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Original Article

Association of Metabolic Syndrome or Weather Conditions with the Severity and Prognosis of Sudden Sensorineural Hearing Loss

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BACKGROUND: It is reported that sudden sensorineural hearing loss (SSNHL) is closely related to diabetes, hypertension, and hyperlipidemia. While the metabolic syndrome (MetS) is a multifactorial disease that includes diabetes, hypertension, dyslipidemia, and obesity, which are known to be associated with SSNHL. Weather conditions have long been known to affect the SSNHL. This study aimed to make a clear connection between MetS, or weather conditions, and the severity and prognosis of SSNHL.

METHODS: 127 SSNHL patients have been divided into the MetS group and the non-MetS group, and the demographic and clinical characteristics of the 2 groups have been analyzed retrospectively.

RESULTS: There were 52 (40.9%) patients in the MetS group, while there were 75 (59.1%) patients in the non-MetS group. The rate of vertigo, hypertension, diabetes, lower high-density lipoprotein cholesterol (HDL-C) levels, high triglyceride (TG), and body mass index (BMI) ≥25 (kg/m^2) were significantly higher in the MetS group than those in non-MetS group. Vertigo, hypertension, and Mets were linked to the severity of hearing loss. The rate of complete recovery and partial recovery in the MetS group was clearly lower than that in non-MetS group. According to the multivariate analysis, MetS was significantly associated with a poorer prognosis of SSNHL; a high ambient temperature difference at onset and hypertension were correlated with a poor prognosis.

CONCLUSION: These results demonstrate that the severity and prognosis of SSNHL can be influenced by the MetS. High ambient temperature differences at onset and hypertension were indicators of a poor prognosis for SSNHL.

KEYWORDS: Metabolic syndrome, prognosis, sensorineural hearing loss, weather

INTRODUCTION

Sudden sensorineural hearing loss (SSNHL) is usually recognized as a hearing loss with over 3 contiguous audiometric frequencies, which is at least 30 dB, in less than 72 hours.[1] The estimated annual global incidence of SSNHL is approximately 10 per 100 000 people, which is evenly spread between genders and affected sides.[2]

The increasing prevalence of SSNHL has been a hot topic for many years, but there still lacks evidence of a large epidemiological sample. Although nearly 60% of patients have reported a spontaneous complete or partial recovery, permanent deafness remains a large percentage.[3] Underlying pathogenesis for SSNHL has been proposed in previous studies, which includes viral infections, vascular compromise, autoimmune processes, and labyrinthine membrane ruptures.[2,4] Relationships between SSNHL with hypertension,[5] diabetes[6] and obesity[7] have been demonstrated, which are also known as cardiovascular risk factors.

The cluster of risk factors for cardiovascular disease is metabolic syndrome (MetS), including at least 3 of the following factors: obesity, hyperglycemia or diabetes, hypertension, raised triglyceride (TG) levels, and decreased high-density lipoprotein cholesterol

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(HDL-C) level.[8] Several studies have shown that SSNHL seems to be related to an increased risk of cardiovascular events, based on the hypothesis of a vascular etiology.[9,10] The inner ear is an end-organ vascularized by the labyrinth artery, with no collateral vessels to restore blood flow to the ischemic area. Because of the high metabolic activity of the cochlear hair cells, they are particularly vulnerable to hypoxic or ischemic injury, so reduced blood flow is often considered a cause of SSNHL.[11] Microangiopathy, which is related to all 5 factors of metabolic syndrome in its pathology, is one of the pathological mechanisms leading to SSNHL vascular lesions.[12] Pathological microangiopathy has been shown to be present in some SSNHL patients.[13]

Interruption of cochlear blood flow has been considered to be one of the causes of SSNHL.[14] Some scholars have suggested that weather conditions are contributing factors of cardiovascular disease.[15] We can speculate that metabolic syndrome and weather conditions could affect the severity and recovery of SSNHL. The aim of the study was to investigate the causal link between MetS, weather conditions, and the severity and recovery of SSNHL. We hypothesized that patients with MetS risk factors were more likely to suffer from SSNHL, and the prognosis of SSNHL is poor at temperature extremes.

