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ORIGINAL RESEARCH

Increased prevalence of hearing loss, tinnitus and sudden deafness among patients with Sjögren's syndrome

Tzong-Hann Yang,[1,2,3,4,5] Sudha Xirasagar,[6] Yen-Fu Cheng,[7,8,9,10,11] Chin-Shyan Chen,[11,12] Herng-Ching Lin [13,14]

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Y-FC, C-SC and H-CL contributed equally.

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For numbered affiliations see end of article.

Correspondence to
Professor Herng-Ching Lin; henry11111@tmu.edu.tw

ABSTRACT

Background This study aimed to provide an updated prevalence of hearing loss, tinnitus, vertigo and sudden deafness on patients with Sjögren's syndrome and matched comparison patients.

Methods Data for this study were retrieved from the Taiwan Longitudinal Health Insurance Database and Taiwan's registered catastrophic illness dataset. This study included 20 266 patients with Sjögren's syndrome as the study group and 60 798 propensity score-matched comparison patients as the comparison group. We used multivariable logistic regressions to estimate the ORs and 95% CI for tinnitus, hearing loss, vertigo and sudden deafness among Sjögren's syndrome patients versus comparison patients.

Results χ^2 tests showed there were statistically significant differences between the study group and comparison group in the prevalence of tinnitus (10.1% vs 6.3%, p<0.001), hearing loss (5.6% vs 3.3%, p<0.001), vertigo (4.6% vs 3.2%, p<0.001) and sudden deafness (0.8% vs 0.6%, p<0.001). Multiple logistic regression revealed that patients with Sjögren's syndrome had a greater tendency to have tinnitus (OR=1.690, 95% CI 1.596–1.788), sudden deafness (OR=1.368, 95% CI 1.137–1.647), hearing loss (OR=1.724, 95% CI 1.598–1.859) and vertigo (OR=1.473, 95% CI 1.360–1.597) relative to comparison patients after adjusting for age, income, geographic location, residential urbanisation level, diabetes, hypertension, hyperlipidaemia and rheumatoid arthritis.

Conclusions We found higher prevalence of hearing loss, vertigo, tinnitus and sudden deafness among patients with Sjögren's syndrome relative to comparison patients. Findings may provide guidance to physicians in counselling patients with Sjögren's syndrome regarding a higher risk of hearing loss, tinnitus, sudden deafness and vertigo.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ There is some literature documenting empirical evidence on the prevalence of the symptoms and signs of eight-nerve disorder associated with Sjögren's disease (SjD).

⇒ Several studies report a possible linkage between SjD and audiovestibular dysfunction, limited to case reports, case series and clinical studies.

WHAT THIS STUDY ADDS

⇒ There were statistically significant differences between patients with SjD and comparison group in the prevalence of tinnitus (10.1% vs 6.3%), hearing loss (5.6% vs 3.3%), vertigo (4.6% vs 3.2%) and sudden deafness (0.8% vs 0.6%).

⇒ Patients with SjD had a greater tendency to have tinnitus (OR=1.690), sudden deafness (OR=1.368), hearing loss (OR=1.724) and vertigo (OR=1.473) relative to comparison patients

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Findings may provide guidance to physicians in counselling patients with SjD regarding a higher risk of hearing loss, tinnitus, sudden deafness and vertigo.

⇒ Careful audio-vestibular assessment and precautions to minimise risks may be suggested on patients with SjD.

INTRODUCTION

Sjögren's syndrome, also known as Sjögren's disease (SjD), is a multisystem, chronic autoimmune disorder of the connective tissues, primarily characterised by lymphoid infiltration of the exocrine glands, chiefly the salivary and lacrimal glands, causing dryness of the mouth and eyes, but also often accompanied by extraglandular manifestations, such as cutaneous lesions, Raynaud's phenomenon, joint pain and internal organ (eg, pulmonary, renal, hepatic, thyroid and neurological) involvement.[1] It is the second most common autoimmune rheumatic disease affecting an estimated 4 million cases in the USA.[2] This disease entity could manifest in the primary form without extraglandular manifestations or a multisystem form that overlaps with other rheumatic diseases.[3 4] The exact aetiology remains elusive, although B-cell dysfunction and hyperactivity are thought to underlie the tissue damage observed in these patients.[5]

