

Association between Metabolic Syndrome Components and Sudden Sensorineural Hearing Loss

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Abstract

Introduction: Sudden sensorineural hearing loss (SSNHL) is a common form of hearing loss, and has been associated with several inflammatory diseases, which are known to cause vascular and neurological problems. Metabolic syndrome, whose main components are diabetes mellitus and dyslipidaemia, is considered a chronic inflammatory disease. Since both medical conditions share common aetiology, this literature review aims to examine the potential correlation/association between SSNHL and metabolic syndrome and the prognosis by analysing electronic databases.

Methods: A literature review which systematically searched relevant studies from four internet databases: PubMed, Scopus, Google Scholar and the Cochrane. The studies searched were limited to original studies submitted between year 2011 and 2023, covering randomized controlled trial, case control, cohort, or cross sectional, analysing 1) the prevalence of Metabolic syndrome among SSNHL patients, and/or 2) the rate of recovery and prognosis of SSNHL patients who had metabolic syndrome.

Results: Sixteen observational studies have been examined and reviewed. Twelve of these studies analysed the correlation between the metabolic syndrome and its components and SSNHL, and they demonstrated that risk of having SSNHL increases for patients who were diagnosed with components of metabolic syndrome. One of the studies claimed that people with metabolic syndrome have 3.54-fold increased risk of having SSNHL ($P < .001$). Nine of these studies analysed the correlations between metabolic syndrome and recovery rate of patients diagnosed with SSNHL. All 9 studies showed that metabolic syndrome negatively influenced the recovery rates of patients diagnosed with SSNHL, with one of the studies demonstrated that the likelihood of being unresponsive to treatment was higher in those with metabolic syndrome, with odds ratio of 2.18 ($P < .001$).

Conclusion: Our findings suggest positive association between prevalence of SSNHL and metabolic syndrome; the risk of having SSNHL increases for patients who were diagnosed with components of metabolic syndrome. Our findings also suggest that SSNHL patients who are also diagnosed with metabolic syndrome have worse recovery rate and poorer prognosis.

Keyword: SSNHL, sudden sensorineural hearing loss, metabolic syndrome, prognosis

Abstrak

Latar Belakang: Gangguan pendengaran sensorineural mendadak (SSNHL) adalah bentuk umum dari gangguan pendengaran, dan telah dikaitkan dengan beberapa penyakit inflamasi kronik yang menyebabkan masalah vaskular dan neurologis. Sindrom metabolik, yang komponen utamanya adalah diabetes mellitus dan dislipidemia, dianggap sebagai penyakit inflamasi kronis. Karena kedua kondisi medis memiliki etiologi yang sama, tinjauan literatur ini bertujuan untuk memeriksa potensi korelasi/hubungan antara SSNHL dan sindrom metabolik dan prognosis dengan menganalisis basis data elektronik.

Metode: Kami secara sistematis mencari dan memeriksa basis data internet yaitu: PubMed, Scopus, Google Scholar, dan Cochrane. Studi yang disertakan terbatas pada studi asli yang diajukan antara tahun 2011 dan 2023. Metode penelitian dapat berupa randomized controlled trial, case control, cohort, or cross sectional, yang menganalisis 1) prevalensi sindrom metabolik diantara pasien SSNHL, dan/atau 2) tingkat pemulihan dan prognosis pasien SSNHL yang memiliki sindrom metabolik.

Hasil: sebanyak enam belas studi observasional telah diperiksa dan ditinjau. Dua belas dari studi ini menganalisis korelasi antara sindrom metabolik dan komponennya dan SSNHL, dan hasilnya menunjukkan bahwa risiko memiliki SSNHL meningkat untuk pasien yang didiagnosis dengan komponen sindrom metabolik. Salah satu penelitian mengklaim bahwa orang dengan sindrom metabolik memiliki 3,54 kali lipat peningkatan risiko memiliki SSNHL ($P < 0,001$). Sembilan dari studi ini menganalisis korelasi antara sindrom metabolik dan tingkat pemulihan pasien yang didiagnosis dengan SSNHL. Semua 9 penelitian menunjukkan bahwa sindrom metabolik secara negatif mempengaruhi tingkat pemulihan pasien yang didiagnosis dengan SSNHL, dengan salah satu penelitian menunjukkan bahwa kemungkinan tidak responsif terhadap pengobatan lebih tinggi pada mereka dengan sindrom metabolik, dengan odds rasio 2,18 ($P < 0,001$).