MATERIAL AND METHODS

Study Population

We retrospectively reviewed the electronic medical records of patients diagnosed with SSNHL from January 2020 to April 2021. This study was approved by the Research Ethics Committee of Northern Jiangsu People's Hospital of Jiangsu Province (Approval number: 2019107, Date: November 14, 2019). Sudden sensorineural hearing loss is usually interpreted as a hearing loss in 3 contiguous frequencies of at least 30 dB occurring within a 72-hour period. All patients underwent all examinations, like audiometric tests, including initial and follow-up pure-tone audiometry (PTA), speech audiometry, tympanometry, auditory brainstem-evoked responses, and magnetic resonance imaging (to exclude acoustic neuroma). In addition, the components of metabolic syndrome were tested with blood. The exclusion criteria for SSNHL patients were as follows: (1) more than 15 days after the onset of SSNHL, have received the relevant treatment; (2) sudden hearing loss caused by a identified etiology, such as acoustic trauma history, Meniere's disease, exposure to ototoxic medications; (3) suffered otologic operation; (4) magnetic resonance images suggestive for congenital cochlear malformations; (5) otitis media in the last 10 weeks; (6) neurologic disorders predisposing to deafness. No informed consent from patients is required because this is a retrospective study and all analyses were based on existing anonymized data.

MAIN POINTS

- Mets will affect the severity and prognosis of SSNHL(sudden sensorineural hearing loss), with poor prognosis in SSNHL accompanied by Mets.
- According to Dr. Siegel's standards for hearing recovery, patients with concomitant Mets have lower rates of complete and partial recovery compared to patients with isolated SSNHL.
- When sudden sensorineural hearing loss occurs, significant differences in ambient temperature lead to poor prognosis.
- The prognosis of hearing loss in SSNHL patients with hypertension is poor.

Treatment Process

All patients were treated in keeping with SSNHL standards during their stay. Adult patients were administered intravenous methylprednisolone pulse therapy at 80 mg/day for the first 3 days; for a further 3 days, doses were adjusted to 40 mg/day. The initial dose for underweight patients (<40 kg) is 1 mg/kg/day intravenous methylprednisolone, and this dosage needs to be tapered off gradually, combined with vasoactive drugs during hospitalization, such as *Ginkgo biloba* extract,[16] betahistine.[17-20] If patients have a strong feeling of vertigo, we will use Gastrodin[21] to make them comfortable. All patients received 3 injections of steroids in the tympanic cavity as an additional treatment. Hyperbaric oxygen was not used due to facilities. The hearing results collected in the study were the tenth day after receiving treatment, or the last day if the hospitalization was less than 10 days.

Audiologic Evaluation

Pure-tone audiometry was administered to examine the hearing levels. Pure-tone air conduction hearing thresholds were obtained at frequencies of 0.5, 1.0, 2.0, and 4.0 kHz. Hearing levels at 0.5 and 1 kHz were averaged to describe the PTA-low, and hearing levels at 2 and 4 kHz were averaged to describe the PTA-high.[22] The severity of hearing loss was classified based on PTA as mild (21-40 dB), moderate (41-55 dB), moderate to severe (55-70 dB), severe (71-90 dB), and profound (>90 dB).

Improvement Assessment

We arranged the PTA test for all patients before the start of the treatment and the tenth after the treatment to determine the hearing threshold from initial to final. The therapeutic effects were assessed by Dr. Siegel 's definition.[23] The final hearing threshold is growing up to 25 dB or even higher; this group is defined as a complete recovered population; partial recovery means the final hearing threshold has a greater than 15 dB improvement, usually 25-45 dB; slight improvement means the final hearing threshold has greater than 15 dB improvement, usually greater than 45 dB; and no improvement means the final hearing threshold has less than 15 dB improvement, usually greater than 75 dB. In this study, complete recovery and partial recovery were defined as "cured," and the last 2 were considered as "uncured."

Definition of Metabolic Syndrome

The National Cholesterol Education Program has an Adult Treatment Panel III criteria to decide the MetS types.[24] For MetS types, they must fulfill 3 or more of the following criteria: hypertension (blood pressure ≥130/85 mm Hg) or receiving antihypertensive treatment, diabetes (fasting blood sugar level ≥110 mg/dL) or known treatment for diabetes mellitus, triglyceridemia (triglyceride level ≥150 mg/dL), fasting high-density lipoprotein (HDL) cholesterol levels <40 mg/dL (in males) or <50 mg/dL (in females), and overweight defined by American Association of Clinical Endocrinologists (AACE) guidelines[25] (BMI ≥ 25.0 kg/m^2).

Weather Conditions

We supposed that the characteristics of SSNHL is different in different seasons. To make the case definite, we divided each year into 4 conventional seasons: springtime (March 1-May 31), summertime

(June 1-August 31), autumn (September 1-November 30), and wintertime (December 1-February 28/29).[26] The ambient temperature and the temperature difference between day and night on the day of the disease were provided by the official website of the Yangzhou Meteorological Bureau.

