

Treatment of Tinnitus: A Scoping Review

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Abstract

Background: Tinnitus is a perception of an auditory sensation without the presence of an external sound. It has devastating impact on the quality of life and psychosocial aspect of the sufferer. Mechanisms of tinnitus not clear; however, its management include counselling, hearing aids, tinnitus masking, relaxation therapy, cognitive behaviour therapy and tinnitus retraining therapy. **Objective:** To conduct a scoping review to explore the role of counselling, hearing aids, tinnitus masking, relaxation therapy, cognitive-behavioural therapy and tinnitus retraining therapy in India. To also provide an overview of efficacy of these approaches in tinnitus management. **Research Design:** Scoping review. **Study Sample:** Experimental studies, follow-up assessments, and reviews assessing tinnitus treatment approaches were identified as a result of an electronic database met search. **Results:** The evidence suggests that all tinnitus management programs have their unique benefits in the treatment of tinnitus. Given the confounding variables that include length of therapy, tinnitus severity and subject population, the overall level of evidence is equivocal. Nonetheless, the efficacy of CBT appears reasonably established and combined approach (masking + counselling + attention diversion) appears to be most promising for audiologists for future tinnitus management. A common ground of therapeutic elements was established and evidence was found to be robust enough to guide clinical practice. **Conclusion:** The use of more robust methodology with well-defined control groups, as well as randomization of clinical trials in future studies would increase the quality of evidence in the study of tinnitus management. **Clinical recommendation:** Combined therapies (masking + counselling + attention diversion) appear more appropriate in the treatment of tinnitus as the evidence is not sufficient to support a specific treatment method.

Keywords: tinnitus, tinnitus masking, tinnitus retraining therapy, cognitive behaviour therapy, tinnitus management.

Abbreviations: GPG: General Practice Guide; BDI: Beck Depression Inventory; THI: Tinnitus Handicap Inventory; THQ: Tinnitus Handicap Questionnaire; TQ: Tinnitus Questionnaire; TRQ: Tinnitus Reaction Questionnaire; TRT: Tinnitus retraining therapy; TSQ: Tinnitus Severity Questionnaire; VAS: Visual Analogue Scale; RI: Residual Inhibition; MML: Minimum Masking Level; QOL: Quality of Life; ADS: Anxiety Depression Scale, TFI: Tinnitus Functional Index; TBF: Adapted German version of the original English THI; HA: Hearing Aid; TCI: Tinnitus Control Instrument; TMT: Tinnitus Masking Therapy; CBT: Cognitive Behavioural Therapy

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INTRODUCTION

Tinnitus is defined as a sensation of sound perceived by an individual in the absence of any external sound source. Dobie¹ reported chronic tinnitus to be prevalent more among seniors (12% after age 60) than in young adults (5% in the 20-30 age groups), but also agreed that it can occur at any age. Tinnitus sensation in 2-3% of the general population has been found to affect the quality of life, involving disturbances in sleep, impairment at work and psychiatric distress. Chronic tinnitus has been reported to be associated with noise induced hearing loss in young population due to increasing industrial and recreational noise² or hearing loss accompanying the aging process³. Tinnitus has been found to impact many different domains of functioning catering to a need of a multidisciplinary approach for its management in order to adequately help the patients⁴.

The management procedure includes interruption of the neural signal generating the sound by presenting sound itself or to reduce the accompanying distress, anxiety or depression. According to the recommendation of GPG, the management of tinnitus includes hearing aids, counselling, TRT, relaxation therapy, CBT, TM & sleep management. However, these are based on anecdotal evidences, expert opinion and lack an evidence base. Therefore, there is need to study how much high-level evidence exists for the efficacy of the GPG suggested tinnitus management strategies.

Review of literature is an integral part of research as reported by Bellini and Rumrill⁵. This involves identification and analysis of documents containing information related to the research problem⁶, with the purpose of providing context for the research and its justification, identifying the areas which have been already covered as well as the research gaps. There are various approaches for review of literature such as narrative⁵, meta-analysis⁷, empirical⁸, systematic⁹ and scoping reviews¹⁰. Phillips and MxFerran¹¹ reported that due to the lack of Randomized Control Trials (RCTs), systematic reviews have been able to include only very few studies on sound based therapies for tinnitus. Therefore, the existing systematic reviews in the topic of tinnitus management cannot confirm the strength of current evidence¹². Scoping review can be an alternate approach to systematic review for open trial research where there is lack of RCTs on the topic of tinnitus management. Scoping review does not exclude research based on research quality, but rather identifies lack in research areas which have not been reviewed comprehensively before¹³. From the included studies, all the data are charted and key issues are identified, and an optional "consultation process" involving the discussion with key stake holders, may take place.

The present scoping review search examines tinnitus management strategies and validated measures of tinnitus intrusiveness, anxiety, or depression reported. The research question is "Does high level evidence exist

to support some, if not all GPG recommended strategies for management of tinnitus?".

