



# Hearing and Diet (Narrative Review)

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## Abstract

It seems that food factors and the type of nutrition have an effect on the function of the auditory system. Hearing is one of the most important senses for social communication and high cognitive behaviors. Sensorineural hearing loss leaves adverse and permanent consequences in all aspects of personal and social life of affected patients. Hence, this narrative review study was designed to determine the relationship between sensorineural hearing loss and type of diet. Based on the inclusion criteria, the full text of 62 articles published between 2005 and 2023 were extracted from Scopus, Medline [PubMed], Web of Science, and Google Scholar websites and constituted the sources of this research. The results of the studies showed that by limiting the consumption of foods rich in cholesterol, sugar, carbohydrates, and protein, hearing is protected against the factors that cause sensorineural hearing loss. Also, increasing the consumption of vegetables, fruits, omega-3, antioxidants in the form of vitamins A, C, E reduce hearing susceptibility due to noise exposure, presbycusis, ototoxic agents, and etc. Healthy diet includes eating all the nutrients the body needs in a balanced way. Healthy lifestyle factors including continuous physical activity, good sleep quality, quitting smoking, stay away from stressful factors or relaxation, and avoiding exposure to environmental noise. By following healthy eating and lifestyle patterns, the conditions for hearing, physical and mental health are provided.

**Keywords** Hearing · Nutrition · Sensorineural Hearing Loss

## Introduction

Hearing is the first sense to wake up and the last sense to fall asleep [1]. Even, outer hair cells of the inner ear's cochlea are active for about twenty minutes after death and are sensitive to sound [2]. The first sense of the fetal period is hearing, which is formed around 4 months of fetal life. The neonate is born with the experience of hearing his mother's voice and the sounds around mother's uterus [3]. The greater the auditory experience (such as listening to music, native language conversations, environmental sounds), the greater the development and flexibility of the auditory nervous system and auditory cortex [2]. Therefore, the most complete form of thinking and language is created with the participation of the sense of hearing [3].

Without the contribution of the sense of hearing, it is not possible to understand non-objective or mental concepts (such as goodness, courage, and beauty) [2]. Congenital deaf people are not able to understand mental concepts [4]. Non-objective concepts form the basis of memory, thinking, language, logic, mathematics, philosophy, art and all cognitive activities [5, 6].

Improper diet, excessive obesity, stress, smoking, high cholesterol and urea, abnormal blood pressure are among the predisposing factors of sensorineural hearing loss [7].

The formation of free radicals in the cochlea of the inner ear is one of the causes of sensorineural hearing loss [8]. Free radicals, which are created as a by-product during the normal activities of cells, cause the deletion of the mitochondrial genome [9]. The most effective strategy to prevent sensorineural hearing loss is to inhibit the formation of free radicals in the cochlea, which are caused by aging, exposure to noise, ototoxic factors and other environmental damages [10]. The protective effects of antioxidants can neutralize the role of predisposing factors for hearing loss [11]. Investigating the relationship between sensorineural hearing loss and nutritional status or receiving antioxidants

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through a healthy diet is one of the important issues of maintaining hearing health, because the type of nutrition can play a significant role in preventing or causing hearing loss [12].

The relationship between sensorineural hearing loss and nutritional status can be questioned from three aspects: Does the type of nutritional status have positive or negative effects on the hearing system? Do supplements and antioxidants play a protective role in hearing? What are the adverse consequences of poor nutrition on adult hearing? Therefore, this narrative review study was designed with the aim of determining the relationship between sensorineural hearing loss and type of diet.

## Materials and Methods

Inclusion criteria for this study were original research articles in English that worked on adults. Exclusion criteria were animal studies, research on children, self-reported hearing loss, and the effects of alcohol and tobacco on the auditory system.

After a detailed search based on the titles of the articles and studying their summaries, the full text of them that met the criteria for entering this research were acquired. The search sites of this study were Scopus, Medline [PubMed], Web of Science and Google Scholar, which were published between 2005 and 2023. Therefore, 102 articles were selected based on their titles, and after studying their abstracts, the full text of 62 articles were extracted and became the source of this research.