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Impairment of the eighth cranial nerve or damage to the hearing and vestibular end organs result in audiovestibular dysfunction such as hearing loss, tinnitus, vertigo and sudden deafness. Although several authors postulate a high likelihood of cranial neuropathies associated with SjD pathological processes, there is some literature documenting empirical evidence on the prevalence of the symptoms and signs of eight-nerve disorder associated with SjD. In particular, several studies report a possible linkage between SjD and audiovestibular dysfunction, limited to case reports, case series and clinical studies. There is no report of population-based studies on this topic. This nationwide, population-based observational study was conducted to provide an updated prevalence of hearing loss, tinnitus, vertigo and sudden deafness on patients with SjD and matched comparison patients in the Taiwanese population.

METHODS

Database

We retrieved data for this retrospective observational study from Taiwan's Longitudinal Health Insurance Database 2010 (LHID2010). Taiwan initiated its National Health Insurance (NHI) programme in 1995 as a single-payer, mandatory social insurance programme covering comprehensive medical care for all Taiwanese citizens. The LHID2010 includes beneficiary registration files of a random sample of 2 000 000 NHI beneficiaries and their claims files on ambulatory care visits and inpatient admissions, and prescriptions dispensed at NHI-contracted pharmacies. Many researchers from Taiwan universities, research institutes and medical centres have used the LHID2010 to conduct epidemiological studies of diseases and treatments.

Identification of study patients

This study examines a study group and a comparison group. For the study group, we retrieved the claims records of all patients aged over 20 years with a diagnosis of SjD (ICD-9-CM 710.2 or ICD-10-CM M35. 0) or with a catastrophic illness certificate (CIC) for SjD in ambulatory care claims from clinics or outpatient departments of hospitals between 1 January 2015 and 31 December 2018. In total, we identified 20 266 patients with SjD in the study group. In Taiwan, the diagnosis of SjD is primarily conducted by rheumatologists through a comprehensive diagnostic process. This process involves meticulous physical examinations and the collection of laboratory data, including anti-SSA, anti-SSB and unstimulated whole salivary flow rate. Rheumatologists routinely refer patients to ophthalmologists for assessments such as the Schirmer's test and a slit-lamp examination to evaluate tear break-up time, ocular surface staining or the van Bijsterveld score. Simultaneously, referrals are made to otolaryngologists or oral medicine doctors for lip biopsies, with the results interpreted by pathologists. Therefore, the diagnosis of SjD in Taiwan entails a comprehensive evaluation led by rheumatologists.[6] In addition, the NHI has established 31 categories of catastrophic illnesses, including cancers, haemophilia, autoimmune diseases and chronic renal failure, to alleviate severe financial hardship for affected families.[7 8] Patients diagnosed with SjD are entitled to exemption from copayment for all medical costs. To obtain a CIC for SjD, patients are required to meet the criteria outlined in the 2002 AECG, 2012 ACR or 2016 ACR/EULAR classification criteria, which are subsequently reviewed by a committee.[9 10] Therefore, we believe that the diagnosis of SjD has a very high validity in Taiwan.

For the comparison group, we identified patients from the remaining LHID2010 enrolees aged ≥20 years from the registry of beneficiaries. We excluded all enrolees who had a diagnosis of SjD, tinnitus, vertigo, hearing loss and sudden deafness, in a claim prior to the study period. We used propensity score matching to select comparison patients (matching ratio=3:1). We calculated a propensity score to have SjD for each patient using the predictors, sex, age, geographic location, monthly income and urbanisation level of the patient's residence, medical comorbidities (diabetes, hypertension, hyperlipidaemia) and rheumatoid arthritis. The selected variables were entered into a multivariable logistic regression model as predictors to calculate the expected probability of receiving an SjD diagnosis. Urbanisation level is classified into five levels (1=most urbanised, 5=least urbanised) according to published criteria used by the Taiwanese National Health Research Institute. The criteria used are population density, ratios of vulnerable/advantaged population subgroups to the overall population (elderly aged over 65, agricultural workers and college degree holders), and, number of physicians per 100 000 population. Following propensity score estimation for the remaining beneficiaries, they were grouped into quintiles based on propensity scores. We used the method of nearest neighbour within callipers to match comparison patients using an a priori value for the callipers of 0.2, because exact score-matched comparison patients may not be identified for every patient with SjD. The final study sample consisted of 20 266 patients with SjD and 60 798 comparison patients.