METHODS

The research included relevant studies by using the following electronic data base: Google Scholar, Medline, Springer Link, Pubmed. The key words were: tinnitus, tinnitus masking, counselling, TRT, cognitive behaviour therapy, attention diversion task, tinnitus intervention, tinnitus treatment. Reference lists of the articles were reviewed and hand searching of key journals about the topic was undertaken. After initial consideration of title relevance to the study, 105 articles were shortlisted of which 41 studies were selected for charting of data. Only 2 studies were identified that were published before 2005; since 2005 there have been 39 studies, illustrating an increase in interest in the field. Measures used in the studies included the THI¹⁴, THQ¹⁵, TSI¹⁶, TRQ¹⁷, TQ¹⁸, BDI¹⁹, and VAS²⁰. Cohen's d was calculated to find out effect size of the study. For calculating Cohen's d, mean and standard deviation of the results were taken for both control and experimental groups. To interpret the effect size, guidelines developed by Cohen²¹ were used: d = 0.2 (small effects), d = 0.5 (medium effects) and d = 0.8 (high effects). Out of the total of 32 articles, 5 articles were related to counselling, 6 to tinnitus masking, 5 to TRT, 5 to CBT, 2 to attention diversion task, 6 to hearing aids and 3 to relaxation training.

RESULTS

Out of the 41 studies that met the search criteria, 32 were research studies (Table 1), and 9 were review studies (Table 2). A descriptive summary including the type of study, research design, sample size, types of intervention, measurement, result and study's effect size are provided in the tables. Cognitive behaviour therapy appears reasonably established. Tinnitus masking, counselling and hearing aids studies suggested positive effects on tinnitus management. Sound therapy combined with hearing aids and counselling is an effective treatment for tinnitus intervention. Throughout the study, the term statistical significance refers to a reliable numerical difference between the group means while clinical significance refers to specific change in questionnaire scores implying a functional improvement of the condition in an individual patient.

Research studies

Counselling in the treatment of tinnitus

Park and Bae²² in a study attempted to find time-effective small group counselling equivalent to individual counselling by comparing the treatment outcome of individual and small group counselling. A significant decline in the mean score of awareness, THI, loudness, annoyance and effect on life was found after providing counselling when outcome were assessed at 3 and 6 months post therapy. The result showed that the mean VAS (awareness/tinnitus loudness/ annoyance)/THI scores at 3 months decreased from 71.7 ± 30.5 (mean

Table 1. Summary of characteristics of included studies (n = 32) in chronological order.

Study	Design, Sample size	Interventions	Measurements	Results	Effects size
Counselling Park and Bae ²²	N = 149	-Directive counselling with ambient sound stimulation -Outcome between individual and small group counselling	- follow up after 3 month - follow up after 6 month	Counselling was effective for tinnitus patients and small group counselling was more effective comparable to the individual counselling	medium effects
Malouff et al. ²³	N = 162	-Counselling based on self-help book in reducing distress related to tinnitus	-2 months follow up -4 months follow up -1 year follow up	Post treatment result showed significant reduction in tinnitus related distress	medium effects d = 0.25 (TRQ)
Henry et al. ²⁴	N = 269 Randomized selection	-Educational counselling on 94 subjects -Traditional support on 84 subjects -No treatment on 91 subjects	-baseline -after 1 month -after 6 month - after 12 month	Educational counselling can significantly benefit tinnitus patients	medium effects d = .45
Hall and Ruth ²⁵	N = 200 (M = 122, F = 78)	-Direct Counselling (written information +brochure from ATA)	-baseline and after 3 & 6 months follow up -severity of tinnitus and THI scores	Counselling reduces impact of tinnitus; however, loudness of tinnitus does not change significantly	small effects
Tinnitus Masking de Barros Suzuki et al. ²⁷	N = 10 (M = 5, F = 5)	-Used sound generators (Reach 62 or Mind 9 models) for at least 6 hours daily for 18 months.	-pre and post measurement -at baseline, after 1,3,6,9,12, 15 and 18 month follow up -MML, THI, VAS and HADS	Those had whistle-type tinnitus showed best response to tinnitus masking.	small effects
Ogut et al. ²⁸	N = 42 (M = 23, F = 19)	-Efficacy of tinnitus masking therapy	-after 4.5 months of therapy -pre & post measurement of severity, annoyance, loudness,RI,QOL	Post treatment result showed reduction in severity, annoyance and loudness thus improved patients quality of life	small effects
Schaette et al. ²⁰	N = 15	-Eleven participants had hearing loss and were fitted with HA -Four participants had normal hearing and fitted with SG	VAS and TQ	Those patients whose tinnitus pitch was <6khz got more relief with combined HA + sound generator	high effects Cohen's d = 2.14
Davis et al. ²⁹	N = 50	-Neuromonic treatment group (n = 20) -Counselling + masking (n = 15) -Counselling(n = 15)	measurement after 3, 6, 12 months of treatment - stabilization measurement after 6 months	Improvement in Neuromonic group was significantly better compared to counselling with noise group and only counselling group	small effects
Henry et al. ³⁰	N = 123	-Tinnitus masking or -Tinnitus Retraining Therapy	-THI, THQ, TSI measurement at 0, 3, 6, 12 & 18 months of treatment	TM provides more benefit for persons with 'moderate' problem whereas TRT provides greater benefit for persons with 'very big' problem	medium effects
Sinha and Makar ³¹	N = 15 (M = 9, F = 6)	-MML+40dBSL -Tinnitus pitch match masking tone at ipsilateral ear	-masking, -counselling,	Masking with counselling was more effective on patient with normal hearing with tinnitus compared to those have SNHL with tinnitus	small effects
TRT Tyler et al. ³²	Randomized selection N = 48	-Counselling (F-7, M-11) -Total masking (F-3, M-8) -TRT (mixing point masking)(F-8, M-11)	-pre and post measurement -after 12 month follow up -after 18 month follow up	Improvement difference between masking, counselling and TRT groups was not significant (X2 with two degrees of freedom = 1.67, p = 0.44)	medium to high effects (counseling = 0.51. masking = 0.84 TRT = 0.57)
Bauer and Brozoski ³³	N = 43	-TRT and General Counselling	-baseline -at 6, 12 and 18 months after enrolment	TRT along with counselling were effective in reducing annoyance and impact of tinnitus	high effects d = 1.13

