

## Benefits of Vitamins C and E in Sensorineural Hearing Loss

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### Abstract

**Introduction:** Sensorineural hearing loss is a growing problem tends and has been associated with toxic effects of free radicals such as reactive oxygen species and nitric oxide in the auditory system.

With this in mind, studies have shown that the administration of vitamins has positive effects and may decrease the sensorineural hearing loss.

**Objective:** In this sense, through a systematic review aims to examine the available scientific literature about the effectiveness of the use of vitamins C and E in the improvement of the auditory system performance in individuals with sensorineural hearing loss.

**Methods:** Keywords and conducted a search of scientific articles in electronic databases were set, and selected four studies, according to criteria defined and centered on the issue under study.

**Conclusion:** Comparison of the results of the chosen articles reveals decrease of concrete evidence in hearing thresholds provided by taking vitamins C and E, reaching a hearing gain of 30 dB.

**Keywords:** Vitamin C; Vitamin E; Treatment hearing loss; Sensorineural hearing loss; Audiometry

### Introduction

Hearing loss is one of the most common deficits in the human population, reaching around 360 million people worldwide, with more and more people affected and prone to occur at an earlier age [1]. It is seen as a problem that entails consequences such as inability to interpret speech sounds, difficulties in communication, delay in language acquisition and social isolation [2].

Among the most common causes of hearing loss are infectious diseases, ototoxic drugs, exposure to noise and aging (presbycusis), which is associated with Sensorineural hearing loss [3]. This occurs when there is damage on the inner ear or nerve pathways of the inner ear to the brain, being the most common type of hearing loss [4,5].

For a large number of people affected, there is the possibility of being benefited through medicines, surgery, hearing aids and cochlear implants [2]. In addition to these aids, studies have shown that the administration of vitamins has positive effects and may reduce Sensorineural hearing loss, since it has been associated with the toxic effects of free radicals, such as reactive oxygen species and nitric oxide, present in the auditory system that lead to cellular apoptosis [6-8].

Based on this, the vitamins acquire an important paper with regard to the diminution of these free radicals. Among all the existing vitamins are vitamins A, C and E that have been highlighted by their antioxidant action, protecting the cell membranes, lipids and proteins from oxidative damage [9-11].

In this systematic review, vitamins C and E will be studied. Vitamin C is a water-soluble vitamin that has the power to eliminate reactive oxygen and nitrogen species and has the ability to maintain vitamin E levels by recycling the radical to the antioxidant form [10]. In turn, vitamin E is a fat-soluble antioxidant and is seen as a protector of cell membranes and oxidative damage of lipid peroxidation [12].

Thus, these two vitamins will be studied with regard to the benefits of its administration in people with sensorineural hearing loss, based on studies in people with presbycusis, sudden idiopathic sensorineural hearing loss and noise-induced hearing loss. According to some studies, the administration of these vitamins may lead to a decrease in the auditory threshold up to approximately 30 dB HL, thus improving hearing recovery [13].

This study has made due the need to understand if vitamins C and E may play a beneficial role in the performance of the auditory system, thus improving the hearing of individuals with sensorineural hearing loss. The increase in the average life expectancy, the intense noise to which we are exposed and the exposure to the technologies increasingly at an early age makes the hearing loss a tendentially increasing problem in an adjoining future. With this in mind and since the proper functioning of the auditory system is precious, it is essential not only to make the population aware of the care to be taken, but also to develop methods that can benefit the hearing health.

Thus, based on the literature, the following question was elaborated: "Will supplementation with vitamins C and E improve the performance of the auditory system in cases of sensorineural hearing loss?"

This systematic review aims to study, through the analysis of the existing literature, the effectiveness of the use of vitamins C and E in improving the performance of the auditory system in individuals with sensorineural hearing loss in order to elaborate a research project later.

## Methods

The research was carried out in the PubMed, Medline and SciELO databases, requiring the collaboration of the

Library of the Coimbra Health School and the Library of the Dona Estefânia Hospital for access to the articles intended. The following keywords were used: vitamin C, vitamin E, treatment hearing loss, sensorineural hearing loss, Audiometry.

In order to carry out this systematic analysis, it was defined as a research criterion studies that addressed the effects of vitamins C and E on the performance of the auditory system, taking into account the year in which the same studies were carried out, giving privilege to the last 5 years.

In this way, it was only considered necessary to include an article outside this time frame. In addition to these criteria, articles could not be systematic reviews and should be written in English.