Measures of outcomes

We selected the following outcome variables of interest: tinnitus, hearing loss, vertigo and sudden deafness. In this study, prevalence was defined as the proportion of a population who have a diagnosis of hearing loss, tinnitus, vertigo and sudden deafness between 2015 and 2018. The presence of these diagnoses were identified by finding their respective ICD codes in the ambulatory visit claims, tinnitus (ICD-9-CM code 388.3 or ICD-10-CM H93.1, H93.11, H93.12, H93.13 or H93.19), hearing loss (ICD-9-CM 389 or ICD-10-CM H90 or H91), sudden deafness (ICD-9-CM 388.2 or ICD-10-CM H91.2) or vertigo (ICD-9-CM 386.1, 386.10 and 386.19 or ICD-10-CM H81.391, H81.311, H81.312 or H81.313). One previous

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study has used the same ICD codes to examine the association of Fabry disease with hearing loss, tinnitus and sudden hearing loss.[11] In Taiwan, otolaryngologists play a key role in the management of patients with hearing and balance disorders. Usually, the diagnosis and quantification of hearing loss involves air-conduction and bone-conduction pure tone audiometry tests in a soundproof room. Asymmetric sensorineural hearing loss (SNHL) was defined as a threshold difference of ≥15 dB in two or more frequencies, or an asymmetry of ≥15% on word discrimination scores. In cases of asymmetric hearing loss, an auditory brainstem response (ABR) test was administered to differentiate between cochlear and retrocochlear hearing loss. ABR was considered abnormal if there was a difference in interaural latency greater than 0.3–0.4 ms, abnormal absolute wave V latencies (>6.1 ms with less than 40 dB hearing loss), or absent or distorted waveform morphology. Patients with an abnormal ABR and without any contraindication for MRI underwent an MRI (T1W and/or T2W with Gd-DPTA contrast enhancement) of the brain and cerebellopontine angle to determine the cause of retrocochlear hearing loss. Patients with vertigo typically underwent a comprehensive evaluation, including both physical and otoneurological tests. Physical examinations consisted of nystagmus examination, Romberg test, Dix-Hallpike test, supine roll test, stepping, tandem gait, dysdiadokinesi and dysmetria tests. Otoneurological evaluations included electronystagmography/videonystagmography, caloric test, and cervical or ocular vestibular-evoked myogenic potentials tests.

Statistical analysis

We performed statistical analyses using the SAS system (SAS System for Windows, V.9.4, SAS Institute, Cary, NC). We used χ^2 tests and t-tests to explore differences in patient sociodemographic characteristics and medical comorbidities between the study group and comparison group. Multivariable logistic regressions were carried out to calculate the ORs and 95% CI for tinnitus, hearing loss, vertigo and sudden deafness among SjD patients versus comparison patients. Two-sided p<0.05 was used for statistical significance.

RESULTS

The sociodemographic characteristics and medical comorbidities of patients with SjD and comparison patients are presented in table 1. We retrieved 20 266 patients with SjD, 73.1% of them are female with an average age 52.1. After propensity-score matching, we found no significant differences between patients with and without SjD on sex (p=1.000), age (p=0.782),

Table 1 Demographic characteristics and medical comorbidities of patients with Sjogren's syndrome and propensity score-matched comparison patients (n=81 064)

	Patients with Sjogren's syndrome (n=20 266)		Comparison patients (n=60 798)		
Variable	Total (n)	%	Total (n)	%	P value
Age, mean (SD)	52.1 (16.3)		52.0 (16.3)		0.782
Males	5443	26.9	16 329	26.9	>0.999
Monthly income					0.666
<NT$1–15 841	3529	17.4	10 428	17.1	
NT$15 841–25 000	7749	38.2	23 386	38.5	
≥NT$25 001	8988	44.4	26 984	44.4	
Geographic region					0.006
Northern	9091	44.9	27 888	45.9	
Central	7372	36.4	21 316	35.1	
Southern	3596	17.7	10 917	18.0	
Eastern	207	1.0	677	1.1	
Urbanisation level					0.770
1 (most urbanised)	6295	31.1	18 786	30.9	
2	5865	28.9	17 663	29.1	
3	3529	17.4	10 600	17.4	
4	2714	13.4	8006	13.2	
5 (least urbanised)	18 636	9.3	5743	9.4	
Hypertension	7095	35.0	21 285	35.0	>0.999
Diabetes	4161	20.5	12 483	20.5	>0.999
Hyperlipidaemia	7356	36.3	22 068	36.3	>0.999
Rheumatoid arthritis	1334	6.6	4002	6.6	>0.999