## Results

Recent findings show that different cell parts of the cochlea do not have the same vulnerability to reactive oxygen species (ROS), but the outer hair cells and the basal part of the cochlea are more vulnerable than the hair cells of the apex and the supporting cells [13].

Many natural and synthetic drugs have an effect on oxidative stress. For example, Turmeric, is one of these natural drugs. The analysis of its chemical composition has shown that this medicinal plant has an active and strong biological compound, called Nanocurcumin [12]. The most important biological effects of Nanocurcumin are anti-inflammatory, antioxidant and prevention of hearing loss [13].

Another is coenzyme Q10, which is part of the electron transport chain and participates in cellular aerobic respiration and energy production in the form of ATP, and 95% of the human body's energy is produced in this way [14]. Therefore, organs that need more energy, such as the heart and liver, have the highest amount of coenzyme Q10. It is a

cofactor for mitochondrial enzymes such as complexes one, two and three, which play a vital role in oxidative phosphorylation. For the synthesis of this substance in the body, several cofactors are needed, including vitamins B2, B6 and B12, folic acid, niacin and vitamin C [15]. Coenzyme Q10 also has a proven antioxidant and anti-free radical property, which is about 50 times more than vitamin E [14]. This compound is naturally synthesized in the body, but its amount decreases with age. This enzyme has membrane stabilizing properties and acts as an antioxidant in association with vitamin E [14, 15].

To summarize the results and obtain more detailed information about the scientific resources collected in this field, by referring to Table 1, a summary of the results of the articles corresponding to the purpose of this research can be seen.

## Discussion

In this research, 62 articles were studied. The findings showed that nutritional status affects the hearing performance of adults [9–13], and antioxidants play a protective role for the hearing system [14–27]. Melatonin is one of the strongest sources of antioxidants [11]. This hormone helps regulate the sleep-wake cycle in the body, has sedative and pain-relieving properties, delays the onset of aging, is effective in weight control and slimming [28]. Melatonin has a protective role in the hearing system and is a very effective factor in preventing permanent sensorineural hearing loss [29]. It is produced only in the darkness of the night, so it is necessary to have enough night sleep. People who work night shifts or have a habit of waking up at night face a significant decrease in the blood level of melatonin hormone [30]. Therefore, the risk of permanent and irreversible hearing loss is higher in them [31]. Melatonin is known as the youth hormone and is found in foods such as pineapple, banana, onion, and etc. [32]. With increasing age, the amount of secretion of this hormone in the body decreases, which can be one of the reasons for aging [33].

Another antioxidant is coenzyme CoQ10, which is produced naturally in the body. It reduces changes associated with hearing loss by suppressing mitochondrial apoptosis-mediated cell death. Ketoin coenzyme has a favorable effect in preventing sensorineural hearing loss. Small amounts are found naturally in many foods, but levels are high in meat, heart, liver, offal, soybean oil, fish, and peanuts [34].

Also, a diet rich in vegetables, fruits, legumes, and seafood, especially fish, significantly reduces the risk of hearing loss [35, 36]. Saturated fats (poly unsaturated fatty acids) such as omega-3 found in fish, vegetables, fruits and antioxidants in the form of vitamins [13], coffee [19], chocolate