Kesimpulan: Temuan kami menunjukkan hubungan positif antara prevalensi SSNHL dan sindrom metabolik; risiko terjadinya SSNHL meningkat untuk pasien yang didiagnosis dengan komponen sindrom metabolik. Temuan kami juga menunjukkan bahwa pasien SSNHL dengan sindrom metabolik memiliki tingkat pemulihan yang lebih buruk dan prognosis yang lebih buruk.

Keyword: SSNHL, sudden sensorineural hearing loss, Metabolic syndrome, prognosis

Introduction

Sudden sensorineural hearing loss (SSNHL) is a medical condition in which patients experience a sudden disturbance in hearing ability unilaterally (usually within 72 hours), which is usually of 30 dB or greater in magnitude, over at least three contiguous audiometric frequencies. SSNHL is sensorineural hearing loss, and it is relatively common complaint in otologic practices. In United States alone, SSNHL affects 5 to 27 out of 100,000 people annually, and the incidence rate is 66,000 new cases per year.¹

Sudden sensorineural hearing loss (SSNHL) has variety of identifiable etiologies, such as neoplastic, infectious, autoimmune, neurologic, ototoxicity and idiopathic, with idiopathic as the main cause, with as much as 90% cases are thought to be idiopathic.^{1,2} although extensive researches have been conducted, there are still controversy regarding the etiology and appropriate care of patients with idiopathic SSNHL. Regardless of etiology, full recovery of hearing thresholds after SSNHL happened may occur completely, may be partial, or may not happen at all. There are many factors which can impact hearing recovery, such as age at onset of hearing loss, the severity of hearing loss and frequencies affected, presence of vertigo, and how quickly SSNHL is treated.³

One of the pathologic mechanisms of SSNHL is vascular dysfunction. In this condition, blood supply to the cochlea by the labyrinthine artery decreases, which in turn reducing oxygen concentration in the cochlear lymph, causing cell death and resulting in SSNHL. Microangiopathy has been found in patients diagnosed with SSNHL, and since metabolic syndrome has been associated with microangiopathy, it could be the factor for the incidence of and recovery from SSNHL.⁴

The metabolic syndrome (MetS) is a condition in which patients have combination of at least 3 out of 5 of following disorders: obesity, insulin resistance, glucose intolerance, impaired regulation of body fat and high blood pressure.⁵ National Cholesterol Education Program's Adult Treatment Panel III (NCEP: ATP III) defines MetS as the presence of three or more of the following characteristics: (1) abdominal obesity: waist circumference of ≥ 102 cm in men and ≥ 88 cm in women; (2) hypertriglyceridemia: ≥ 150 mg/dL (≥ 1.69 mmol/L); (3) a low level of high-density lipoprotein cholesterol (HDL-C): < 40 mg/dL (< 1.03 mmol/L) in

men and < 50 mg/dL (< 1.29 mmol/L) in women; (4) elevated blood pressure: systolic blood pressure (SBP) ≥ 130 mm Hg or diastolic blood pressure (DBP) ≥ 85 mmHg; and (5) elevated fasting glucose: ≥ 100 mg/dL (≥ 5.6 mmol/L).⁶

Hearing loss is one of the many suspected complications associated with metabolic syndrome. Occupational noise exposure causes between 7% and 21% of hearing loss (called Noise Induced Hearing Loss (NIHL)) cases among workers. The lowest prevalence is generally found in developed countries, where incidents are lower due to good implementation of Hearing Conservation Programs (HCPs), and highest in developing countries, and it is estimated that around 600 million workers are exposed to occupational noise worldwide. According to NIOSH (National Institute of Occupational Safety and Health), it is estimated that 14% of the working population in the U.S. is employed in environments where *A-weighting* db sound exposure levels exceed 90 decibels.⁷