At the end of the research, it was possible to count eight found articles that have the established criteria for the research. After the analysis, four of the articles were excluded from this systematic review, being rejected those that were not performed in humans and that did not use the method of audiometric evaluation.

The article Dietary vitamin C supplementation reduces noise-induced hearing loss in guinea pigs, although it was a study with vitamin C, was excluded not only for its year, but also for the non-human sample used and the instrument used was the BAEP (Brainstem auditory evoked potential) and not the Audiometry as established [14].

In turn, the exclusion of article A prospective study of vitamin intake and the risk of hearing loss in men, it is due to the fact that the instrument used is not established as a criterion, since it is a questionnaire [15].

Lastly, the article entitled Nutrient-enhanced diet reduces noise-induced damage to the inner ear and hearing loss, Bennett DC and the article Antioxidant-enriched diet does not delay the progression of age-related hearing loss, Halsey K et al. are two studies with both vitamins related to this review, however, as the sample are rats and they used the BAEP these articles were not included [16,17] (Table 1).

Art	Sample	Method	Results	Conclusion
1	N = 24 guinea pigs albino (2 weeks) 8: supplemented diet group 8: normal diet group 8: deficient diet group	35 days on a normal diet, supplemented or with insufficient levels of ascorbate (vitamin C). Exposure to noise from 4 kHz to 114 dB SPL for 6 h to induce permanent threshold shift (PTS). After exposure to noise, use of BAEP.	The supplemented diet group showed significantly lower PTS compared to the other groups.	Dietary factors influence individual susceptibility to hearing loss, and suggest that high levels of vitamin C may be beneficial in reducing susceptibility to noise-induced hearing loss.
2	N = 26273 men (40 to 75 years at the beginning of the study)	Questionnaires on lifestyle and medical history every two years and questionnaire on intake of vitamin C, E, b-carotene, B12, and folate supplements every four years. The aforementioned hearing loss was professionally diagnosed and the year of diagnosis was obtained from the 2004 questionnaire. The cases were defined as losses diagnosed between 1986 and 2004	3559 cases of hearing loss were identified. Overall, there was no significant difference between vitamin intake and the risk of hearing loss.	Higher intake of vitamin C, E, B12, or b-carotene does not reduce the risk of hearing loss in adult males. Men age 60 and older may benefit from folate intake to reduce the risk of hearing loss.
3	N = 31 male rats (5-6 months) 16: control group 8: diet group A 7: diet group B	Pre-diet control for at least one month before the 28-day supplemented diet with a combination of b-carotene, vitamins C and E and magnesium in different amounts for each group. Measurement of the thresholds through the BAEP at 5, 10, 20, 28.3, and 40 kHz before the noise presentation and after 14-16 days of a single noise exposure of 8-16KHz for 2 hours. Cochlear tissues were collected for histology.	The diet B group showed lower PTS in relation to the control group, decreasing the threshold between 10-20dB at 10 and 20 KHz. There were no significant differences between diet A and B.	A diet supplemented with b-carotene, vitamin C, vitamin E and magnesium effectively reduces noise-induced oxidation in the inner ear.
4	N = 100 rats, females (10-24 months) 50: control group 50: group with antioxidants	Supplementation with vitamin A, C, E, L-carnitine and $\alpha$ -lipoic acid was given to one group. Measurement of thresholds through 4, 12, 24 and 48 kHz BAEP at 10, 12, 18 and 24 months of age.	Thresholds increased with age, but there were no significant differences between groups at any time or frequency. There were no differences in hair cell loss and ganglion degeneration between groups at 24 months of age.	The supplemented diet may change the antioxidant capacity of the cochlea but does not improve age-related sensorineural hearing loss in rats.

Table 1: Summary of articles not included.

Therefore, the studies chosen to integrate the systematic review were articles Vitamin E and vitamin C in the treatment of idiopathic sudden sensorineural hearing loss (2008), Effect of high dose intravenous vitamin C on idiopathic sudden sensorineural hearing loss: a prospective single-blind randomized controlled trial (2013), Effect of vitamin E supplementation on carbogen-induced amelioration of noise induced hearing loss in man (2011) and Dietary antioxidant intake is associated with the prevalence but not incidence of age-related hearing loss (2011).

## Results

The studies included in this systematic review were chosen for the importance they showed and for being appropriate for achieving the intended objectives.

In this way, the scientific article entitled Vitamin E and vitamin C in the treatment of idiopathic sudden sensorineural hearing loss, Furukawa M although it exceeds the time limit chosen as the criterion of the research, it was considered important because it is a study done to 87 patients with idiopathic sensorineural

deafness with the objective of investigating the efficacy of vitamins C and E in this type of hearing loss. For this purpose, inclusion criteria were the sudden onset of sensorineural hearing loss, lack of knowledge of the cause, non-fluctuating hearing, mean tonal loss greater than 40 dB and treatment started up to 14 days after the onset of the loss [10].