Ariuzumi et al. ³⁴	N = 270	-TRT with sound generator (SG)	-baseline -after 6 and 18 months of intervention	-patient with lower loudness of tinnitus showed better improvement in TRT with SG intervention	medium effects d = 0.46
Saydel et al. ³⁵	N = 237 (M = 118, F = 119) Randomly assigned	-Patients received 7 consecutive days of a multidisciplinary therapy ie modified TRT, Jacobson progressive muscle relaxation, attention training -control group	-TQ, TSQ, ADS -data were obtained before therapy and after 7 days, 6 & 12 months of therapy	Pre and post result comparison showed significant reduction in both short term & long term tinnitus related distress and psychometric stress variables	small effects
Caffier et al. ³⁶	N = 70 treatment(n = 40) control (n = 30)	-Counselling, -tinnitus control instruments, -auditory and -relaxation training, therapy.	-TQ, VAS, TSQ -after 6 months, 12 months & 24 months of follow up	pre and post therapy comparison showed a statistical significant decrease in cognitive and emotional distress most effectively.	small effects
CBT Philippot et al. ³⁷	N = 30 (M = 18, F = 12)	-Mindfulness based CBT -Relaxation technique	-baseline -pre and post treatment -F/U after 6 weeks	Mindfulness based CBT more effective than Relaxation technique	high to medium (Mind. d = 1.44 Relax. d = 0.44)
Abbott et al. ³⁸	N = 56 Cluster randomized design	-Cognitive behaviour therapy program -An information only control program	-pre-treatment result -post-treatment result	CBT program was not found to be superior to the information program for treating tinnitus distress.	medium effects 0.41 (TRQ)
Robinson et al. ³⁹	N = 65	-CBT including training in activity planning, relaxation training and primarily cognitive restructuring	-baseline -after 8, 16, 52 weeks of treatment. -TRQ, BDI and TS scale	Statistically significant improvement in reducing impact of tinnitus	high effects
Andersson et al. ⁴⁰	Randomized selection N = 23 (M = 12, F = 11)	-Cognitive Behaviour Therapy	-pre and post -6 weekly group therapy for 2 hrs duration -follow up after 3 months	Anxiety sensitivity index score and mean annoyance rating reduced after CBT	medium effects d = 0.45 (TRQ)
Hiller and Haerkotter ⁴¹	N = 136	-Tinnitus education group n-70 (34 with NG and 36 without NG) -Cognitive behaviour therapy group n-66 (33 with NG and 33 without NG)	-pre-treatment -after 6 months of intervention -after 18 months of intervention	Impact of tinnitus significantly reduced from both treatments; no significant difference observed in improvement between groups with and without NG.	high to medium effects d = 1.08 (TQ), d = 0.69 (VAS),
Attention diversion Training Spizel et al. ⁴³	N = 18	-Multisensory attention diversion training 20 daily sessions for 30 minutes	-pre & post treatment assessment of TFI, TS and improvement in attention abilities	After 20 sessions of attention diversion training, tinnitus severity reduced significantly and attention abilities improved	medium effects Cohen d = 0.48 (TFI)
Serchfield et al. ⁴⁴	N = 10 (M = 3, F = 7)	-Auditory object identification and localization (AOIL) use for auditory training -15 day(30min/day)	-tinnitus pitch , loudness and MML were measured and compared before and after auditory training	MML and loudness level reduces significantly after treatment, however, no significant change in loudness of tinnitus	medium effects d = 0.47
Hearing aids for tinnitus therapy Henry et al. ⁴⁵	N = 30 (experimental n = 15, control n = 15)	-Randomly divided 15 fitted with HA and 15 fitted with HA plus sound generator. -counselling	- follow up after 3 month -pre & post-treatment assessment of TFI	Patients group with HA and patients group with HA+SG groups showed significant improvement	small effects
McNeill et al. ⁴⁶	N = 70	-26 reported tinnitus totally masked -28 reported partially masked -16 reported tinnitus not masked (control)	-prior to H/A fitting -follow up three months H/A fitting	Significant progressive improvement shown across partial to total masking of tinnitus by fitting HA	high effect d = 1.25
Parazzini et al. ⁴⁷	N = 91 randomized	-Randomly divided into two groups; 49 fitted with open-ear hearing aids, 42 with sound generators	-structured interviews along with questionnaires, VAS, THI and THQ.	Tinnitus therapy was equally effective with sound generators and open-ear hearing aids.	small effects

