



Tinnitus: Ringing in the Ears

An Overview

By the Vestibular Disorders Association

What is tinnitus?

Tinnitus is abnormal noise perceived in one or both ears or in the head. Tinnitus (pronounced either “TIN-uh-tus” or “tin-NY-tus”) may be intermittent, or it might appear as a constant or continuous sound. It can be experienced as a ringing, hissing, whistling, buzzing, or clicking sound and can vary in pitch from a low roar to a high squeal.

Tinnitus is very common. Most studies indicate the prevalence in adults as falling within the range of 10% to 15%, with a greater prevalence at higher ages, through the sixth or seventh decade of life.¹ Gender distinctions are not consistently reported across studies, but tinnitus prevalence is significantly higher in pregnant than non-pregnant women.²

The most common form of tinnitus is *subjective tinnitus*, which is noise that other people cannot hear. *Objective tinnitus* can be heard by an examiner positioned close to the ear. This is a rare form of tinnitus, occurring in less than 1% of cases.³

Chronic tinnitus can be annoying, intrusive, and in some cases devastating to a person’s life. Up to 25% of those with chronic tinnitus find it severe enough

to seek treatment.⁴ It can interfere with a person’s ability to hear, work, and perform daily activities. One study showed that 33% of persons being treated for tinnitus reported that it disrupted their sleep, with a greater degree of disruption directly related to the perceived loudness or severity of the tinnitus.^{5,6}

Causes and related factors

Most tinnitus is associated with damage to the auditory (hearing) system, although it can also be associated with other events or factors: jaw, head, or neck injury; exposure to certain drugs; nerve damage; or vascular (blood-flow) problems. With *severe* tinnitus in adults, coexisting factors may include hearing loss, dizziness, head injury, sinus and middle-ear infections, or mastoiditis (infection of the spaces within the mastoid bone). Significant factors associated with *mild* tinnitus may include meningitis (inflammation of the membranous covering of the brain and spinal cord), dizziness, migraine, hearing loss, or age.⁷

Forty percent of tinnitus patients have decreased sound tolerance, identified as the sum of *hyperacusis* (perception of over-amplification of environmental

sounds) and *misophonia/ phonophobia* (dislike/fear of environmental sounds).⁸ While most cases of tinnitus are associated with some form of hearing impairment, up to 18% of cases do not involve reports of abnormal hearing.⁹

Ear disorders

Hearing loss from exposure to loud noise:

Acute hearing depends on the microscopic endings of the hearing nerve in the inner ear. Exposure to loud noise can injure these nerve endings and result in hearing loss. Hearing damage from noise exposure is considered to be the leading cause of tinnitus.

Presbycusis: Tinnitus can also be related to the general impairment of the hearing nerve that occurs with aging, known as presbycusis. Age-related degeneration of the inner ear occurs in 30% of persons age 65–74, and in 50% of persons 75 years or older.¹⁰

Middle-ear problems: Tinnitus is reported in 65% of persons who have preoperative *otosclerosis* (stiffening of the middle-ear bones),¹¹ with the tinnitus sound typically occurring as a high-pitched tone or white noise rather than as a low tone.¹² *Otitis media* (middle-ear infection) can be accompanied by tinnitus, which usually disappears when the infection is treated. If repeated infections cause a *cholesteatoma* (benign mass of skin cells in the middle ear behind the eardrum), hearing loss, tinnitus, and other symptoms can result.¹³

Objective tinnitus has been associated with *myoclonus* (contraction or twitching) of the small muscles in the middle ear.^{14,15} Conductive hearing loss resulting from an accumulation of earwax in the ear canal can sometimes cause tinnitus.

Vestibular disorders: Hearing impairment and related tinnitus often accompany dysfunction of the balance organs (vestibular system). Some vestibular disorders associated with tinnitus include *Ménière's disease* and *secondary endolymphatic hydrops* (resulting from abnormal amounts of a fluid called *endolymph* collecting in the inner ear) and *perilymph fistula* (a tear or defect in one or both of the thin membranes between the middle and inner ear).