In Indonesia, research on the effects of occupational noise exposure on the occurrence of NIHL is still limited. It is estimated that the prevalence of NIHL reached 2.6% in 2013 and is expected to continue to increase.⁸ In a study conducted on ferry operators on the Ketapang-Gilimanuk route in Indonesia, it was found that 34.85% of respondents experienced NIHL.⁹

This paper, Therefore, aimed to evaluate the association between the presence of MetS (and its individual components) and SSNHL.

Methods

Four internet databases; PubMed, Scopus, Google Scholar and the Cochrane were used to search the publications. The PICO model was used where population are general populations, intervention or exposure were metabolic syndrome and its components, comparisons were between people with SSNHL who also had components of metabolic syndrome and those with SSNHL who didn't have metabolic syndrome, and the outcome was sudden sensorineural hearing loss (SSNHL). Keywords that were used for searching in the databases were "sudden sensorineural hearing loss" OR "hearing loss" OR "hearing impairment" OR "sensorineural hearing loss" AND "metabolic syndrome" OR "diabetes mellitus" OR "dyslipidemia" OR "obesity"

The studies included were limited to original studies submitted between year 2011 and 2023. the methods of the study could be randomized controlled trial, case control, cohort, or cross sectional, analyzing 1) the prevalence of Metabolic syndrome among SSNHL patients, and/or 2) the rate of recovery and prognosis of SSNHL patients who had metabolic syndrome. The participants were adults or active people. Language that was used in the studies included was English.

Results

After going through the literature searching process using inclusion and exclusion criteria, we found 16 relevant studies that matched the eligibility that can be seen in table 1 below. All the studies were observational studies and the methods of the study were case control, cohort, or cross sectional. The participants were adults, usually were patients diagnosed with SSNHL or patients who had completed audiometry and laboratory tests.

Table 1. Sixteen relevant studies that matched the eligibility of the searching method used through internet databases.

No	Author (Year), Population	Method	Result
1	Rim, et al (2021).(5) 94,223 Korean people who underwent health check-ups from January 2010 to December 2020	Cross sectional study. Subjects were divided into two groups, with and without metabolic syndrome. Of the 94,223 subjects, 11,414 (12.1%) had metabolic syndrome and 82,809 did not.	The average pure tone hearing thresholds were significantly higher in subjects with metabolic syndrome than in subjects without it in all age groups. ($p < 0.001$). Rates of hearing loss in subjects with 0, 1, 2, 3, 4, and 5 of the components of metabolic syndrome were 7.9%, 12.1%, 13.8%, 13.8%, 15.5% and 16.3%, respectively, indicating a significant association between the number of components of metabolic syndrome and the rate of hearing loss ($p < 0.0001$).
2	Rinaldi, et al (2020). (10) 39 Patients with ISSHL and 44 controls were enrolled in this study	Cohort study. 39 Patients with ISSHL and 44 age and sex matched control were enrolled in this study from January 2017 to November 2018.	According to Siegel criteria, a complete or partial recovery was observed in 60% of patients with MetS and in 91,66% of patients without MetS. MetS was associated with ISSHL and this association negatively influenced the hearing recovery of these patients.
3	Park, et al (2022). (11) 239 SSNHL and 239 healthy people.	Case-control study, 239 patients who experienced SSNHL are compared with the same number of healthy subjects (N = 478). Metabolic syndrome-related variables of SSNHL patients were compared to those of healthy control subjects.	The risk for SSNHL was 4.3 times higher in patients with metabolic syndrome compared with patients without the syndrome (95% confidence interval, 1.98 to 9.33), even after adjusting for variables that showed significant between-group differences. The likelihood of being unresponsive to treatment was higher in those with metabolic syndrome (1.21 to 3.93; adjusted odds ratio = 2.18).