Searchfield et al. ⁴⁸	N = 58	-Counselling with hearing aid fitting (n = 29) -Only counselling (n = 29)	-pre & post intervention	Improvement almost twice in counselling with HA group than in the only counselling group	small effects d = 0.33
Moffat et al. ⁴⁹	N = 28	-Control group-I, (n = 8) not fitted with hearing aids. -Experimental group-II (N = 11) fitted with standard amplification -Group-III (n = 9) fitted with high bandwidth HAs	-psychoacoustic measures of tinnitus recorded in all groups before and after one month of hearing aids fitting	No significant difference observed between groups; however Group-II showed significant changes in tinnitus spectrum following treatment	small effects d = 0.34
Trotter et al. ⁵⁰	N = 2153	-826 participants fitted with unilateral hearing aids -614 participants fitted with binaural hearing aids	-pre and post fitting tinnitus perception measured using VAS	-Reduction in tinnitus perception following hearing aid fitting. -Tinnitus masked better with DHAs compared to AHAs.	could not be determined
Relaxation training Biesinger et al. ⁵¹	Randomized N = 80	-Relaxation training (n = 40) -waitlist control group (n = 40)	-before and immediately after treatment -1 & 3 months after treatment VAS & TBI-12	-Significant reduction in tinnitus severity, and its impact in relaxation training group	medium effects d = 0.43 (TBI-12)
Weise et al. ⁵²	N = 130 Randomized selection	-Relaxation training (n = 130) -waitlist control group (n = 130)	-before treatment -after 3 months of follow up -after 6 months of follow up	Improvement in tinnitus annoyance, loudness, changes in depressive symptoms & coping cognition observed.	medium effects d = 1.63 (TQ)
Ireland et al. ⁵⁴	Randomized N = 30	-Relaxation training with instruction (n = 15) -control (15)	-pre & post-treatment -after 6 weeks of follow up	No significant effects after relaxation training	small effects d = 0.05 (BDI)

± SD)/ 5.1 ± 2.1/ 6.1 ± 2.5/ 5.8 ± 2.8/ 49.8 ± 21.5 to 51.4 ± 32.1 (P = 0.000)/ 4.4 ± 2.3 (P = 0.053)/ 3.8 ± 2.5 (P = 0.000)/ 4.1 ± 2.7 (P = 0.000)/ 36.1 ± 23.8 (P = 0.000) in individual counselling and from 71.7 ± 28.5/ 5.1 ± 2.2/ 6.0 ± 2.3/ 5.7 ± 2.2/ 47.7 ± 18.4 to 54.6 ± 27.6 (P = 0.000)/ 4.7 ± 2.0 (P = 0.091)/ 4.2 ± 2.0 (P = 0.000)/ 4.4 ± 2.2 (P = 0.000)/ 38.1 ± 19.7 (P = 0.001) in small group counselling. The result indicated that small group counselling of modified TRT can be used effectively for tinnitus relief in crowded otolaryngology clinics.

Malouff et al.²³ in their study examined the efficacy of bibliotherapy in assisting individuals experiencing distress related to tinnitus. They examined the effectiveness of a counselling based self-help book in reducing distress. The post intervention assessment showed significantly less tinnitus-related distress and general distress 2 months later. They maintained a significant reduction in distress on follow-up 4 months after receiving the tinnitus self-help book. Follow up after 1 year also revealed reduced distress. The study concludes that bibliotherapy can provide inexpensive treatment that is not bound by time or place.

Henry et al.²⁴ conducted a randomized clinical trial to see the effect of educational counselling based on TRT principles on the treatment of clinically significant tinnitus on a total of 269 participants. Participants were randomized into one of three groups: educational counselling, traditional support, and no treatment. The

results showed a significant reduction in the mean score of TSI in the educational counselling group after 6 months (p < 0.001) and 12 months (p < 0.001) of treatment, suggesting that the educational counselling significantly benefits many tinnitus patients and can be an integral part of clinical management of tinnitus.

