Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

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An Examination of Tinnitus from Both Clinical and Epidemiological Perspectives: A Comprehensive Review Study

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DOI: 10.36347/sajb.2024.v12i02.001 | **Received:** 09.02.2024 | **Accepted:** 11.03.2024 | **Published:** 15.03.2024

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Abstract **Review Article**

Tinnitus refers to the subjective perception of sounds in the brain or ears, such as buzzing, clicking, or hissing, in the absence of any external auditory stimuli. It is a commonly encountered phenomenon among individuals worldwide. The primary aim of this study was to examine recent advancements in the literature concerning the frequency, origins, control, and therapy of the subject in question. The researchers utilized prominent research engines such as Google, Google Scholar, Science Direct, and others to gather publications about tinnitus. The findings indicated that tinnitus is widely prevalent on a global scale and can be ascribed to neurological, hereditary, and environmental reasons. The therapy and therapeutic options for this condition are diverse and depend on the underlying causes.

Keywords: Tinnitus, perception, psychological factors, neurological factors, prevalence.

1. INTRODUCTION

The present study investigated the literature for tinnitus from various aspects including giving an overview of the topic, management, and treatment.

2. An Overview of Tinnitus

Tinnitus is the conscious awareness of sounds in the brain or ears, such as buzzing, clicking, or hissing, without any external noise being present (De Ridder *et al.*, 2022). Worldwide, over 740 million persons (14.4%) experience tinnitus and over 120 million adults (2.3%) face significant difficulties due to severe tinnitus (Jarach *et al.*, 2022). Tinnitus is a common illness, although each person's experience with it will be unique. Tinnitus can lead to substantial distress and is linked to adverse effects on daily living for many individuals (Choo *et al.*, 2024). The repercussions encompass agitation, sadness, worry, melancholy, disrupted sleep patterns, reduced attention, and social disengagement (Zeman *et al.*, 2014). Tinnitus is a common and painful illness that presents with a variety of causes and symptoms (Choo *et al.*, 2024).

Tinnitus is the name given to the audible ringing or buzzing that can be felt in the ears or skull even when no outside noise is present (Kim *et al.*, 2024). According to research, the prevalence of tinnitus among persons ranges from 5% to 30% (Bhatt *et al.*,2016; Lee and Kim, 2018). One out of three seniors experience tinnitus, making it a more common condition among the elderly (McCormack *et al.*, 2016). Although one occurrence of tinnitus might not be cause for alarm, it is important to note that only 1-7% of patients have tinnitus that is so bothersome that it interferes with their everyday lives (Kim *et al.*, 2024). Consequently, tinnitus is becoming more well-known, especially when it significantly lowers the quality of life and is seen frequently in otolaryngology clinics (Kim *et al.*, 2024).

Noise exposure is a well-known risk factor for tinnitus, often linked to sensorineural hearing loss (SNHL) or anxiety typically seen in older individuals, despite its complicated causes (Jafari *et al.*, 2019). There is a lack of extensive research on the occurrence of tinnitus in various populations (Le *et al.*, 2017; Perez-Carpena *et al.*,2024).

Several epidemiological studies have investigated large groups of individuals with tinnitus, such as adoptees, twins, and familial aggregation studies (Maas *et al.*, 2017). These studies have found evidence that tinnitus has a strong genetic component, especially in cases of severe tinnitus affecting both ears (Amanat *et al.*, 2021). The hidden inheritance is due to the genetic diversity of the DNA sequence. Further genetic studies have revealed both common and unusual variations linked to various tinnitus symptoms (Clifford *et al.*, 2020).

3. Reasons of Tinnitus

Tinnitus can result from pathological alterations in auditory circuits or from illnesses not connected to the auditory system (Langguth *et al.,* 2013). Previous studies have found several reasons for tinnitus, with a specific emphasis on the field of neurology. However, despite the wide range of physiopathological mechanisms that contribute to tinnitus, these pathways are insufficient to fully explain the illness (Shore and Wu, 2019; Lee *et al.,* 2022).