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Table 2 Prevalence rates of tinnitus, hearing loss, vertigo and sudden deafness among patients with Sjogren's syndrome versus comparison patients

	Total (n=81 064)		Patients with Sjogren's syndrome (n=20 266)		Comparison patients (n=60 798)		P value
Variable	n, %		n, %				
Presence of tinnitus	5851	7.2	2043	10.1	3808	6.3	<0.001
Presence of hearing loss	3169	3.9	1133	5.6	2036	3.3	<0.001
Presence of vertigo	2881	3.6	935	4.6	1946	3.2	<0.001
Presence of sudden deafness	525	0.7	165	0.8	360	0.6	<0.001

residential urbanisation level (p=0.770), monthly income (p=0.666), diabetes (p>0.999), hypertension (p=1.000), hyperlipidaemia (p=1.000) and rheumatoid arthritis (p=1.000).

Table 2 presents the prevalence of the outcomes of interest among patients with SjD and comparison patients. We found that the prevalence of tinnitus, hearing loss, vertigo and sudden deafness were 7.2%, 3.9%, 3.6% and 0.7%, respectively, among the total sample of 81 064 patients. χ^2 tests showed there were significant differences between patients with SjD and comparison patients in terms of tinnitus (10.1% vs 6.3%), hearing loss (5.6% vs 3.3%), vertigo (4.6% vs 3.2%) and sudden deafness (0.8% vs 0.6%) (all p values<0.001).

Table 3 shows the results of multiple logistic regression analysis. The unadjusted OR for tinnitus, sudden deafness, hearing loss and vertigo, respectively for the SjD group relative to the comparison group were 1.678 (95% CI 1.586–1.775), 1.379 (95% CI 1.146–1.659), 1.709 (95% CI 1.586–1.841) and 1.463 (95% CI 1.351–1.584).

Table 3 Covariate-adjusted odds of tinnitus, hearing loss, vertigo and sudden deafness among Sjogren's syndrome versus comparison patients (n=81 064)

	OR (95% CIs)			
Variable	Tinnitus	Sudden deafness	Hearing loss	Vertigo
Sjogren's syndrome (unadjusted)	1.678 (1.586–1.775)	1.379 (1.146–1.659)	1.709 (1.586–1.841)	1.463 (1.351–1.584)
Sjogren's syndrome (adjusted)*	1.690 (1.596–1.788)	1.368 (1.137–1.647)	1.724 (1.598–1.859)	1.473 (1.360–1.597)
Age	1.019 (1.017–1.021)	1.011 (1.004–1.018)	1.037 (1.034–1.040)	1.021 (1.018–1.024)
Sex	0.798 (0.749–0.851)	0.932 (0.765–1.136)	1.139 (1.052–1.233)	0.499 (0.450–0.552)
Monthly income				
<NT$15 841 (reference group)	1.000	1.000	1.000	1.000
NT$15 841–25 000	1.147 (1.059–1.242)	0.947 (0.738–1.214)	0.825 (0.747–0.912)	1.185 (1.062–1.322)
≥NT$25 001	1.165 (1.078–1.260)	1.008 (0.792–1.284)	0.937 (0.851–1.032)	1.119 (1.005–1.247)
Geographic region				
Northern (reference group)	1.000	1.000	1.000	1.000
Central	1.185 (1.108–1.267)	1.483 (1.197–1.838)	1.038 (0.949–1.236)	0.969 (0.881–1.065)
Southern	1.047 (0.964–1.137)	1.197 (0.915–1.565)	0.847 (0.757–0.948)	0.928 (0.828–1.041)
Eastern	1.325 (1.049–1.673)	0.829 (0.305–2.256)	0.846 (0.594–1.206)	1.113 (0.860–1.536)
Urbanisation level				
1 (reference group)	1.000	1.000	1.000	1.000
2	1.047 (0.973–1.126)	0.763 (0.604–0.963)	0.948 (0.861–1.044)	1.048 (0.946–1.160)
3	1.067 (0.978–1.163)	0.701 (0.528–0.930)	0.885 (0.787–0.996)	1.123 (0.996–1.268)
4	1.015 (0.922–1.117)	0.951 (0.714–1.267)	1.069 (0.944–1.212)	1.039 (0.908–1.188)
5	0.961 (0.863–1.071)	0.732 (0.515–1.039)	0.991 (0.860–1.142)	1.053 (0.908–1.221)
Hypertension	1.191 (1.115–1.272)	1.176 (0.951–1.454)	1.154 (1.058–1.259)	1.416 (1.292–1.552)
Diabetes	0.975 (0.912–1.043)	1.123 (0.908–1.389)	1.039 (0.954–1.133)	0.966 (0.882–1.058)
Hyperlipidaemia	1.517 (1.428–1.613)	1.464 (1.203–1.783)	1.324 (1.222–1.434)	1.613 (1.482–1.756)
Rheumatoid arthritis	1.224 (1.110–1.351)	1.085 (0.777–1.515)	1.269 (1.114–1.446)	1.296 (1.139–1.475)