No	Author (Year), Population	Method	Result
4	Breda, et al (2022). (12) Adult ISSNHL (>18 years old) patients.	Retrospective cohort study, composed of adult (> 18 years old) ISSHL patients admitted for treatment between January 2015 and December 2019. The final sample was composed of 81 patients, 48 without MetS (nMetS) and 33 with MetS.	Regarding the Siegel recovery category, the nMetS group had significantly better results (p = 0.001), with 44% of complete recoveries against 6% in the MetS, and 58% of the MetS patients had the worst outcome, contrasting with 27% in the nMetS group. The nMetS group had an overall better evolution in terms of hearing recovery and had a significant improvement in the median hearing gain (20.6 dB versus 8.8 dB; p = 0.008). Additionally, the multivariate analysis revealed that the presence of MetS is a significant risk factor for a worse outcome (odds ratio [OR] = 0.30; 95% confidence interval [95%CI] = 0.10-0.85).
5	Jalali, et al (2020). (13) SSNHL patients and sex-, aged-matched controls	Case control study. 81 SSNHL patients and 243 sex-, aged-matched controls participated from January 2018 to July 2019	A total 12 patients (14.8%) with SSNHL and 27 subjects (11.1%) in control group had MetS (p > 0.05). The rate of low levels of high-density lipoprotein-cholesterol (HDL-C), hypertriglyceridemia, and hypertension was significantly higher in the SSNHL group than those in the control group (p < 0.05). A trend of odds SSNHL was observed with increasing the number of MetS components (p < 0.001). The multivariable analysis revealed that the rate of hypertriglyceridemia and low HDL-C concentration was significantly higher in the SSNHL groups compared to the controls
6	Jung, et al (2018). (14) 124 patients treated for SSNHL at a single tertiary university hospital.	This retrospective medical record review of 124 patients treated for SSNHL at a single tertiary university hospital was performed from June 1, 2014, through May 31, 2016.	Mean (SD) pure-tone audiometry thresholds were similar at baseline in the groups with and without metabolic syndrome (65.0 [24.2] vs 60.8 [24.2] dB; MD, 4.3 dB; 95% CI, 3.2-5.4 dB), but recovery rates after treatment were significantly lower in the group with metabolic syndrome (16 [22.9%] vs 23 [42.6%]; MD, -19.7%; 95% CI, -35.4% to -3.2%). The rate of recovery from SSNHL was lower among patients with metabolic syndrome than among those without metabolic syndrome, and prognosis was poorer in patients with 4 or more diagnostic factors of the metabolic syndrome.

No	Author (Year), Population	Method	Result
7	Kim, et al (2021). (15) Subjects were adults who completed audiometric tests as part of the Korea National Health and Nutrition Examination Survey	Cross-Sectional Studies. Subjects were 10,356 adults (4,509 males, 5,847 females) aged 40-80 years, who completed audiometric tests and laboratory examinations as part of the Korea National Health and Nutrition Examination Survey between 2010 and 2012.	Thirty eight point one percent and 28.6% met the MetS by NCEP III and IDF criteria, respectively. Prevalence of HL was 29.3% and 63.9% for low- and high-frequency HL, respectively. MetS defined by NCEP III was associated with higher risk of high-frequency HL (OR, 1.35; 95% CI, 1.05-1.73), while MetS by IDF criteria was not. The interaction by the noise exposure on the MetS and high-frequency HL was not significant (P-interaction=0.100). There was no association between MetS and low-frequency HL, regardless of applied diagnostic criteria for MetS
8	Lam, et al (2021). (16)	systematic review and meta-analysis, to examine the association between sudden sensorineural hearing loss (SSNHL) and risk of metabolic syndrome (MetS), and the association between MetS and prognosis of SSNHL. This study systematically searched MEDLINE, Embase, and Cochrane Central Register electronic databases from their dates of conception to February 4, 2020, and this study included observational studies analyzing 1) the prevalence of MetS among SSNHL patients, or 2) the prognosis of SSNHL patients in MetS patients	Three studies examining the prevalence of MetS among patients with SSNHL (11,890 total participants; 3,034 SSNHL participants) yielded a significantly increased risk of MetS among SSNHL, with a pooled odds ratio of 1.88 (95% CI, 1.01–3.50). Three studies examining the association of SSNHL prognosis in patients with MetS (608 SSNHL participants, 234 concomitant SSNHL, and MetS participants) demonstrated that SSNHL patients with MetS were significantly more likely to have poorer recovery compared to SSNHL patients without MetS (pooled odds ratio 2.77; 95% CI, 2.33–3.28).
9	Bhargava, et al, (2021).(17) Patients diagnosed for metabolic syndrome	a cross-sectional study. A total of 100 patients diagnosed for metabolic syndrome (IDF criteria) were included in the study	A total of 62% patients had sensorineural hearing loss. Maximum (35%) had mild hearing loss, followed by moderate hearing loss (23%). Only 4 (4%) cases had severe hearing loss. Older age, wider waist circumference, higher fasting blood glucose levels and lower blood pressure were found to be significantly associated with sensorineural hearing loss and its severity on univariate analysis. However, on multivariate assessment only age and waist circumference showed a significant association with hearing loss.