The parahippocampal gyrus and hippocampus have been identified in several studies as part of a tinnitus network (Berger *et al.,* 2024). The emotional reaction to tinnitus is commonly associated with the term "limbic system," which is regularly used in the study of these components (Georgiewa *et al.,* 2006). Despite being well recognized, the existing literature does not seem to provide evidence that this is the main functional role of these structures in chronic tinnitus (Berger *et al.,* 2024). This section focuses on a specific function that is primarily associated with the brain, which is its role as a memory system (Hockley and Shore, 2023). Tinnitus is viewed as an auditory object preserved in memory that can endure due to activity emanating from the parahippocampal gyrus and hippocampus (Wallhäusser-Franke *et al.,* 2003).

Tinnitus, a common and inheritable aural problem, is managed using a diverse range of medical approaches (Clifford *et al.,* 2024). Previous GWAS have found strong genetic links between tinnitus and hearing loss, but clear differentiating signals are still lacking (Wells *et al.,* 2021). A GWAS study found 39 genetic loci linked to tinnitus in 596,905 military veteran program participants (Clifford *et al.,* 2024). Genetic elements related to supporting the structure of the cochlea and neural synapses were discovered (Tarabichi *et al.,* 2018). Sophisticated analytical techniques were used to confirm many common genetic variations in tinnitus, which has a unique genomic structure marked by significant polygenicity and a high proportion of variations not found in people with hearing loss (Clifford *et al.,* 2024).

4. Therapeutic Approaches to Tinnitus

There are several therapy guidelines for tinnitus. The United States 2014 standards (Tunkel *et al.,* 2014) recommend "hearing aid evaluation," "cognitive behavioral therapy (CBT)," and "education and counseling". Tinnitus retraining therapy (TRT) is not discussed in isolation (Jastreboff, 2007) since it includes directional counseling, sound therapy, and the use of hearing aids for people with hearing loss. Each of these factors can be analyzed individually. Sound treatment is one aspect of TRT that is not strongly recommended, making it an elective procedure. However, opposition to medical care is sometimes more severe than simply rejecting to endorse it. The guidelines for treating tinnitus underline the necessity of avoiding the routine use of antidepressants, anticonvulsants, anxiolytics, and intratympanic drug administration (Tunkel *et al.,* 2014).

The 2019 European guidelines (Cima *et al.,* 2019) strongly back up CBT. Because there isn't enough good study to back up TRT, there isn't a clear recommendation or endorsement for it. Hearing aids can help with associated tinnitus, but cochlear implantation (CI) is the best option for people who have serious hearing loss. There is a negative view of drugs in the rules. Antidepressants shouldn't be taken by people who have never been depressed before, and anxiolytics help with worry but don't help with tinnitus (Cima *et al.,* 2019). However, the 2020 Japanese standards (Ogawa *et al.,* 2020) also talk about how cost-effective CBT is. Hearing aids and sound treatment (TRT) are also thought to be helpful. Even though it's hard to tell how well medications will work, the standards say that people with depression or anxiety should take them (Ogawa *et al.,* 2020).

Research has been undertaken regarding the pharmaceutical compound gabapentin, which is related to carbamazepine. The effectiveness of the placebo effect was noted; nevertheless, individuals experiencing tinnitus due to hearing loss exhibited greater efficacy (Bauer and, Brozoski, 2006; Tavares *et al.,* 2022). Additionally, herbal remedies have been the focus of meticulous investigation. Tinnitus patients are frequently prescribed medications containing ginkgo biloba due to the drug's well-established safety. Although their safety has been established, their demonstrated mechanism of action remains unknown (Sereda *et al.,* 2022). Due to their safety, scientists are investigating the possibility of combining them with other formulations. A multitude of studies have investigated complex formulations that comprise magnesium, melatonin, vitamin B, complex vitamins A, C, and E, and selenium, in addition to G. biloba, magnesium, and vitamin B (Chauhan *et al.,* 2023). On occasion, tinnitus sufferers have reported substantial improvements (Knäpper *et al.,* 2023). Additional research is required to ascertain their efficacy, given that these are merely preliminary trials. An additional plant combination known to alleviate depression, St. John's wort, was examined in a randomized controlled trial (RCT) alongside G. biloba; however, the outcomes did not indicate that it provided a superior treatment compared to single-treatment approaches (Kim *et al.,* 2023). The fascination surrounding herbs persists among numerous individuals. Research has demonstrated that the administration of complex mixtures comprising Tanacetum vulgare, Urtica dioica, and Rosa canina significantly diminishes tinnitus symptoms in comparison to a control group (Khosravi *et al.,* 2023). It is recognized that these mixtures alleviate the symptoms of peripheral neuropathy. While additional research is necessary to obtain more definitive results concerning their efficacy, it is encouraging to note that they are generally secure to use (Kim *et al.,* 2024).