*Adjusted for age, sex, monthly income, geographic region, urbanisation level, diabetes, hypertension, hyperlipidaemia and rheumatoid arthritis.

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In addition, patients with SjD showed higher odds of all four conditions relative to comparison patients after adjusting for sex, age, geographic location, income, residential urbanisation level, diabetes, hypertension, hyperlipidaemia and rheumatoid arthritis: tinnitus (adjusted OR (AOR)=1.690, 95% CI 1.596–1.788), sudden deafness (AOR=1.368, 95% CI 1.137–1.647), hearing loss (AOR=1.724, 95% CI 1.598–1.859) and vertigo (AOR=1.473, 95% CI 1.360–1.597).

DISCUSSION

To our knowledge, this is the first population-based study documenting an association between SjD and audiovestibular dysfunction manifesting as hearing loss, tinnitus, vertigo and sudden deafness.

SjD and hearing loss

Our study, using population-based data, shows that patients with SjD have a higher risk of hearing loss than those without SjD (AOR=1.724, 95% CI 1.598–1.859), which is consistent with other studies based on case reports and case series. Studies have shown that hearing loss, mainly sensorineural, but also conductive,[12] and mixed type hearing loss,[13] could be highly prevalent in patients with SjD,[13–18] with 4.5%–46% of patients with SjD showing SNHL[12 16 17 19–22] in line with our study finding of 5.6%. SNHL associated with SjD usually affects hearing of high frequency sounds (2 kHz–8 kHz).[14 16 20 23] Intriguingly, using extended high-frequency audiometry, the prevalence of hearing loss in the 10 kHz–16 kHz range is 95.2%.[23] An earlier study reported that the majority of patients with SjD and SNHL experienced no symptoms and only displayed hearing loss identifiable through audiological examination.[10] Some studies suggested that the hearing loss may originate in cochlear and retrocochlear dysfunction but other studies did not find evidence of a retrocochlear origin.[18 20 22 24] Severe loss of the intermediate cells of the stria vascularis, IgG deposition on the basilar membrane of blood vessels of stria vascularis, and shrinkage of the spiral ganglia neurons were found in histopathology studies of the inner ear in both patients with concurrent SjD and SNHL as well as SjD mouse models.[25] Immunological mechanisms of SNHL induced by SjD may contribute to a type II immune response, that is, circulating antibodies against the antigens of the inner ear and stimulated T cells, resulting in impairment of the inner ear.[25] Some studies found a type III immune response. Aberrant helper T cells triggered autoantibody generation by the B cells, and the resulting immune complexes were deposited in the stria vascularis of the cochlear or auditory arteries, resulting in impairment of the hair cells or the spiral ganglion.[26] Autoinflammatory microvasculitis affecting the labyrinthine arteries also causes degeneration of the stria vascularis and hair cell damage.[26 27] Finally, a type IV response is shown to cause cytotoxic T cells to attack the hair cells of the inner ear, bringing about high-frequency tone hearing loss.[26]