No	Author (Year), Population	Method	Result
10	Shi, et al (2019)(18) Patients treated in author's ENT department	Retrospective cohort study. Records of 212 patients with SSNHL treated in our department were retrospectively reviewed, All patients were divided into two groups, the MetS group and the Non-MetS group, and the clinical characteristics and prognosis between two groups were compared.	In the MetS group, the BMI, systolic pressure, TG, fasting plasma glucose level were higher than that in the Non-MetS group, while the HDL-C level was lower than that in Non-MetS group (P<0.01), and the rates of profound hearing loss, flat audiogram and total deafness audiogram were higher than that in the Non-MetS group (P<0.05). In the MetS group, the overall recovery rate, complete recovery rate and marked recovery rate were 57.8%,6.0% and 14.5%, respectively, which was lower than that in the Non-MetS group (79.8%,19.4% and 27.9%, P<0.05)
11	Sun, et al (2015)(19) Participants aged ≤ 65 years who enrolled in the National Health and Nutrition Examination Survey (1999-2004)	multi-stage cross-sectional survey, to investigate the relationship between metabolic syndrome and hearing. This study included 2100 participants aged ≤ 65 years	After adjusting for potential confounders, such as age, medical conditions, and smoking status, the participants with more components of metabolic syndrome were found to have higher hearing thresholds than those with fewer components of metabolic syndrome (p < 0.05 for a trend).
12	Zhang, et al, (2019). (20) Patients diagnosed with ISSNHL	A retrospective cohort study. patients who were diagnosed with ISSNHL between January 2015 and January 2018 were divided into a MetS group and a Non-MetS group according to the diagnostic criteria of MetS.	The rates of complete recovery and partial recovery of the MetS group were significantly lower than those of the Non-MetS group (p < 0.05). According to the multivariate analysis, MetS was significantly correlated with a poor prognosis (OR = 2.912, p = 0.008), and the OR increased with an increase in the number of MetS components. Late onset of treatment, high initial hearing threshold, and presence of diabetes mellitus and hyperlipidemia were associated with a poor prognosis (p < 0.05).
13	Chien, et al (2015). (21) Patients diagnosed with SSNHL and control from the Department of Otorhinolaryngology, Kaohsiung Medical University Hospital.	A case-control study. This study retrospectively investigated 181 cases of sudden sensorineural hearing loss and 181 controls from 2010 to 2012, comparing their clinical variables	Subjects with metabolic syndrome had a 3.54-fold increased risk (95% confidence interval [CI] = 2.00-6.43, P < .01) of having sudden sensorineural hearing loss compared with those without metabolic syndrome, after adjusting for age, sex, smoking, diabetes mellitus, hypertension, and hyperlipidemia. With increases in the number of metabolic syndrome components, the risk of sudden sensorineural hearing loss increased (P for trend <.01).