5. Management of Tinnitus

Numerous models have sought to explain tinnitus's physiology, but the etiology of the condition remains unknown (Apoorva *et al.,* 2024). According to certain theories on the causes of tinnitus, negative emotions or reactions to the disease may contribute to its long-term development (De Ridder *et al.,* 2011). Tinnitus is an aural disorder that has been associated with mental health issues; the present pandemic may affect its prevalence (Apoorva *et al.,*2024).

Some ways to deal with tinnitus are through medication (like sedatives, anxiety medicines, and antidepressants), sound therapies (like sound therapy and tinnitus retraining therapy), psychological methods (like cognitive behavioral therapy and counseling), electromagnetic stimulation, and biofeedback. These methods have been used by different people with varying levels of success. By lowering the activity of the sympathetic nerve system (Vempati and Telles, 2002), yoga has been shown to lower cortisol levels (Vorkapic *et al.,* 2014).

Tinnitus sufferers were able to perceive sounds even in the absence of an external auditory stimulus (Namvar *et al.,* 2024). The illness in question has the potential to significantly impair their health and quality of life (McCormack *et al.,* 2016). Millions of individuals around the world have this hearing impairment, and they require effective treatment to cope with its distressing effects (Acharya, 2023). An aspect that individuals perceive and sustain their tinnitus is attentional processes, a subject that is presently under investigation (Roberts *et al.,* 2013). Attention is one of the most fundamental functions of the brain. It facilitates individuals in directing their focus toward pertinent matters while disregarding extraneous information (Posner, 1994).

Attentional neurophysiological mechanisms involve intricate cross-connections among various brain regions, such as the prefrontal cortex, parietal cortex, and sensory processing areas (Mohsen and Pourbakht, 2018). Attentional regulation is facilitated by these brain interactions; it enables individuals to modify their processing and perception in addition to concentrating their attention on pertinent stimuli (Henry and Wilson, 2001). By employing attentional models that posit discrete processes of attentional regulation, we can enhance our comprehension of the correlation between attention and the perception of tinnitus. Three attentional networks comprise Posner's attention model (Posner and Petersen, 1990), executive, orienting, and alerting. Attentional bias occurs when individuals with tinnitus experience disruptions in their attention networks, causing them to adjust their focus toward or away from stimuli associated with tinnitus (Hu *et al.,* 2021; Kok *et al.,* 2022). Numerous attention models offer significant contributions to our understanding of the intricate correlation between tinnitus and attention. As an illustration, the biased competition model posits that the allocation of attentional resources is influenced by the salience and competitiveness of stimuli (Desimone and Duncan, 1995). Possible consequences include attentional bias towards tinnitus and challenges in diverting attention away from tinnitus sensations due to the heightened visibility of tinnitus-associated stimuli and their competition with other auditory inputs (Rauschecker *et al.,* 2010). Attentional processes involve making and updating predictions about sensory inputs, according to the predictive coding framework (Friston *et al.,* 2005); aberrant prediction errors are a factor in attentional disorders in humans. The attentional control theory is a well-established conceptual framework that offers significant insights into the mechanisms that underlie attentional processes in the perception and modulation of tinnitus. Individuals with tinnitus may have difficulty regulating their attention, which could result in attentional biases toward stimuli associated with the condition, according to this theory. Hence, this increased degree of concentration might intensify the discomfort and perception associated with tinnitus. Attentional biases away from tinnitus may facilitate habituation to the illusory sound and potentially alleviate distress, according to this theory (Coombes *et al.,* 2009).

6. CONCLUSIONS

The present study showed that tinnitus is a common problem worldwide and affects millions of people. Its causes are varied and can be psychological, neurological, inheritance, and possibly others. Therapeutic options include medications and psychological interventions.

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