**Table 1** Obtain information about the scientific resources collected in the field of nutrition and hearing

Scasso et al. (2017)	They investigated the effectiveness of supplemental antioxidant containing coenzyme 10 and multivitamin in preventing the hearing effects of Cisplatin. In this study, 26 adult patients (18 in the case group and 8 in the control group) undergoing chemotherapy with cisplatin were investigated. Patients' hearing thresholds were evaluated once before chemotherapy and then 30 days after the completion of treatment. Hearing disorders associated with cisplatin consumption in the case and control groups included 6 (75%), 2 (11.1%), and tinnitus in 5 (62.5%), 2 (11.1%) patients, respectively. The researchers of this study finally concluded that the oral use of antioxidant Q10 prevents hearing problems caused by Cisplatin in cancer patients undergoing chemotherapy [15].
Choi et al. (2014)	They studied the effect of betacarotenes, vitamins C and E on 2992 people in the age group of 20 to 69 years (47.8%: men, 52.2%: women). Their findings showed that people who consumed more vitamin A (beta-carotene) and magnesium had better hearing thresholds [16].
Kang et al. (2014)	They investigated the effect of antioxidants on the hearing status of 1910 people (42.4%: men, 57.6%: women) with an mean age of 62.5 (8.3) years. Their results confirmed that people who consumed more carotenoids, retinol, riboflavin, niacin, and vitamin C had better hearing thresholds in all frequencies [17].
Jung et al. (2019)	They studied the effect of high potassium on the diet of 5925 people (42.9%: men, 57.1%: women) whose mean age were 57.6 (11.2). Their findings showed that a diet rich in potassium was significantly associated with better hearing thresholds at all frequencies [18].
Lee et al. (2018)	They investigated the effect of coffee on the hearing status of 13,448 people in the age group above 19 years. They concluded that people aged 40 to 64 years who drank coffee every day had a significantly lower risk of hearing loss at all frequencies than people who did not drink coffee daily [19].
Lee et al. (2019)	They studied the effect of eating chocolate on the hearing thresholds of 3575 people. Their mean age were 52 years (39.6%: men, 60.4%: women). Their findings showed that people (26.78%) who regularly consumed chocolate had a lower risk of unilateral or bilateral hearing loss. Eating chocolate regularly reduced the possibility of bilateral sensorineural hearing loss in high frequencies [20].
Kaya et al. (2015)	They investigated the effect of vitamins A, C, E and selenium in 70 patients with sudden sensorineural hearing loss. Their patients were treated with methyl prednisolone, dextran, trimetazidine dihydro chloride, hyperbaric oxygen, vitamin A (natural beta-carotene, 26,000 IU), vitamin C (ascorbic acid, 200 mg), vitamin E (d-alpha-tocopherol, 200 IU), and selenium (50 µg) twice daily for 30 days. Their findings showed that in cases where the patients' hearing loss were less than 46 decibels, taking vitamins A, C, E and selenium were effective in improving hearing thresholds and treating sudden sensorineural hearing loss [21].
Chen et al. (2023)	They studied the relationship of vitamins with hearing loss, vision disorder and sleep problem in 25,312 people. Vitamins included niacin, folic acid, vitamin B6, A, C, E and carotenoids. The results obtained from this research showed that the consumption of vitamins were related to the decrease in the prevalence of hearing loss, visual impairment and sleep disorders. An increase in lycopene was also associated with a decrease in the prevalence of hearing loss [22].
Chen et al. (2022)	They conducted a review to identify the relationship between nutrition, lifestyle and auditory-vestibular dysfunction. Their findings showed that as a result of inflammation caused by aging and oxidative stress, auditory-vestibular dysfunction occurs. The nutritional status of people can have anti-inflammatory and antioxidant effects to reduce these lesions. A high-fat diet causes oxidative stress. Low protein intake is also associated with the development of age-related hearing loss. Increasing the consumption of carbohydrates and sugary substances have the positive relationship with the occurrence of disorders in auditory-vestibular functions. While the Mediterranean diet can prevent the creation of these wastes. Antioxidants in the form of vitamins A, C and E along with lifestyle modification are effective in preventing auditory-vestibular disorders. Lifestyle modification including continuous physical activity, good sleep quality, quitting smoking and avoiding exposure to environmental noise [23].
Croll et al. (2019)	They reported that in their study population, higher consumption of unsaturated fats rich in omega-3 were associated with improvement of their hearing thresholds. Whereas, people who consumed a lot of sugar and snacks had worse hearing thresholds [24].
Gallagher et al. (2019)	They observed that there is a direct relationship between the health of hearing function and the consumption of healthy food [25].
Adel Ghahraman et al. (2021)	They reported that coffee, of which caffeine is an important component, may improve the speed of nerve transmission in the central pathways of the auditory and vestibular system. The effects of caffeine depend on its dosage, which can cause negative effects even with high consumption and cause tinnitus or hearing loss. The effects of caffeine on the peripheral system are less. While it creates more effects at the level of the central nervous system [26].
Savastano et al. (2007)	They investigated the effect of antioxidant therapy on idiopathic tinnitus. In this study, 31 patients with bilateral tinnitus were treated orally with a combination of phospholipid and vitamins (glycerol phosphoryl choline, glycerol phosphoryl ethanolamine, beta-carotene, vitamin C, vitamin E) for 18 weeks. The mean hearing thresholds of the patients, the intensity of tinnitus and the non-toxic effect on ROS (48 h before and after the intervention) were investigated. The results of this study showed that the serum level of ROS decreased significantly after antioxidant therapy and the severity of tinnitus significantly improved, but the improvement of hearing thresholds were not statistically significant [27].