In 49 patients with a mean age of 55.5 ( $\pm$  16.6), was administered orally vitamin E (600 mg/day) and vitamin C (1200 mg/day) for at least 4 weeks and the remaining subjects, with a mean age of 57.4 ( $\pm$  13.1), were the control group and they don't take any vitamin. All patients were treated with steroids and / or alprostadil.

The instrument used was Audiometry in which a hearing gain was obtained after the therapy of 29.4 dB and an improvement rate of 63.3% in the study group, while the control group showed an improvement of 18.5 dB and 44.0 % rate of improvement.

In this way, the results were conclusive of the beneficial effects of vitamins C and E, due to the reduction of the level of oxygen reactive metabolites by internal ear ischemia and by reperfusion injury after treatment. In addition, patients less than 60 years of age had a better recovery in mean tonal loss compared to patients over 60 years of age.

In turn, the article Effect of high dose intravenous vitamin C on idiopathic sudden sensorineural hearing loss: a prospective single-blind randomized controlled trial, Ahn S, et al. was aimed at evaluating the high dose intravenous efficacy of vitamin C in 72 patients with sudden idiopathic sensorineural hearing loss [13]. The inclusion criteria presented in this article is exactly the same as the article above. Regarding the exclusion criteria, these defined chronic kidney disease, congestive heart failure, diabetes, vestibular Schwannoma and renal calculi, since there is a potential volume overload and the accuracy of the blood sugar test is impaired by the presence of vitamin C.

Thus, 36 subjects with a mean age of 52 years ( $\pm$  15.3) were administered systemic steroids (1 mg/kg/day) for 15 days (control group), and the remaining 36 subjects, mean age 50.3 Years ( $\pm$  12.4), vitamin C (200 mg/kg/day) and steroids were administered for 10 days, followed by oral vitamin C (2000 mg) for 30 days after discharge. Through Simple Tone Audiometry, they found a significant recovery in the vitamin C group compared to the control group, improving from 67.6  $\pm$  19.8 dB HL to 37.1  $\pm$  28.8 dB HL one month after treatment.

They concluded that this vitamin may improve hearing recovery in patients with this type of hearing loss and therefore suggest that vitamin C reduces levels of reactive oxygen metabolites due to internal ear ischemia or inflammation.

Another article included was Effect of vitamin E supplementation on carbogen-induced amelioration of noise induced hearing loss in man [18]. This study explores the effect of vitamin E and carbogen (5% CO<sub>2</sub> + 95% O<sub>2</sub>).

On the conservation of hearing in individuals exposed to intense occupational noise. For this, they used a sample composed by 40 males with a mean age of 36.4 ( $\pm$  7.3), with normal hearing or with a mean hearing threshold of 25.4  $\pm$  7.1 dB at 0.5, 1, 2 and 4 kHz, exposed to noise for 5 hours of their working hours.

Individuals in the carbogen and carbogen groups combined with vitamin E, before and after work, breathed carbogen for 5 minutes over a period of six days. In turn, the administration of vitamin E (400 mg/day) was made at breakfast by the vitamin E and carbogen groups combined with vitamin E. Audiometry showed that the individuals in the carbogen group had a lower temporary threshold change at frequencies above 3 kHz and the vitamin E group showed greater protection at 0.25, 0.5 and 1 kHz. In turn, the carbogen group combined with vitamin E had a very similar hearing threshold at all frequencies, ranging from -1 to 3 dB.

These results were thus conclusive that both carbogen and vitamin E prevented the development of temporary threshold change, reducing the risk of noise-induced hearing loss.

Concerning the article Dietary antioxidant intake is associated with the prevalence but not incidence of age-related hearing loss [9]. It was studied age-related hearing loss taking into account the frequency of food intake of carotene, cryptoxanthin, lutein, zeaxanthin, lycopene, vitamins A, C and E, iron and zinc.

This analysis was performed on 2956 individuals over 50 years of age from 1997 to 1999 and from 2002 to 2004 with a 5-year interval between the evaluations of each individual and was performed through a self-administered food frequency questionnaire with 145 items and by Audiometry. It stands out from the obtained results the association of the vitamin E with a reduction of probability of loss prevalent in 14%.