Vestibulo-cochlear nerve damage and central auditory system changes

The vestibulo-cochlear nerve, or eighth cranial nerve, carries signals from the inner ear to the brain. Tinnitus can result from damage to this nerve. Such damage can be caused by an *acoustic neuroma*, also known as a *vestibular schwannoma* (benign tumor on the vestibular portion of the nerve), *vestibular neuritis* (viral infection of the nerve), or *microvascular compression syndrome* (irritation of the nerve by a blood vessel).

The perception of chronic tinnitus has also been associated with hyperactivity in the central auditory system, especially in the auditory cortex.¹⁶ In such cases, the tinnitus is thought to be triggered by damage to the *cochlea* (the peripheral

hearing structure) or the vestibulo-cochlear nerve.

Head and neck trauma

Compared with tinnitus from other causes, tinnitus due to head or neck trauma tends to be perceived as louder and more severe. It is accompanied by more frequent headaches, greater difficulties with concentration and memory, and a greater likelihood of depression.¹⁷

Somatic tinnitus is the term used when the tinnitus is associated with head, neck, or dental injury—such as misalignment of the jaw or temporomandibular joint (TMJ)—and occurs in the absence of hearing loss. Characteristics of somatic tinnitus include intermittency, large fluctuations in loudness, and variation in the perceived location and pattern of its occurrence throughout the day.¹⁸

Medications

Many drugs can cause or increase tinnitus. These include certain non-steroidal anti-inflammatory drugs (NSAIDs, such as Motrin, Advil, and Aleve), certain antibiotics (such as gentamicin and vancomycin), loop diuretics (such as Lasix), aspirin and other salicylates, quinine-containing drugs, and chemotherapy medications (such as carboplatin and cisplatin). Depending on the medication dosage, the tinnitus can be temporary or permanent.³

Vascular sources

Pulsatile tinnitus is a rhythmic pulsing sound that sometimes occurs in time with the heartbeat. This is typically a result of noise from blood vessels close to the inner ear. Pulsatile tinnitus is usually not serious. However, sometimes it is associated with serious conditions such as high or low blood pressure, hardening of the arteries (arteriosclerosis), anemia, vascular tumor, or aneurysm.

Other possible causes

Other conditions have been linked to tinnitus: high stress levels, the onset of a sinus infection or cold, autoimmune disorders (such as rheumatoid arthritis or lupus), hormonal changes, diabetes, fibromyalgia, Lyme disease, allergies, depletion of cerebrospinal fluid, vitamin deficiency, and exposure to lead. In addition, excessive amounts of alcohol or caffeine exacerbate tinnitus in some people.

Diagnosis

Examination by a primary care physician will help rule out certain sources of tinnitus, such as blood pressure or medication problems. This doctor can also, if necessary, provide a referral to an ear, nose, and throat specialist (an otolaryngologist, otologist, or neurotologist), who will examine the ears and hearing, in consultation with an audiologist. Their evaluations might involve extensive testing that can include an audiogram (to measure hearing), a tympanogram (to measure the stiffness of the eardrum and help detect the

presence of fluid in the middle ear), otoacoustic emissions testing (to provide information about how the hair cells of the cochlea are working), an auditory brainstem response test (to measure how hearing signals travel from the ear to the brain and then within parts of the brain), electrocochleography (to measure how sound signals move from the ear along the beginning of the hearing nerve), vestibular-evoked myogenic potentials (to test the functioning of the saccule and/or inferior vestibular nerve), blood tests, and magnetic resonance imaging (MRI). Neuropsychological testing is also sometimes included to screen for the presence of anxiety, depression, or obsessiveness—which are understandable and not uncommon effects when tinnitus has disrupted a person’s life.

