a distinct or separate entity. When a distinct diagnosis was made, the most common was vestibular neuritis and was treated accordingly together with the treatment for COVID-19.

Information on ear pain was even more scarce but also occurred within a month from the onset, with a majority gaining complete recovery. Ear pain in COVID-19 patients was mostly due to otitis externa and otitis media, the most common causes of ear pain even in non-COVID-19 patients. These were managed accordingly and had a resolution in the majority of cases.

Ear discharge was reported the least, and all were due to otitis media. These may be attributed to the virus as the cause of the middle ear infections. All cases were resolved after being given the appropriate management.

For all the otologic and vestibular symptoms in the review, data available indicate that majority of these were considered a component of COVID-19 and were managed within the protocols approved in their settings. The onset, duration, and outcome of these symptoms proved to be consistent with this approach. There were a few cases of COVID-19 disease that presented with otologic and vestibular symptoms that, upon further investigation, were found to have distinct (e.g., SSHNL, otitis media, vestibular neuritis cases) or alternative[14,15,31] diagnoses for their symptoms. These cases, in addition to the relatively low prevalence of these symptoms in COVID-19,[3] showed that additional work-up, such as imaging studies or other serologic studies may be necessary for investigating the true etiology of these symptoms, which may aid in further therapeutic management and prognostication. Prior history of otologic or vestibular problems, or other comorbidities, asymmetry and severity of symptoms, or the absence of the more typical symptoms of COVID-19 may provide clues as to the need for further investigation.

The persistence of hearing loss, tinnitus, and vertigo in some of these patients showed us that COVID-19 may have long-term effects that may need to be monitored in patients. Analyzing the clinical patterns of these symptoms in COVID-19 provides insight into the continuing enigma regarding the virulence and pathophysiology of the SARS-CoV-2 virus. At the same time, they lend support to the theory that disease entities, such as SSNHL and vestibular neuritis, may indeed have viral etiologies.[50,52]

LIMITATIONS

The studies included were prone to recall and reporting bias. Some of the studies, particularly the cross-sectional studies, were designed such that patients were asked to recall their symptoms

retrospectively, which affected the completeness and accuracy of the reports. The use of self-reported symptoms for some studies, rather than the use of more objective tests such as audiometry may have also led to underreporting. In addition, authors were more likely to report symptoms as COVID-19 associated if they occurred shortly before or after the onset of the typical symptoms of COVID-19. Isolated otologic and vestibular symptoms were less likely to be tested for and, therefore, associated with COVID-19, which prevented characterization of these cases in terms of onset, duration, and recovery.

The studies were also different in their definitions for persistent symptoms as they were based primarily on when the study was performed or when the patients were last followed up, which ranged between a few weeks to 6 months. Long-term sequelae of these symptoms were also not determined.

Our search strategy was also limited to studies that mentioned "vestibular" or "vertigo" symptoms to exclude studies that discussed nonspecific or other causes of dizziness (such as neurologic or cardiac). At the same time, we realize that this may have caused selection bias because some authors use the terms dizziness and vertigo interchangeably. Studies that used the term "dizziness" that were nevertheless included in our search strategy were still included in the study if the discussion suggests a vestibular etiology.

CONCLUSION

Otologic and vestibular symptoms were present in COVID-19 patients, majority as part of the systemic nature of the disease. The onset, duration, and course were consistent with the natural history of a systemic viral infection. COVID-19 should be considered in any patient with a new-onset hearing loss, tinnitus, or vertigo/dizziness, even in the absence of infectious or respiratory symptoms. COVID-19, at its best, is just like any other systemic viral illness with an acute onset of symptoms that may involve different systems of the human body, with a self-limiting duration of 2 weeks on average, and would usually require standard treatment for viral infections. When specific diagnoses are made for these symptoms (e.g., SSNHL, otitis media, vestibular neuritis), they are treated in the same manner as one would for non-COVID-19 cases, in addition to the management for COVID-19. In certain cases, there may be a need for additional work-up to rule out other causes. Much of the information on these symptoms are still not fully known owing to a lack of standard detailed data gathering procedure. It is ideal for a global health organization to formulate standard procedures for data collection so that there will be a detailed and complete documentation of the many aspects of this disease. The importance of these data cannot be overemphasized for the progress in understanding the pathophysiology, clinical presentation and course, and effective management of COVID-19.

AUTHOR CONTRIBUTIONS

Kimberly Mae C. Ong: Conceptualization, methodology, formal analysis, investigation, resources, data curation, writing-original draft preparation, review and editing, visualization. **Teresa Luisa G. Cruz**: Conceptualization, formal analysis, investigation, data curation, writing-original draft preparation, review, visualization.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

As this study is a systematic review of published literature, institutional ethical committee approval and informed consent were not obtained.

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