## Discussion

The comparison of the results of the chosen articles reveals concrete evidences of improvements in the auditory thresholds provided by taking vitamins C and E. Individuals with sensorineural hearing loss after treatment with vitamin C showed a decrease in auditory thresholds in the investigations done by Furukawa, et al. and Ahn, et al. [10,13].

Regarding the effect of vitamin E, Furukawa, et al. Kapoor et al. and Burlutsky et al. also point out that this vitamin benefits individuals with sensorineural hearing loss and also stops their evolution [9,10,19,].

These studies, although meeting the main objective of this systematic review, present some differences between them with respect to the methodology used.

The study by Burlutsky, et al. which is related to presbycusis has a longer study period than the rest as well as a larger sample [9]. It also presents a methodology that is more distinct from the rest because it uses the frequency of food intake of the vitamins of each individual through a questionnaire. Thus, it becomes more difficult to have precision regarding the amount of vitamins that each individual ingests compared to the other studies where the vitamins were administered in supplement form, ideally the combination of these two methods. In turn the results are not directly comparable with the other studies as they are presented as a percentage of probability of hearing loss, indicating that a 14% decrease in the probability of hearing loss with vitamin E may occur.

Kapoor et al. when studying the effect of vitamin E and carbogen in subjects with normal hearing with exposure to noise found greater protection at 0.25, 0.5 and 1 kHz in the group that took vitamin E, not being directly comparable with the other studies. This study is related to noise induced hearing loss and was the one that presented a smaller sample [18].

In the remaining studies, the comparison of the results becomes more direct not only by the way they are presented, but also by the sample composed of individuals with idiopathic sensorineural hearing loss. Both Furukawa et al and Ahn et al have approximately a 30dB hearing gain [10,13].

In these two studies the administration of vitamins lasts for 4 weeks and all subjects are submitted to steroids as standard treatment for idiopathic hearing loss in both the control and study groups.

Of the included articles, only these two present inclusion criteria, such as the sudden onset of sensorineural hearing loss, lack of knowledge of the cause, non-fluctuating hearing, mean tonal loss greater than 40 dB, and treatment initiated up to 14 days after onset of the loss. According to Furukawa, et al. in the cases in which treatment starts after 14 days, the results may be compromised [10].

Regarding the exclusion criteria, only in the article by Ahn et al. were defined, being chronic kidney disease, congestive heart failure, diabetes, vestibular Schwannoma and renal calculi. In these cases, vitamin C supplementation has to be very well controlled as it can lead to problems due to these diseases [13].

In the same article by Ahn et al, the relevance of communication in the quality of life was highlighted, thus highlighting the importance of performing the Vocal Audiogram in this type of studies [13]. However, neither this study nor any of the included ones applied this method of evaluation, being used in all of them only the Audiogram.

Audiogram is intended to determine the minimum audible intensity that is the auditory threshold. Thus, it assumes an essential role in these studies, because by comparing the results obtained with this method of evaluation performed at different times of each study, it is possible to evaluate the auditory threshold changes.

For the sample ages, all the studies were composed by a sample with a mean age greater than 50 years, except for the study elaborated by Kapoor et al. who had a sample with lower ages, around 36.4 years ( $\pm 7.3$ ) [18].

Although the results are not shown in the respective section of the article by Furukawa et al. which is a flaw, this study evaluated the relationship between age and the results obtained, and in the group that took vitamin C and E Patients less than 60 years of age presented greater recovery of hearing [10]. This result evidences the fact that the age of the sample is a relevant study variable in relation to the decrease in the auditory threshold, and therefore, the sample of future studies should be made up of individuals between the ages of 50 and 60 years.

When these types of studies are developed, it is necessary to consider the possible side effects from the administration of vitamins, although they are rarely found, there are contraindications and possible side effects that should not be ignored. In the studied articles only reference was made to vitamin C in the article by

Ahn et al. so that when taken in large doses can cause diarrhea in case it is not absorbed due to the change in colon osmolarity [10].

The major obstacle encountered in interlinking the included studies was that they were not methodologically homogeneous with regard to the methods used, the composition of the samples, the duration of the studies and the description of the results. However, this multiplicity demonstrates the beneficial results that the use of these vitamins can give to individuals with sensorineural hearing loss, including presbycusis, sudden idiopathic sensorineural hearing loss and noise-induced hearing loss.

In order to proceed with research on this topic, it becomes relevant to apply further studies with characteristics similar to those described in the included articles. Considering the importance of communication in social life, it would be relevant to perform the Audiogram together with the Vocal Audiogram, in order to observe the results in terms of auditory thresholds and speech discrimination, respectively.