Treatment

If a specific cause of the tinnitus is identified, treatment may be available to relieve it. For example, if TMJ dysfunction is the cause, a dentist may be able to relieve symptoms by realigning the jaw or adjusting the bite with dental work. If an infection is the cause, successful treatment of the infection may reduce or eliminate the tinnitus.

Many cases of tinnitus have no identifiable cause, however, and thus are more difficult to treat. Although a person’s tolerance of tinnitus tends to increase with time,¹⁹ severe cases can be disturbing for many years. In such chronic cases, a variety of treatment

approaches are available, including medication, dietary adjustments, counseling, and devices that help mask the sound or desensitize a person to it. Not every treatment works for every person.

Masking devices

A masking device emits sound that obscures, though does not eliminate, the tinnitus noise. The usefulness of maskers is based on the observation that tinnitus is usually more bothersome in quiet surroundings²⁰ and that a competing sound at a constant low level, such as a ticking clock, whirring fan, ocean surf, radio static, or white noise produced by a commercially available masker, may disguise or reduce the sound of tinnitus, thus making it less noticeable. Some tinnitus sufferers report that they sleep better when they use a masker. In some users, maskers produce *residual inhibition*—tinnitus suppression that lasts for a short while after the masker has been turned off.

Hearing aids are sometimes used as maskers. If hearing loss is involved, properly fitted hearing aids can improve hearing and may reduce tinnitus temporarily. However, tinnitus can actually worsen if the hearing aid is set at an excessively loud level.

Cochlear implants, used for persons who are profoundly deaf or severely hard-of-hearing, have been shown to suppress tinnitus in up to 92% of patients.^{21,22} This is likely a result of masking due to

newly perceived ambient sounds or from electrical stimulation of the auditory nerve.

Other devices under development may eventually prove effective in relieving tinnitus. For example, the recently introduced acoustics-based Neuromonics device involves working with an audiologist who matches the frequency spectrum of the perceived tinnitus sound to music that overlaps this spectrum. This technique aims to stimulate a wide range of auditory pathways, the limbic system (a network of structures in the brain involved in memory and emotions), and the autonomic nervous system such that a person is desensitized to the tinnitus. Assessing the true effectiveness of this device will require further scientific study, although observations from an initial stage of clinical trials indicate that the device can reduce the severity of symptoms and improve quality of life.²³

Tinnitus retraining therapy

Tinnitus retraining therapy (TRT) is designed to help a person retrain the brain to avoid thinking about the tinnitus. It employs a combination of counseling and a non-masking sound that decreases the contrast between the sound of the tinnitus and the surrounding environment.²⁴ The goal is not to eliminate the perception of the tinnitus sound itself, but to retrain a person's conditioned negative response (annoyance, fear) to it.

In one comparison of the effectiveness of tinnitus masking and TRT as treatments, masking was found to provide the greatest benefit in the short term (three to six months), while TRT provided the greatest improvement with continued treatment over time (12–18 months).²⁵

Psychological treatments

Chronic tinnitus can disrupt concentration, sleep patterns, and participation in social activities, leading to depression and anxiety. In addition, tinnitus tends to be more persistent and distressful if a person obsesses about it. Consulting with a psychologist or psychiatrist can be useful when the emotional reaction to the perception of tinnitus becomes as troublesome as the tinnitus itself¹⁹ and when help is needed in identifying and altering negative behaviors and thought patterns.

Medication

No drug is available to cure tinnitus; however, some drugs have been shown to be effective in treating its psychological effects. These include anti-anxiety medications in the benzodiazepine family, such as clonazepam (Klonopin) or lorazepam (Ativan); antidepressants in the tricyclic family, such as amitriptyline (Elavil) and nortriptyline (Aventyl, Nortrilen, Pamelor); and some selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine (Prozac).^{26,27,28,29}

Other drugs have been anecdotally associated with relief of tinnitus. These include certain heart medications, anesthetics, antihistamines, statins, vitamin or mineral supplements, vasodilators, anticonvulsants, and various homeopathic or herbal preparations. Scientific evidence is lacking to support the effectiveness of many of these remedies.^{27,30,31} Some appear to be placebos, while some are possibly mildly or temporarily effective but with potential side effects that are serious.