SjD and tinnitus

Patients with SjD showed higher odds of tinnitus in our study (OR=1.690, 95% CI 1.596–1.788), similar to the odds of hearing loss. Our finding is consistent with prior studies reporting an association of tinnitus with SjD. In our study, the prevalence of tinnitus in patients with SjD is 10.1%, compared with prior studies showing rates ranging between 13.5% and 41.7%.[14 17 23] Tinnitus is a perceived sensation of sound near the head without an external stimulus. Tinnitus could be caused by temporomandibular disorders,[28] conductive hearing loss,[13] hearing loss of cochlear origin,[29] retrocochlear lesions[26] or central nervous system involvement in patients with SjD.[30] Functional MRI and positron-emission tomography scanning studies demonstrate that the loss of cochlear signals to modulate neurons in the central auditory pathways could lead to disturbances of neural activity in the central auditory system, thought to underlie the perception of tinnitus.[31 32]

SjD and vertigo

Patients with SjD showed higher rates and adjusted risk of vertigo in our study. Several case reports and case series have reported the occurrence of vertigo among patients with SjD.[33–39] In our study, the prevalence of vertigo in patients with SjD is 4.6%, compared with 8.1%–28.3% reported in other studies.[14 17 23] In contrast, some studies reported the absence of vertigo occurrence among patients with SjD.[19 22 24] In one study, there was no complaint of vertigo by patients with SjD, although the N1 latency value of the ocular vestibular-evoked myogenic potentials test was significantly longer than normal values, and the posterior semicircular canal and lateral semicircular canal vestibulo-ocular reflex gain values were significantly lower in patients with SjD.[19] The above study suggests the presence of subclinical vestibular dysfunction although the patients did not complaint of overt vertigo. Vertigo is an illusory sensation of movement in the surroundings which arises from asymmetric signals generated in the vestibular system due to impairment or malfunction of the labyrinth, vestibular nerve, or central vestibular pathways in the midbrain or cerebellum. It appears plausible that the onslaught of the immune response on the vestibular end organ and vestibular pathway, similar to the pathological pathways affecting the hearing system, without, however, involving the vestibular ganglia neurons may explain the relatively lower risk of vertigo than hearing loss among patients with SjD, observed in our study.[27]

SjD and sudden deafness

An early report of cases of sudden deafness successfully treated by immune suppressive therapy led to a theory of autoimmune hearing loss in 1979.[40] There is scant literature on the association of SjD with sudden deafness. In our study, patients with SjD had higher odds of sudden deafness relative to comparison patients (OR=1.368, 95% CI 1.137–1.647), with a prevalence of 0.8% among

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patients with SjD. Our finding is in line with a study from Korea showing that the occurrence of sudden deafness is significantly higher among patients with connective tissue diseases including SjD and Behçet disease.[41] There are also several case reports of the occurrence of sudden deafness in patients with SjD.[34 42 43] Sudden deafness could be a consequence of autoantibody pathology as described earlier. We also observed that both the odds and prevalence of sudden deafness are lower than those for hearing loss in our study, suggesting that most cases of SjD-associated hearing loss may experience insidious onset rather than rapidly progressive hearing loss which manifests as sudden deafness, that is, ≥30 dB loss in three continuous frequency bands within 3 days.

Our study has several strengths. Taiwan's health system offers widely accessible and financially affordable healthcare with negligible copayment rates for Taiwanese citizens since the initiation of NHI in 1995. This is likely to minimise selection bias that could be a threat to validity due to socioeconomic disparities or structural barriers to healthcare access in rural or underserved areas. Further, our study could identify and exclude patients with prior SjD and hearing loss, tinnitus, vertigo and sudden deafness, based on claims data from all types of healthcare providers and settings that may treat these patients. The LHID2005 has data on every episode of healthcare utilisation by all Taiwanese residents, including ambulatory care visits, emergency department visits and inpatient admissions. Having comprehensive, accessible and affordable healthcare has enabled patients, regardless of socioeconomic status, to seek care for relatively low-acuity conditions, such as SjD, hearing loss, tinnitus, vertigo and sudden deafness. Use of NHI claims data eliminates recall bias, often a weakness of self-reported survey data. The retrospective observational study design, selecting comparison patients by propensity score matching, also strengthens the validity of findings, reduces selection bias and misclassification bias, and supports a causal association between SjD and audiovestibular dysfunction manifesting as hearing loss, tinnitus, vertigo and sudden deafness.