Statistical Analysis

The IBM Statistical Package for the Social Sciences Statistics software, version 21.0 (IBM SPSS Corp.; Armonk, NY, USA), was used for statistical analysis. We assessed the compliance of continuous variables with a normal distribution using the Kolmogorov–Smirnov test. Continuous variables were expressed as means ± SD and compared by an independent sample *t*-test or Mann–Whitney *U*-test. Categorical variables were expressed in frequency and percentage and compared by Pearson's χ^2 test when observed counts were sufficient, and when expected counts were insufficient, we used the Fisher exact test. Furthermore, we compared the normally distributed continuous variables of the 3 groups of data by analysis of variance. Any factors that were significant in the univariate analysis were included in the multivariate analysis. *P* less than .05 was considered to indicate statistical significance.

RESULTS

Demographic and Clinical Characteristics of the Participants

A total of 127 patients (67 males and 60 females with an average age of 50.23 years, standard deviation: 11.84 years, range: 24-76 years) were included in this study. There were 52 SSNHL patients diagnosed with MetS in the MetS group and 75 patients without MetS in the non-MetS group. Table 1 includes the clinical characteristics of the target people who were with diagnosed metabolic syndrome. The percentages of patients with vertigo, hypertension, diabetes, high TG, low HDL, and BMI $\geq$ 25 kg/m^2 were significantly higher in the MetS group than in those without metabolic syndrome ($P < .05$). Compared to the non-MetS group, individuals in the MetS group had higher levels of BMI, triglyceride levels, even fasting plasma glucose, and a lower HDL-C level ($P < .05$).

Table 1. Demographic and Clinical Characteristics of Sudden Sensorineural Hearing Loss Patients With and Without Mets

Characteristics	MetS (n = 52)	Non-MetS (n = 75)	*P*
Continuous variables (mean ± SD)			
Age, year	50.62 ± 12.41	49.96 ± 11.50	.760 (*t*-test)
Initial PTA, dB	74.19 ± 19.10	68.03 ± 23.35	.182
Low-PTA, dB	73.03 ± 21.69	70.13 ± 22.67	.569
High-PTA, dB	74.82 ± 17.53	64.85 ± 27.82	.104
BMI (kg/m^2)	25.36 ± 3.31	22.99 ± 2.95	**<.01** (*t*-test)
TG level, mg/dL	156.40 ± 77.30	74.17 ± 41.21	**<.01**
HDL-C level, mg/dL	45.65 ± 11.35	56.77 ± 12.62	**<.01**
FPG level, mg/dL	144.79 ± 55.50	108.84 ± 29.46	**<.01**
TC level, mg/dL	179.00 ± 35.24	169.37 ± 31.87	.110
Categorical Variables			
Gender: Male/female (n)	28/24	39/36	.838
Side: Right/left (n)	23/29	42/33	.192
Tinnitus (n, %)	47 (90.4%)	68 (90.7%)	.957
Vertigo (n, %)	23 (44.2%)	15 (20.0%)	**.003**
Smoking (n, %)	14 (26.9%)	17 (22.7%)	.583
Alcohol consumption (n, %)	10 (19.2%)	8 (10.7%)	.174
Hypertension (n, %)	35 (67.3%)	6 (8.0%)	**<.01**
Diabetes (n, %)	35 (67.3%)	31(41.3%)	**.004**
High TG (n, %)	33 (63.5%)	5 (6.7%)	**<.01**
Low HDL (n, %)	34 (65.4%)	9 (12.0%)	**<.01**
BMI ≥25 (kg/m^2) (n, %)	32 (61.5%)	21 (28.0%)	**<.01**
Hearing loss severity (n, %)			
Mild and moderate	7 (13.5%)	24 (32.0%)	**.017**
Moderate–severe	11 (21.2%)	13 (17.3%)	.589
Severe and Profound	34 (65.4%)	38 (50.7%)	.100
MetS components (n, %)			
3/0	40 (76.9%)	25 (33.3%)	
4/1	10 (19.2%)	27 (36.0%)	
5/2	2 (3.8%)	23 (30.7%)	

Values in bold indicate statistical significance.
BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; High-PTA, pure-tone average at high frequency transduction; Low-PTA, pure-tone average at low frequency transduction; MetS, metabolic syndrome; PTA, pure-tone audiometry; SSNHL, sudden sensorineural hearing loss; TC, total cholesterol; TG, triglycerides.