The objective of a study by Hall and Ruth²⁵ was to explore the patient's outcome with consultation as the primary audiologic intervention. THI was used to assess the outcome of consultation on a series of over 200 patients. The results showed that the patient's perception of tinnitus decreased significantly following 6 to 18 months of consultation.

Wilson et al.²⁶ studied critical analysis of directive counselling as a component of TRT. The theoretical and practical problems with TRT were identified. The study suggested the inclusion of randomized, controlled studies with no treatment and placebo condition to be undertaken to claim the efficacy of TRT. Suggestions were made about the role of psychologists and non-psychologists in the provision of counselling and cognitive therapy services to tinnitus patients.

Tinnitus matching and masking for tinnitus therapy

de Barros Suzuki et al.²⁷ evaluated the effectiveness of using sound generators to relieve tinnitus in those patients who were unresponsive to previous drug treatments. Ten individuals with chronic tinnitus were selected. Individuals used sound generators (Reach 62

Table 2: Charting the data of scoping review for review studies.

Author	Title	Methods	Result
Cima et al. ⁵⁷	Cognitive-behavioural treatment for tinnitus: A review of the literature	Review of literature	CBT is effective when compared to no-treatment or alternative treatment control conditions.
Shekhawat et al. ⁵⁸	Role of hearing aids in tinnitus intervention: A scoping review	Review of literature	The weight of evidence suggests the merit of hearing aids in tinnitus treatment but there is still a need for stronger methodology and RCTs in future research.
Hoare et al. ¹²	Systematic review and meta-analysis of randomized controlled trials examining tinnitus management	Review of literature	Interventions most in need of high level evidence studies are hearing aids, sound enrichment and TRT, whereas the efficacy of therapist delivered CBT appears to be reasonably established. Audiologists require new investigation for tinnitus management.
Hobson et al. ⁵⁵	Sound therapy in the management of tinnitus in adults	Review of literature	Sound therapy on its own is of unproven benefit in the treatment of tinnitus. Use of hearing aid improves the hearing handicap and quality of life; however, it is very difficult to determine how much it affects the tinnitus handicap.
Henry et al. ⁵⁹	Using therapeutic sound with progressive audiologic tinnitus management	Review of literature	Hearing aids can benefit participants with tinnitus by masking tinnitus, reducing stress associated with hearing loss. Stimulates auditory system that is deprived of auditory stimulation.
Jastreboff ⁵⁶	Sound therapy for tinnitus management	Review of literature	Sound therapy can be effective in tinnitus intervention, and hearing aids are important tool for offering sound therapy
Henry et al. ³⁰	Clinical Guide for Audiologic Tinnitus Management I: Assessment	Descriptive tinnitus assessment	Article explains each of the assessment components in detail. Concludes that adoption of the ATM assessment protocol by audiologist can contribute to the establishment of uniform procedures for the clinical management of tinnitus patients.
Henry et al. ³⁰	Clinical guide for audiologic tinnitus management II: treatment	Describes audiologic tinnitus management	Hearing aid fitting and use of noise generator forms an integral part of this treatment approach
Henry et al. ³⁰	General review of tinnitus: prevalence, mechanisms, effects and management	Review of literature	Hearing aids lead to tinnitus relief. They can be fitted with the primary purpose of providing tinnitus relief or to offer tinnitus relief as a secondary benefit.

or Mind 9 models) for at least 6 hours daily for 18 months. The patients were evaluated at baseline, after 1 month and at 3 months intervals until 18 months using MML, THI, VAS and HADS. In 9 patients there was a reduction of THI, VAS, HAD score and changes in psychoacoustic characteristics of tinnitus (MML) from baseline to after 18 months. Those who had whistle-type tinnitus showed best response to tinnitus management. Correlation among the adjustments and tinnitus loudness and minimum masking level was found. Only 1 patient who had high indication of depression on HADS did not respond to sound therapy.

Ogut et al.²⁸ evaluated the efficacy of Tinnitus Masking Therapy (TMT) on 42 patients. Average follow up time with TMT was 4.5 months in patients with tinnitus history ranging from 3 to 180 months. THQ & TRQ scores were used to see the progression in relief from tinnitus. On an average, there was a decrease in severity of tinnitus (47.8%), relief from annoyance (55.9%) and decrease in affects of tinnitus on life (67.2%) after three months. Total rate for any degree of relief was 79.3% in normal hearing group, whereas in hearing loss group it remained at 61.2%. These effects were attributed more to residual inhibition or suppression of tinnitus therapy (TMT).