Limitations

Despite its strengths, the study has some limitations. First, the LHID2010, similar to other claims data, is susceptible to coding errors. We used the documented ICD codes for tinnitus, hearing loss, sudden deafness or vertigo. These data may not as accurate as diagnoses documented in medical records that are used in clinical care studies, based on protocolised clinical examinations and application of criteria. Second, despite excluding all patients who had a history of SjD from potential inclusion in the study as comparison patients, it remains possible that some comparison patients suffered from undiagnosed SjD. However, if such bias affected our data, the results would be biased towards the null. Third, the LHID2010 lacks data on confounding variables such as chronic noise exposure, family history, risk behaviours such as smoking and alcohol use, occupation, lifestyle, diet, genetic factors and laboratory data regarding SjD. Fourth, ethnic Han Chinese constitute the vast majority of enrolees under the Taiwan NHI programme. Our findings may not generalise to other regions or countries due to differences in ethnicity and living environment. Fifth, this study did not investigate the potential associations of tinnitus, sudden deafness, hearing loss and vertigo with SSA positivity. The requirement for SSA positive diagnosis coding not being tied to reimbursement in SjD treatment led to a significant under-representation of SSA positive cases in the LHID2010 data. Finally, one study using the same dataset LHID2010 has also reported an association of Fabry disease with hearing loss, tinnitus and sudden hearing loss.[11]

CONCLUSION

We found higher prevalence of hearing loss, vertigo, tinnitus and sudden deafness among patients with SjD relative to comparison patients. Our findings offer empirical evidence for physicians who care for patients with SjD, enabling them to counsel patients on the possibility of hearing loss, tinnitus, sudden deafness and vertigo. Careful audio-vestibular assessment and precautions to minimise risks may be indicated to enable early identification, prompt treatment and timely aural rehabilitation, as hearing loss is known to be associated with increased risk of dementia, psychological stress, suicide and injuries.

Author affiliations
[1]Department of Otorhinolaryngology, Taipei City Hospital, Taipei, Taiwan
[2]Department of Speech, Language and Audiology, National Taipei University of Nursing and Health, Taipei, Taiwan
[3]Department of Otorhinolaryngology, National Yang Ming Chiao Tung University, Taipei, Taiwan
[4]Center of General Education, University of Taipei, Taipei, Taiwan
[5]Research Center of Data Science on Healthcare Industry, College of Management, Taipei Medical University, Taipei, Taiwan
[6]Department of Health Services Policy and Management, Arnold School of Public Health, University of South Carolina, Columbia, South Carolina, USA
[7]Department of Medical Research, Taipei Veterans General Hospital, Taipei, Taiwan
[8]Department of Otolaryngology-Head and Neck Surgery, Taipei Veterans General Hospital, Taipei, Taiwan
[9]Institute of Brain Science, National Yang Ming Chiao Tung University, Taipei, Taiwan
[10]School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan
[11]Research Center of Data Science on Healthcare Industry, Taipei Medical University, Taipei, Taiwan
[12]Department of Economics, National Taipei University, Taipei City, Taiwan
[13]School of Health Care Administration, College of Management, Taipei Medical University, Taipei, Taiwan
[14]Research Center of Sleep Medicine, Taipei Medical University Hospital, Taipei, Taiwan

Contributors Conceptualisation: T-HY and HCL. Methodology: H-CL and C-SC. Validation: H-CL, Y-FC and T-HY. Formal analysis: H-CL and Y-FC. Data curation: C-SC. Writing—original draft preparation: SX, C-SC, H-CL, Y-FC and T-HY. Writing—review and editing: SX. All authors have read and agreed to the published version of the manuscript. H-CL is the guarantor of this study.

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ORCID iD

Herng-Ching Lin http://orcid.org/0000-0003-4661-959X

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