Characteristics of Sudden Sensorineural Hearing Loss Patients with Varying Degrees of Hearing Loss

Because of the small sample size, we assigned all patients to 3 groups to describe the severity of hearing loss according to PTA: mild to moderate (31), moderate-severe (24), and severe and profound (72) as listed in Table 2. In our study, as the incidence of vertigo increases, the severity of hearing loss increases ($P = .038$). The presence of hypertension ($P = .054$) and MetS ($P = .057$) may influence the severity of hearing loss, but the difference is not significant.

Hearing Recovery after Treatment in Each Group

Table 3 shows the final recovery rate after 10 days of treatment. In the non-MetS group, the rates of complete recovery and partial recovery were significantly higher than those in non-Mets group ($P < .01$), while the no recovery rate was lower than MetS grou ($P < .05$).

Effects of Metabolic Syndrome Components and Weather Conditions on the Prognosis of Sudden Sensorineural Hearing Loss

Patients were divided into 2 groups based on the treatment outcomes: the recovered group (72) and the not recovered group (55), and they were divided into 3 groups based on Mets components once again: 2 or less, 3, and 4 or more. We classified the severity of hearing loss into 3 categories: mild and moderate, moderate to severe, and severe and profound. Variables with a *P* value less than .05 of the univariate analysis were calculated in the multivariate analysis (Table 4). As shown in the multivariate analysis, MetS factors were remarkably correlated with the poor prognosis ($P = .028$). Hypertension was associated with a worse outcome ($P = .023$).The hearing threshold before treatment ($P = .080$), ambient temperature difference at onset ($P = .056$), and low HDL ($P = .073$) may affect hearing loss recovery, but not exact (Table 5).

Table 2. Relationship Between Clinical Features and Severity of Hearing Loss in Sudden Sensorineural Hearing Loss Patients

	Mild and Moderate (n = 31)	Moderate to Severe (n = 24)	Severe and Profound (n = 72)	*P*
Continuous variables (mean ± SD)				
Age, year	48.35 ± 12.08	52.0 ± 14.44	51.72 ± 11.76	.406
Air temperature at onset, °C	17.68 ± 9.39	14.75 ± 5.93	17.16 ± 9.95	.507
BMI (kg/m^2)	24.07 ± 3.60	24.30 ± 3.34	23.81 ± 3.19	.434
TG level, mg/dL	96.42 ± 56.07	101.38 ± 62.35	114.92 ± 79.23	.697
HDL-C level, mg/dL	53.45 ± 15.04	52.25 ± 13.25	51.68 ± 12.60	.922
FPG level, mg/dL	111.58 ± 35.19	126.38 ± 49.73	127.78 ± 47.63	.258
Categorical variables				
Male/female (n)	15/16	14/10	38/34	
Right/left (n)	11/20	16/8	38/34	
Tinnitus (n, %)	28 (90.3%)	20 (83.3%)	67 (93.1%)	.348
Vertigo (n, %)	5 (16.1%)	5 (20.8%)	28 (38.9%)	**.038**
Smoking (n, %)	6 (19.4%)	5 (20.8%)	20 (27.8%)	.595
Alcohol consumption (n, %)	2 (6.5%)	2 (8.3%)	14 (19.4%)	.179
Hypertension (n, %)	6 (19.4%)	12 (50%)	23 (31.9%)	**.054**
Diabetes (n, %)	13 (41.9%)	14 (58.3%)	39 (54.2%)	.411
High TG (n, %)	8 (25.8%)	6 (25.0%)	24 (33.3%)	.629
Low HDL (n, %)	10 (32.2%)	7 (29.2%)	26 (36.1%)	.805
BMI ≥25 (kg/m^2) (n %)	13 (41.9%)	10 (41.7%)	29 (40.3%)	.985
MetS (n, %)	7 (22.6%)	11 (45.8%)	34 (47.2%)	**.057**

Values in bold indicate statistical significance.
BMI, body mass index; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; MetS, metabolic syndrome; SSNHL, sudden sensorineural hearing loss; TG, triglycerides.

DISCUSSION

Hippocrates, the father of medicine, actually postulated the idea that the fickleness of weather might work in worsening physical health, in the fifth century BC.[27] Since then, weather conditions have been repeatedly identified as the pathogenesis of various diseases. Mees et al[28] suggested that the incidence of idiopathic sudden hearing loss could depend on the weather. Herbert et al[29] found that the atmospheric pressure plays a significant role in the pathogenesis of sudden hearing loss (along with Bell's palsy and Meniere's disease). Lin et al[30] proved that no significant relationship existed between the monthly SSNHL incidence rates and the weather. The statistically significant effect of onset seasons on the prognosis of SSNH could not be proved; however, the ambient temperature difference at onset does have an adverse effect on the recovery of SSNHL in this study. Therefore, the influence of specific weather conditions on SSNHL needs further study.