[20] and magnesium [16]. They have protection effects for the hearing system [13]. Magnesium reduces vascular contractions caused by sound, which occur due to the formation

of free radicals [36]. It is usually found in green leafy vegetables, legumes, nuts and grains [37].

Vitamin C (ascorbic acid) is present in many fruits and vegetables such as oranges, lemons and tomatoes, but it is

not present in grains at all. Vitamin A (beta-carotene) causes yellow, green and red pigments in plants such as carrots, apricots and vegetables. Vitamin E (d-alpha-tocopherol) is found in legumes and fruits such as sunflower seeds, almonds and olives [38].

In malnourished children, high consumption of vitamin A has improved hearing thresholds. Vitamin A, in the form of its active metabolite or retinoic acid, is essential for the normal development of the inner ear, in addition to providing a protective role for the auditory system against continuous exposure to environmental sounds [39]. More consumption of vitamins C, E, riboflavin, magnesium and lycopene have been significantly associated with a larger amplitude of transient evoked otoacoustic emissions and better hearing pure tone thresholds [40].

Also, research shows that people who spent many years in food poverty during childhood have a higher risk of hearing loss in adulthood [13]. Vitamin D deficiency has been observed in patients with sudden sensorineural hearing loss [41]. Deficiency of vitamin B12 and folic acid in the elderly has been associated with an increase in homocysteine concentration, which has destructive effects on the blood flow of the cochlea. Of course, serum vitamin B12 is not directly related to hearing loss. In older age, it is associated with increased serum homocysteine concentration, which has detrimental effects on cochlear blood flow [42].

Increasing the intake of antioxidants could have potentially profound effects on the quality of life of millions of people and reduce health care costs [18]. A healthy diet contributes to better hearing health, and unhealthy eating habits that lead to high body fat density and obesity are associated with the risk of hearing loss [28, 43]. So that a high body mass index (BMI) is associated with a higher prevalence of hearing loss [26, 28]. In one of the recent studies, it has been observed that the level of serum lipids increased in patients with sudden sensorineural hearing loss [44]. However, it appears that fats are essential for maintaining hearing health, and people who ate a low-fat/low-protein diet were at greater risk for age-related hearing loss. In other words, maintaining a balance in the consumption of fatty foods is essential for hearing health [45].

Regarding the consumption of carbohydrates, it is recommended to maintain a balanced consumption so that nutritional poverty or excessive intake does not cause harmful effects on hearing performance [46]. However, foods rich in carbohydrates, fats (triglycerides) and sugar (monosaccharides and disaccharides) do not constitute a healthy diet and have harmful effects on hearing [40]. Excessive consumption of all fats does not cause harmful effects on the hearing system, because a significant relationship has been observed between the prevention of hearing loss and the accumulation of polyunsaturated fatty acids (PUFAs) or

eating fish. People who ate fish rich in omega-3 fatty acids at least twice a week were studied over 5 years and found to have a 42% reduced risk of age-related hearing loss [47]. Correcting vascular disorders at the level of the inner ear cochlea and improving inflammatory changes associated with arteriosclerosis is one of the advantages of the mechanism of action of omega-3 fatty acids [48].

However, in another study that continued for 13 years, no significant relationship was observed between constant eating of fish and hearing level [49]. It seems that the difference in the results of these researches is related to the methods and techniques of hearing tests used, which can cause such inverse results due to the difference in their sensitivity and specificity.