No	Author (Year), Population	Method	Result
14	Zand, et al (2023). (22) Patients with idiopathic SSHNL	Prospective cohort study. 79 patients with idiopathic SSNHL admitted to the ENT ward were involved	There was a significant difference in Hypertension, BMI > 25, high TG and low HDL (p.v = 0.001) between two groups (metabolic syndrome group and non-metabolic syndrome group). The rate of recovered patients was significantly lower in the metabolic syndrome group than in the non-metabolic syndrome group (p.v = 0.001). It was found that metabolic syndrome (OR = 2.02), diabetes mellitus (OR = 7.32), HTN (OR = 4.09), BMI > 25 (OR = 3.24) and high initial hearing threshold (OR = 3.96) were clearly related to the poor prognosis of treatment
15	Aghazadeh-Attari, et al (2017).(23) Professional drivers of Iran.	This cross-sectional study consisted of 11,114 participants. Using Iranian health surveys of professional drivers, this study enrolled 11,114 individuals aged 20-60 years, whose main job is to operate a motor vehicle.	3202 (28.81%) diagnosed with MetS and 7911 (71.18%) without and 2772 (24.94%) with SNHL and 8432 (75.86%) without. Participants with SNHL had a higher number of components of MetS (P<0.001 for all components). These results demonstrated that an association possibly exists between different components of MetS and SNHL.
16	Zhou, et al (2019). (24) ISSNHL patients	228 ISSNHL patients were divided into MetS group and Non-MetS group according to the diagnostic criteria of MetS, and demographic and clinical characteristics and hearing recovery were reviewed between two groups.	In total, 86 (37.7%) patients in MetS group, and 142 (62.3%) patients in Non-MetS group. The rate of hypertension, diabetes mellitus, low HDL-C, high TG and obesity were significantly higher in the MetS group than those in the Non-MetS group (P < 0.05). The complete recovery rate and partial recovery rate were significantly lower in the MetS group than those in the Non-MetS group. According to the multivariate analysis, MetS was significantly associated with a poor prognosis; high initial hearing threshold and presence of diabetes mellitus were correlated with a poor prognosis (P < 0.05).

Discussion

Sixteen studies have been examined and reviewed in this review. Of these 16 studies, 6 were cross-sectional in design, one were prospective studies, five were

retrospective studies, one was systematic review and meta analysis, and three as a case-control studies. Most of the subjects of the studies were adults who were diagnosed with and underwent treatment for SSNHL or people who took health examinations, in particular audiologic examination (audiometry test).

The results of this study demonstrated that there's a positive association between SSNHL and metabolic syndrome. The studies proved 2 things, which were the positive association between metabolic syndrome and occurrence of SSNHL and the negative correlation between metabolic syndrome and the rate of recovery from SSNHL. A study in drivers from Iran demonstrated the importance of analyzing each component of metabolic syndrome, to find true correlation between each component of metabolic syndrome and SSNHL.

Twelve of these studies analyzed the correlation between the metabolic syndrome and its components and SSNHL. After adjustments for other factors through multivariate analyses, four specific components of metabolic syndrome, which were waist circumference, hypertension, and high triglyceride and fasting blood glucose concentrations were proven to be associated with SSNHL. To compare the occurrence of SSNHL in subjects with and without metabolic syndrome, rates of hearing loss were analyzed in subjects with 3, 4, and 5 of the components of metabolic syndrome, and the factors most closely related to hearing loss were identified. As suspected, the risk of having SSNHL increases for patients who were diagnosed with components of metabolic syndrome, and the risk gets higher the more components of metabolic syndrome the patient have. Patients who were diagnosed with 4 or 5 components of metabolic syndrome have higher risk of having SSNHL compared to those who have less than 4 or 5. The odds ratio among studies varies, with study by Chien et al claimed that people with metabolic syndrome have 3.54-fold increased risk of having SSNHL (95% confidence interval [CI] = 2.00-6.43, $P < .01$).