## Conclusion

The proper functioning of the auditory system is precious, so it is important not only that the population is aware of the care to be taken, but also to develop methods that benefit the auditory health.

Vitamins C, and E, having an antioxidant action, protect cell membranes, lipids and proteins from oxidative damage.

The comparison of the results of the chosen articles reveals concrete evidences of improvements in the auditory thresholds provided by the taking of vitamins C and E, reaching a hearing gain of 30 dB.

These results give a better quality of life to people with hearing loss, especially in people with presbycusis, sudden idiopathic sensorineural hearing loss and noise-induced hearing loss.

## References

1. Daniel E (2007) Noise and Hearing Loss: A Review. *J Sch Health* 77(5): 225-231.
2. World Health Organization (2014) Deafness and hearing loss.
3. Campbell K CM (2007) Mechanisms of Toxicity in the Cochlea (Including Physical, Free Radical: Oxidative and Anti-oxidative Mechanisms, Protein Interactions, and Defense Mechanisms). In Wang J & Bobbin R (Ed.), *Pharmacology and Ototoxicity for Audiologists*, Thomson Delmar Learning, USA, Pp: 70-85.
4. American Speech- Language- Hearing Association (2014) *Sensorineural Hearing Loss*.
5. Sataloff J, Sataloff RT (2006) *Occupational Hearing Loss*, Taylor & Francis Group. In Sataloff J, Sataloff RT (Ed.), *the Nature of Hearing Loss*, USA, pp: 19-27.
6. Altıntaş A, Güne S, Kaya H, Kayhan FT, Koç AK, et al. (2015) Vitamins A, C, and E and selenium in the treatment of idiopathic sudden sensorineural hearing loss. *Eur Arch Otorhinolaryngol* 272(5): 1119-1125.
7. Anniko M, Nordang L (2005) Nitro-L-arginine methyl ester: a potential protector against gentamicin ototoxicity. *Acta Oto-Laryngologica* 125 (10): 1033-1038.
8. Clerici WJ, DiMartino DL, Prasad MR (1995) Direct effects of reactive oxygen species on cochlear outer hair cell shape in vitro. *Hearing Research* 84(1-2): 30-40.
9. Burlutsky G, Flood VM, Gopinath B, Hood LJ, McMahon CM, et al. (2011) Dietary antioxidant intake is associated with the prevalence but not incidence of age-related hearing loss. *J Nutr Health Aging* 15(10): 896-900.
10. Furukawa M, Hatano M, Ito M, Okabe Y, Uramoto N (2008) Vitamin E and vitamin C in the treatment of idiopathic sudden sensorineural hearing loss. *Acta Otolaryngol* 128(2): 116-121.
11. Hughes LF, Le Prell CG, Miller JM (2007) Free radical scavengers vitamins A, C, and E plus magnesium reduce noise trauma. *Free Radic Biol Med* 42(9): 1454-1463.
12. Baggett-Strehlau JM, Cole WC, Haas GM, Prasad KN, Wyatt SE (2011) Antioxidant micronutrient impact on hearing disorders: concept, rationale and evidence. *Am J Otolaryngol* 32(1): 55-61.
13. Ahn S, Hur DG, Kang H, Kim H, Park JJ (2013) Effect of high dose intravenous vitamin C on idiopathic sudden sensorineural hearing loss: a prospective single-blind

- randomized controlled trial. *Eur Arch Otorhinolaryngol* 270(10): 2631-2636.
14. Ding D, McFadden SL, Michalak N, Woo JM (2005) Dietary vitamin C supplementation reduces noise-induced hearing loss in guinea pigs. *Hear Res* 202(1-2): 200- 208.
  15. Curhan GC, Curhan SG, Eavey R, Shargorodsky J (2010) A prospective study of vitamin intake and the risk of hearing loss in men. *Otolaryngol Head Neck Surg* 142(2): 231-236.
  16. Bennett DC, Gagnon PM, Le Prell CG, Ohlemiller KK (2011) Nutrient-enhanced diet reduces noise-induced damage to the inner ear and hearing loss. *Transl Res* 158(1): 38-53.
  17. Halsey K, Kanicki A, Schacht J, Sha S, Wearne KA (2012) Antioxidant-enriched diet does not delay the progression of age-related hearing loss. *Neurobiol Aging* 33(5).
  18. Kapoor N, Mani KV, Selvamurthy W, Sharma RK, Shyam R, et al. (2011) Effect of vitamin E supplementation on carbogen-induced amelioration of noise induced hearing loss in man. *Noise Health* 13(55): 452-458.