Examples of recent research studies on some of these anecdotal treatments follow, although this list is not exhaustive:

- In assessing the effectiveness of atorvastatin (Lipitor) in the treatment of tinnitus, scientists observed a trend toward relief of symptoms; however, this trend was not statistically significant when compared with results produced by administration of a placebo.³²
- The relationship between low blood zinc levels and subjective tinnitus was inspected in a small placebo-controlled study. Administration of oral zinc medication produced results that prompted the researchers to note that additional tests were needed to investigate whether duration of treatment might be a significant factor.³³
- Immediate suppression of subjective tinnitus has been observed in patients administered intravenous lidocaine,³⁴ although such relief has

been shown to be very short term.³⁵ The effect of such tinnitus treatment is thought to occur in the central auditory pathway rather than in the cochlea.³⁶

- Scientists demonstrated that the anticonvulsant gabapentin (Neurontin) is no more effective than placebo in treatment of tinnitus.^{37,38}
- When scientists reported their finding that *Ginkgo biloba* extracts and placebo treatments produce very similar results, they also noted that use of the extract could lead to adverse side effects, especially if used unsupervised and with other medications.^{39,40}

Some alternative approaches may eventually yield helpful options in tinnitus treatment. However, most scientists agree that additional well-constructed research is needed before any anecdotally associated preparation can be applied as a proven and effective treatment option.

Surgery

Treating tinnitus with surgery is generally limited to being a possible secondary outcome of surgery that is used in cases when the source of the tinnitus is identified (such as acoustic neuroma, perilymph fistula, or otosclerosis) and surgical intervention is required to treat that condition.⁴¹

Other proposed treatments

Stress-reduction techniques are often advocated for improving general health,

as they can help control muscle groups and improve circulation throughout the body. Such relaxation training, the use of biofeedback to augment relaxation exercises, and hypnosis have been suggested as treatments for tinnitus. Limited research is available on the effectiveness of these methods.

Acupuncture, electrical stimulation, application of magnets, electromagnetic stimulation, and ultrasound have been found to be placebo treatments for tinnitus or to have limited scientific support for their effectiveness.^{27,30,42,43}

Recent and ongoing research studies have attempted to assess whether transcranial magnetic stimulation could be an effective tinnitus treatment. This application is based on the thought that tinnitus is associated with an irregular activation of the temporoparietal cortex (a part of the brain), and thus that disturbing this irregular activation could result in transient reduction of tinnitus.^{44,45,46}

Prevention

Precautionary measures to help lessen the severity of tinnitus or help a person cope with tinnitus are related to some of the causes and treatments listed above. Avoiding exposure to loud sounds (especially work-related noise) and getting prompt treatment for ear infections have been identified as the two most important interventions for reducing the risk of tinnitus.⁴⁷ Wearing ear protection against loud noise at work or

at home and avoiding listening to music at high volume can both help reduce risk.⁴⁸

Other important factors are exercising daily, getting adequate rest, and having blood pressure monitored and controlled, if needed. Additional precautionary measures include limiting salt intake, avoiding stimulants such as caffeine and nicotine, and avoiding ototoxic drugs known to increase tinnitus (some of which are listed above under "Causes and Related Factors").

Summary

Tinnitus is a common condition that can disrupt a person's life. Our understanding of the mechanisms of tinnitus is incomplete, and many unknown factors remain. These limitations contribute to the lack of medical consensus about tinnitus management, stimulate continued research efforts, and motivate anecdotal and commercially based speculation about potential but unproven treatments. Prior to receiving any treatment for tinnitus or head noise, it is important for a person to have a thorough examination that includes an evaluation by a physician. Understanding the tinnitus and its possible causes is an essential part of its treatment.

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