Nine of these studies analyzed the correlations between metabolic syndrome and recovery rate of patients diagnosed with SSNHL. All 9 studies showed that metabolic syndrome negatively influenced the recovery rates of patients diagnosed with SSNHL, resulting in worse prognosis. Studies by Rinaldi, et al and Breda, et al similarly demonstrated that, according to Siegel criteria, a complete or partial recovery from SSNHL was poorer in patients with metabolic syndrome compared to those who don't have metabolic syndrome. Study conducted by Park, et al demonstrated that the likelihood of being unresponsive to treatment was higher in those with metabolic syndrome, with odds ratio of 2.18.

The mechanisms underlying the SSNHL, metabolic syndrome and correlation between both

diseases is thought to be related to peripheral vascular disorders caused by many conditions. The cochlea is very vulnerable to ischemic injury due to lack of collateral circulation artery other than labyrinthine artery.²⁵

According to US National Nutrition Survey, there's a link between hearing loss and hypertension. Hypertension causes hemorrhage in cochlea, thus causing lack of perfusion of oxygen, which in turn causing progressive or sudden sensorineural hearing loss. Hypertension also causes atherosclerosis, which also disturbs and reduces blood flow in blood vessels going through cochlea.²⁵

As demonstrated in few of the studies reviewed in this study, high fasting blood glucose concentrations were considered to be associated with SSNHL. Diabetes mellitus causes microvascular damage, microangiopathy and neuropathy, which can affect peripheral arteries and peripheral nerves supporting inner ear. The damages and pathological changes to labyrinth artery, spiral ganglion, cochlear blood vessels, and cranial nerve 8 had been found in autopsy studies.

Recent studies have proven that high blood triglyceride concentrations are associated with reduced hearing function. The pathological changes that happens are thought to be vacuolar edema and degeneration of the vascular striatum. Decreased nitric oxide (NO) production and increased reactive oxygen levels due to dyslipidemia can cause vascular problems which can lead to damage to cells inside cochlea. The imbalance between triglyceride and HDL in the blood can worsen the pathological damage because HDL can act as anti-inflammatory, antioxidant, and anti-apoptotic agent that can counter the damage caused by high triglyceride. Abdominal adipose tissue has also been associated with hearing loss. Not only adipose tissue can be main source for dyslipidemia, it can also act as endocrine, paracrine and autocrine, releasing harmful substances like leptin or cytokines like TNF- α and IL-6.²⁵

This study has several limitations. due to the nature of this study, we cannot rule out the possibility that the study populations were biased toward people with hearing loss condition, which might not represent general populations. Because these data were from health examinations, we can not determine which of metabolic syndrome and SSNHL occurred first, therefore the nature of correlation between these two conditions can not be determined. Furthermore, it is possible that there might have been subjects who had

been excluded from the criteria for metabolic syndrome because they might have been taking medications to reduce blood pressure, blood glucose and cholesterol levels. Other limitation is the method; because some of the studies were cross-sectional studies, we could not determine the causative relationships between SSNHL and components of metabolic. Lastly, these studies did not evaluate confounding factors for SSNHL like noise at work, ototoxic drugs, otitis media, and family history of hearing loss.

Prospective analysis, which includes comprehensive follow-up data, is required to confirm the correlations between metabolic syndrome and SSNHL.

Conclusion

the risk of having SSNHL increases for patients who were diagnosed with components of metabolic syndrome, and the risk gets higher the more components of metabolic syndrome the patient have. Patients who were diagnosed with 4 or 5 components of metabolic syndrome have higher risk of having SSNHL compared to those who have less than 4 or 5.

Regarding the recovery rate of patients diagnosed with SSNHL, a complete or partial recovery from SSNHL was poorer in patients with metabolic syndrome compared to those who don't have metabolic syndrome. It is also found that the likelihood of being unresponsive to treatment for SSNHL was higher in those with metabolic syndrome.

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