The prevalence of MetS has been growing in recent years and is emerging as a global medical and public health challenge. MetS

Table 3. Treatment Outcomes of Sudden Sensorineural Hearing Loss in Patients With and Without Mets

Outcomes	MetS (n = 52)	Non-MetS (n = 75)	*P*
Recovered	10 (19.2%)	62 (82.7%)	<.01
Complete recovery	5 (9.6%)	30 (40.0%)	<.01
Partial recovery	5 (9.6%)	32 (42.7%)	<.01
Not recovered	42 (80.8%)	13 (17.3%)	<.01
Slight recovery	10 (19.2%)	6 (8.0%)	.061
No recovery	32 (61.5%)	7 (9.3%)	<.01

MetS, metabolic syndrome; SSNHL, sudden sensorineural hearing loss.

Table 4. Factors Influencing the Recovery after the Treatment of Sudden Sensorineural Hearing Loss

Characteristic	Recovered (n = 72)	Not recovered (n = 55)	*P*
Continuous variables (mean ± SD)			
Age, year	49.46 ± 11.75	52.91 ± 12.99	.120 (t-test)
Initial PTA, dB	66.97 ± 22.48	75.60 ± 20.50	**.021**
Low-PTA, dB	68.99 ± 22.07	74.36 ± 22.27	.187
High-PTA, dB	63.98 ± 26.73	75.42 ± 19.81	**.021**
The ambient temperature at onset, °C	17.51 ± 8.71	15.95 ± 9.77	.314
The ambient temperature difference at onset, °C	8.35 ± 2.27	9.78 ± 3.30	**.029**
Categorical variables			
Male/female (n)	42/30	37/31	.150
Right/left (n)	37/35	28/27	.957
Tinnitus (n, %)	65 (90.3%)	50 (90.9%)	.904
Vertigo (n, %)	18 (25%)	20 (36.4%)	.166
Smoking (n, %)	18 (25%)	13 (23.6%)	.859
Alcohol consumption (n, %)	9 (12.5%)	9 (16.4%)	.536
Hypertension (n, %)	9 (12.5%)	32 (58.2%)	<.01
Diabetes (n, %)	32 (44.4%)	34 (61.8%)	.052
High TG (n, %)	11 (15.3%)	27 (49.1%)	<.01
Low HDL (n, %)	12 (16.7%)	31 (56.4%)	<.01
BMI ≥25 (kg/m^2) (n, %)	26 (36.1%)	27 (49.1%)	.142
MetS (n, %)	10 (13.9%)	42 (76.4%)	<.01
MetS components (n, %)			
Two or less	62 (86.1%)	13 (23.6%)	<.01
Three	8 (11.1%)	32 (58.2%)	<.01
Four or more	2 (2.8%)	10 (18.2%)	.003
Hearing loss severity (n, %)			.055
Mild and moderate	23 (31.9%)	8 (14.5%)	.024
Moderate to severe	14 (19.4%)	10 (18.2%)	.857
Severe and profound	35 (48.6%)	37 (67.3%)	.035
Season (n, %)			.015
Spring and winter	25 (34.7%)	31 (56.4%)	
Summer and autumn	47 (65.3%)	24 (43.6%)	

Values in bold indicate statistical significance.
PTA, pure-tone audiometry; TG, triglycerides.

Table 5. Multivariate Analysis of the Recovery after the Treatment of Sudden Sensorineural Hearing Loss

	OR	95% CI	*P*
Initial PTA	1.023	0.997-1.049	.080
Air temperature difference at onset	1.207	0.995-1.463	**.056**
Hypertension			
No	1		
Yes	4.436	1.227-16.036	**.023**
Diabetes			
No	1		
Yes	2.031	0.598-6.903	.293
High TG			
No	1		
Yes	1.187	0.230-6.115	.838
Low HDL			
No	1		
Yes	3.129	0.899-10.897	.073
MetS components			
Two or less	1		
Three	5.567	1.575-19.682	
Four or more	4.525	0.489-41.876	**.028**
Hearing loss severity			
Mild and moderate	1		
Moderate to severe	0.242	0.022-2.606	
Severe and profound	0.265	0.010-6.920	.547
Season			
Spring and winter	1		
Summer and autumn	1.960	0.640-6.00	.234

Values in bold indicate statistical significance.
PTA, pure-tone audiometry; TG, triglycerides.

is a combination of risk factors for cardiovascular disease defined according to the World Health Organization, the NCEP ATP III[24] and the AACE, which has been confirmed to raise the risk of various clinical diseases, such as colorectal cancer[31] and so on. Previous studies reported that the higher the number of MetS components, the poorer the prognosis.[12] Our study analyzes the different results of the recovery and the severity of hearing loss in patients with and without MetS.