Also, a significant relationship has been observed between the low level of protein serum and the risk of hearing loss [44]. Consistent with these findings, insufficient protein intake causes ototoxic side effects. Therefore, low protein intake may have detrimental effects on the auditory system through its consequences for neural function [50]. In general, a healthy diet includes whole grains, vegetables, fruits, and eating all the nutrients the human body needs in a balanced way [51]. By limiting the consumption of foods rich in saturated fats and cholesterol, sugar, carbohydrates, protein and increasing the consumption of vegetables, fruits, unsaturated fatty acids (omega 3), antioxidants in the form of vitamins A, C and E, the susceptibility to sensorineural hearing loss can be reduced [52].

The opposite of this situation is also possible. People who are exposed to various types of noise pollution are more likely to suffer from digestive disorders and stomach upset than normal people [53]. The higher the amount of exposure to loud noises, the higher the possibility of abnormal stomach contractions and acid secretion. Then, the possibility of stomach ulcers and digestive diseases increases [54]. In fact, exposure to loud noises causes a severe stress response of the brain [55], and damage to the cardiovascular system, which leads to inflammation in the blood vessels of these areas and causes serious problems such as heart attack or stroke [56].

Not only healthy nutrition, but also the right lifestyle has a direct relationship with hearing, physical and mental health [40]. Constant stress causes impatience, excitability and the occurrence of various diseases, including tinnitus, dizziness and hearing loss [56]. Suppression of feelings and emotions has harmful effects on the body's metabolic and immune functions. People who suppress their feelings, their immune cells become more inflamed when exposed to pathogenic stimuli [57]. It is recommended to use the correct strategies and solutions in times of stress to resolve the unfortunate situation caused by it [56]. A high and long-term level of cortisol hormone in the body causes complications as



follows, impairment in the cognitive functions of the brain [3], dysfunction of the thyroid gland, blood sugar imbalance, reduction of bone density, reduction of muscle tissue [57], increased blood pressure, weakening of the body's defense system, stimulatory reactions [58], increase in abdominal fat, which is more problematic than fat density in other parts of the body [53]. In addition, living in areas with high crime and social delinquency reduces the mean life of a person [58], increases his vulnerability to hearing loss caused by noise [57], and central auditory processing disorder [56]. One of the most effective ways to reduce stress is to be at the beach. Because the most relaxing and enjoyable sounds are those that have a regular and predictable pattern and are presented with mild to moderate intensity. Sea waves have these characteristics. Also, sea waves produce negative ions. Negative ions are oxygen atoms with an extra electron that increase the body's ability to absorb oxygen and increase the secretion of serotonin, which is the main factor in good mood [59]. One of the predisposing causes of central auditory processing disorder and destructive brain damage in the residents of big cities is their lifestyle and the amount of exposure they have to positive ions [60]. Positive ions cause fatigue, tension, anxiety and depression. Positive ions are carbon dioxide molecules that have lost their electrons and are created in nature by strong winds, dust, humidity and pollution. In homes and offices, air conditioning systems, fluorescent lamps, electrical and computer equipment, televisions, mobile phones produce positive ions [61]. The smoke emitted from the exhaust pipe of vehicles in the environment is nitrogen oxide and carbon dioxide (hydrocarbon). The high amount of carbon dioxide gas has a direct and negative effect on the cognitive functions of the human brain and causes people to suffer from problems such as lack of concentration, fatigue, memory loss, weak decision-making power and laziness [3]. These adverse effects will intensify with the increase in the consumption of fossil fuels and the emission of greenhouse gases [12], and it will be considered as a predisposing factor for increasing the probability of neural damage of the auditory-vestibular system, such as tinnitus, dizziness, vertigo, central auditory processing disorder, and sensorineural hearing loss [62].

## Conclusion

Healthy diet and proper nutrition include the balanced consumption of all the food needed by the body, which is in the form of reducing the consumption of cholesterol, sugar, carbohydrates, proteins, and increasing the consumption of vegetables, fruits, omega-3 and antioxidants. Healthy lifestyle factors including continuous physical activity, good sleep quality, quitting smoking, stay away from stressful

factors or relaxation, and avoiding exposure to environmental noise. Healthy nutrition and lifestyle are predisposing factors for hearing, physical and mental health.

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