Schaette et al.²⁰ conducted a pilot study to test

the hypothesis that acoustic stimulation treatments with hearing aids and noise devices might be cost-effective when the tinnitus pitch is within the stimulated frequency range. 11 patients received hearing aids and 4 received noise devices. There was a significant reduction in the perceived tinnitus loudness, tinnitus related distress in the patient with low pitch tinnitus, whereas tinnitus loudness was significantly increased after 6 months of treatment in the patient with high-pitched tinnitus. This suggests that tinnitus pitch might influence the outcome of acoustic stimulation treatment, when devices with a limited frequency range such as hearing aids are used.

Davis et al.²⁹ compared the efficacy of the Neuromonics Tinnitus treatment with two control tinnitus treatment protocols: 1) A counselling and support program with delivery of a broadband noise stimulus; 2) A counselling and support program only. TRQ scores were collected before and after 3, 6 and 12 months of treatment in a total of 50 patients. The results showed a significant reduction in the TRQ scores of the Neuromonics group at 3, 6 and 12 months ($p < 0.001$). TRQ scores of the Neuromonics group was significantly better than the scores of the Noise + counselling group ($p = 0.008$) and Counselling only group ($p = 0.014$). VAS also showed

significant benefit in tinnitus severity ($p < 0.001$), general relaxation ($p < 0.001$), tolerance of loud sound ($p < 0.001$) as well as audiometric minimum masking levels (MMLs) ($p < 0.001$) in the Neuromonics tinnitus treatment group. The results suggest that customized Neuromonics supported significantly greater and more consistent alleviation of tinnitus symptoms.

Henry et al.³⁰ studied 123 patients to evaluate the clinical efficacy of tinnitus masking (TM) and tinnitus retraining therapy (TRT) methods. Patients were placed quasi-randomly (alternating placement) into TM group (59, M = 53, F = 6) or TRT group (64 all males). Outcome of treatment were evaluated at baseline, 3, 6, 12 and 18 months by THI, THQ and TSI questionnaires. Findings were presented with respect to three categories of patients, describing tinnitus as a 'moderate', 'big', and 'very big' problem at baseline. Based on effect sizes (which reflect the magnitude of the real treatment effect), both groups showed considerable improvement overall. For patients in TM group who rated their tinnitus as a 'moderate' problem, the effect sizes was 0.18 - 0.59 at 6 months and the effects size did not show any improvement over time. However, for TRT group the effect sizes ranged between 0.01 - 0.37 at 6 months of treatment and increased to 0.57 - 0.66 at 12 months, and 0.77 - 1.26 at 18 months. Patients in TM group who rated their tinnitus as a 'big' problem had effect sizes ranging from 0.46 - 0.86 over time; for TRT group, effect sizes ranged 0.41 - 0.77 for the first 6 months and increased to 1.55 by 18 months. In case of patients who rated their tinnitus as 'very big problem', effect size for those in TM group at 3 months was 1.24 and becoming smaller through 18 months; whereas for those in TRT group, the effect size at 3 months was 0.38 and became increasingly larger through 18 months. Thus it was concluded that TM effect remained fairly constant over time while TRT effects improved incrementally. For the patients with a 'moderate', 'big' and 'very big' problem, TM provided the greatest benefit at 3 and 6 months; however, TRT patients experienced great benefit at 12 months and much greater at 18 months. TM may be more effective for patients in the short term, but with continued treatment TRT may produce the greatest effects.

Sinha and Makar³¹ examined if masking of medical resistant tinnitus at effective masking level or sensational level along with distraction, relaxation, counselling and group discussion would be of any help to reduce tinnitus and its impact on day to day life of patients. Stimulus which was matched with tinnitus (NBN/PT/BBN) was presented to tinnitus ear at MML + 40 dBSL for 30 minutes continuously for 30 sessions. The reduction in tinnitus loudness was measured in terms of RI, where 0% indicated complete RI and anything between 10% and 90% indicated partial RI. Pre and post comparison of RI showed that reduction of tinnitus loudness was seen in all patients and it was more in the group with normal hearing compared to that of the group having SNHL.

Tinnitus Retraining Therapy (TRT) in tinnitus management

To compare the effectiveness of retraining therapy with mixing point masking, total masking and with counselling alone, Tyler et al.³² studied a total of 48 persons divided into three groups. There was improvement observed in 16.7% of the patients from counselling group, 36.4% from the total masking group and 31.6% from the mixing point group. The effect size of within group evaluated after 12 months reflected moderate to large treatment effects. No significant differences were found in improvement rates among groups and among group averages for pre and post 18 months THQ scores.

Bauer and Brozoski³³ attempted to compare the effect of tinnitus retraining therapy on the loudness and annoyance of tinnitus with a control group. An integrated computerized test battery of questionnaires and psychophysical procedures was used to evaluate 43 participants at 6, 12 and 18 months after enrolment. The study showed that both TRT and general counselling without additional sound therapy were effective in reducing the annoyance and impact of tinnitus, with largest effect observed in TRT participants (effect size of 1.13). However, a clinically significant effect was also observed in the control group, with an effect size of 0.78.