The initial hearing test result is widely shown as a symbol of a negative prognostic for treatment in SSNHL patients[32]; however, Hosokawa et al[33] found no substantial link between the initial hearing level and the final outcome of treatment in SSNHL patients. Although the present study found that the SSNHL patients with and without MetS share a similar initial PTA, in the MetS group, recovery is complete and partial, and its incidence is low, confirming that there is an inverse relationship between MetS and the prognosis of patients with SSNHL.

A strong relationship between each of the 5 components of metabolic syndrome and SSNHL has been reported in the literature. When the number of diagnostic components of MetS increased, the prognosis of SSNHL became worse.[12,34] A combination of several individual factors can influence the link between MetS and SSNHL. Nagaoka et al[5] have reported that the diagnosis of hypertension was concerned with the increased risk of hearing loss. However, few studies focused on the relationship between MetS and the severity of hearing loss. Lionello et al[35] recently reported that a series of 117 SSNHL patients showed that hypertension was significantly related to hearing outcome. Hypertension can reduce cochlear potential by reducing the vascular supply to the stria vascularis.[36] The stria vascularis can be found in the lateral cochlear wall and is responsible for transmitting auditory signals from the cochlea to the central nervous system.[37] Stria vascularis is sensitive to interruption of blood flow at some point because the vessels are derived from terminal arteries with no collateral supply. Microangiopathy in hypertension may exacerbate the interruption of blood flow in the inner ear,[5] and the presence of vertigo reinforces the underlying vascular problem.[14] This also explains why patients with more severe hearing loss tend to have a poorer recovery.

Diabetes has been considered an independent risk factor for SSNHL in many studies.[5,6] Similarly, a recent meta-analysis has shown that people with diabetes are 3 times more likely to have hearing loss than people without diabetes.[38] According to previous studies, cochlear microangiopathic changes and spiral ganglion atrophy have been observed in human temporal bone studies in diabetic patients.[39] In addition, Kim et al[40] suggested that hyperglycemia may lead to atherosclerosis, microvascular dysfunction, endothelial cell injury, and apoptosis, leading to sudden hearing loss. However, one major drawback of this study is that it could not prove a significant effect of diabetes on the hearing loss severity and prognosis of SSNHL in a statistical sense.

High triglycerides and/or decreased levels of HDL-C are considered another risk factors for SSNHL. High triglycerides affect both the blood supply to the inner ear and the lateral wall hardness of the outer hair cells of the cochlea.[9] This disruption is designed to impair oxygen supply, ultimately in target organs such as the cochlea. Rudack et al[13] showed that dyslipidemia did not appear to be a major risk factor for sudden SSNHL, and in line with this study, we found no obvious correlation between dyslipidemia and SSNHL.
Metabolic syndrome is a cause of the severity of hearing loss and affects the recovery of patients with SSNHL negatively. Moreover, as the number of MetS components increased, the prognosis became poorer. The ambient temperature difference at onset has an inverse correlation with the recovery of SSNHL. Further studies are necessary to demonstrate the conclusion of our study.

Limitations

There are many shortcomings in this study. First, this study retrospectively analyzed a part of the past clinical data, which includes the bias in data selection. Second, we do not know how to determine the duration of the MetS or to treat the MetS components. Another problem with this approach is that it failed to eliminate the effect of differences in duration and treatment for every symptom as required by the diagnostic criteria of MetS. Finally, the diagnostic criteria of MetS are diverse worldwide because of different scientific institutions, ethnic groups, locations, and countries. All these limitations may have a serious effect on the reliability of the conclusion.

Ethics Committee Approval: This study was approved by Ethics committee of the Research Ethics Committee of Northern Jiangsu People's Hospital of Jiangsu Province (Approval number: 2019107, Date: November 14, 2019).

Informed Consent: Informed consent from patients is not required because this is a retrospective study and all analyses were based on existing anonymized data.

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

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