Ariizumi et al.³⁴ studied the clinical characteristics which determine candidates for TRT with a sound generator (SG) as well as the prognosis of this treatment in 270 serious tinnitus patients. A significant relief from tinnitus was found in 65.2% of persons after 6 months of initiation of TRT. The Kaplan-Meier method demonstrated an overall efficacy rate at 18 months to be 86.5%. The study concluded that patients with lower loudness of tinnitus were suitable for TRT with a SG.

Seydel et al.³⁵ evaluated an enhanced TRT for 237 patients suffering from chronic tinnitus. Short term and long term changes in stress variable and tinnitus related distress was investigated using TQ, TSQ and ADS. The modified TRT, including Jacobson progressive muscle relaxation, physiotherapy, education via lectures and training of selective attention as well as changes of appraisal, mental attitude and behaviour towards tinnitus was used in the therapy group; scores on the tools were evaluated after 3 months. The therapy results showed significant reduction in both short-term and long-term distress and psychometric stress variables. These differences in psychometric parameters also concerned duration of tinnitus, age and gender, which may explain the different outcome of therapy.

To evaluate long term changes of tinnitus related distress, Caffier et al.³⁶ collected psychometric data on a total of 70 patients with compensated tinnitus (CT) or decompensate tinnitus (DT) during a standardized 2 year outpatient tinnitus-coping therapy. Two groups of patients randomly assigned to a treatment and waiting list control group were evaluated on TQ, VAS, TSQ at beginning,

6 months and after 24 months of therapy with Tinnitus Control Instrument (TCI) and counselling. The result showed a decrease in the tinnitus and tinnitus related distress supporting the benefit of TCI devices in providing quicker rehabilitation.

Cognitive behaviour therapy in tinnitus management

A randomized clinical trial was conducted by Philippot et al.³⁷ on 30 participants in the age range of 35 to 79 years to examine effectiveness of mindfulness based cognitive therapy and relaxation therapy for treating tinnitus. There was a decrease in negative emotion for the mindfulness group (Cohen $d = 1.44$) but not in the relaxation group (Cohen $d = 0.22$). Better results were seen for mindfulness based cognitive therapy than relaxation therapy supporting the use of psychological intervention for tinnitus treatment.

Abbott et al.³⁸ investigated the effectiveness of a therapist-supported Internet intervention program for tinnitus distress in an industrial setting using a cluster randomized design. Fifty six participants were randomly assigned to either a CBT program or an information-only control program. The CBT program was not found to be superior to the information program; however, the findings could not be generalised due to the small sample size and a high attrition rate.

Robinson et al.³⁹ studied a randomized, waitlist-control trial testing the effect of a brief “manualized,” cognitive-behaviour group therapy on distress associated with tinnitus, quality of well-being, psychological distress including depression, and internal focus. 65 participants were randomly assigned to receive 8 weeks of manualized group CBT either immediately or after an 8-week waiting period and outcome measure were completed at 8, 16 and 52 weeks later. The result showed CBT led to greater improvement on tinnitus distress and depression. TRQ scores showed significant changes in the treatment group than in the waitlist condition. BDI score also showed significant changes by time interaction. The results suggest that CBT, in a group format, can reduce the negative emotion, distress, including depression, associated with tinnitus.

A study was done by Andersson et al.⁴⁰ on 23 elderly patients to find the effect of CBT, on a randomized controlled design with a waiting list control group. A CBT treatment package was delivered in six weekly two-hour group sessions and outcome was measured for annoyance, loudness and sleep quality. The results after 3 months treatment showed that the treatment group improved. Anxiety sensitivity index score and mean annoyance rating showed clear interaction effect and significant difference between groups. The result supported the use of group CBT for the elderly with tinnitus.

Hiller and Haerkotter⁴¹ evaluated whether low level white noise generators enhance CBT. Participants with moderate tinnitus received 4 sessions on tinnitus

education and those with severe tinnitus received full 10 session of CBT. Outcome of pre and post treatment were compared at 6 and 18 months. The results showed patients of both treatment groups improved significantly on measures of tinnitus related distress, dysfunctional cognition, general psychopathology, depression and psychological functioning. Use of noise generator had no additional effects. No overall significant difference was found between tinnitus education and CBT sub groups with and without noise generator. The study emphasized the importance of strength of psychological intervention as sound stimulation did not improve the CBT group.

Attention diversion training for tinnitus therapy

Direct attention refers to the ability to focus on stimuli that are important while avoiding distraction by irrelevant stimuli⁴². The tinnitus signal is incorrectly identified as a relevant stimulus allowing tinnitus to be perceived consciously involving the limbic and autonomic nervous system. The mechanism of TRT attempts to “retrain” so that the tinnitus is correctly identified as irrelevant stimulus and is diminished prior to involvement of cortical areas of the brain.

Spizel et al.⁴³ evaluated whether a multisensory attention training paradigm using audio, visual and somatosensory stimulation, would reduce tinnitus. Eighteen participants with predominantly unilateral chronic tinnitus were randomized between 2 groups receiving 20 daily 30 minute sessions of either integration or attention diversion training. The training resulted in small but statistically significant reduction in Tinnitus Functional Index and Tinnitus Severity Numeric Scale score suggesting that a short period of multisensory attention training reduced unilateral tinnitus.

The study by Serchfield et al.⁴⁴ aimed to determine the effectiveness of structural Auditory Objective Identification and Localization tasks to train persons to ignore their tinnitus. A comparison of pitch-matched Tinnitus Loudness Level, Minimum Masking Level and measure of attention was made pre and post auditory training in 10 participants. The results showed significantly lower pitch match MML and loudness, and increase in attention after training. This suggests that short-duration auditory training which actually engages attention, object identification and which requires a response from participants reduces perception of tinnitus.

Hearing Aids in tinnitus intervention

Henry et al.⁴⁵ attempted to collect data to study the effectiveness of combination of hearing aids built in noise generator for tinnitus management compared to hearing aids alone. Thirty individuals initially completed the primary outcome questionnaire TFI and then returned to be fitted with combination instruments. The hearing aid was adjusted to optimize hearing ability and then individuals were randomized to either the experimental group ($n = 15$) or the control group ($n = 15$). The noise feature of the instruments was activated for the experimental group and

adjusted to achieve optimal relief from tinnitus whereas the control group did not have the noise portion activated. All individuals also received tinnitus counselling. Both groups revealed significant improvement after 3 months in TFI scores, as indicated by reductions in mean TFI index scores; however, differences between groups were not statistically significant ($p = 0.09$). But the experimental group showed a mean reduction in the TFI score greater than control group suggesting that a larger group of participants may have resulted in a significant difference between groups. This study suggests that the use of hearing aids alone or hearing aids with noise generators both provide benefit in alleviating tinnitus.

McNeill et al.⁴⁶ in their study assessed the benefit of hearing aids on tinnitus in 70 subjects with tinnitus. Pre and post comparison were done on TRQ score, changes of tinnitus pitch and loudness to check the effect of hearing aid usage on tinnitus. A change in TRQ score was found with Cohen's d effect size of 1.25 after 3 months of HA use. A greater reduction in TRQ score was found for the group of patients reporting total masking of tinnitus by hearing aid and larger treatment effect size for those where tinnitus pitch fell within the frequency range of their hearing aids than for those where it was outside the range. The study supports the use of hearing aid to reduce the audibility of tinnitus and reaction towards tinnitus.

Parazzini et al.⁴⁷ aimed to compare the effectiveness of TRT with sound generators or with open ear HAs in the rehabilitation of tinnitus in a group of persons who were in the borderline of category 1 and 2 according to Jastreboff categories. A total of 91 persons were divided into two groups where half of the persons were fitted binaurally with sound generator and the other half with open ear hearing aids, both groups receiving same educational counselling sessions. THI and VAS showed significant improvement in both tinnitus treatments starting from the first three months and up to one year of therapy, with statistically significant decrease in the disability every three months. The results suggested that tinnitus therapy was equally effective with sound generator or open ear HAs.

Searchfield et al.⁴⁸ carried out a study to quantify the effectiveness of hearing aids and counselling as a tinnitus treatment option. THQ scores were calculated for pre and post intervention in 58 tinnitus patients receiving counselling with hearing aid and without hearing aid. The percentage improvement in total THQ score for the hearing aid group (37%) was approximately twice that of counselling alone group (13%) suggesting that hearing aid had a therapeutic effect in improving tinnitus along with hearing.

Moffat et al.⁴⁹ investigated the effect of hearing aids on the psychoacoustic properties of tinnitus sensation using both conventional amplification and high-bandwidth amplification regimes. There was significant difference observed in tinnitus spectrum in the group fitted with standard amplification than for those in the

group not fitted with HA, after one month of treatment period. The changes observed under conventional, low-to-medium frequency amplification indicated that the perceptual characteristics of tinnitus depended on the pattern of sensory inputs-notably a contrast in activity between adjacent central auditory regions of more and less afferent activity. The tinnitus percept was not at all affected in the high-band width group suggesting limit on the tractability of tinnitus perception.

Trotter and Donaldson⁵⁰ studied the impact of HAs in perception of 2153 patients with subjective tinnitus and hearing loss. A statistically significant improvement was found in tinnitus perception while comparing the effects of analogue hearing aids (AHA) with digital hearing aids (DHA) in both unilaterally ($p < 0.001$) and bilaterally ($p < 0.001$) aided patients. The study supports the use of digital programmable aids in the management of tinnitus.

Relaxation training in tinnitus treatment

Biesinger et al.⁵¹ conducted a randomized controlled trial to evaluate the effect of relaxation intervention on patients with tinnitus. Eighty patients were assigned to an intervention consisting of 10 relaxation training sessions in 5 weeks or to a waiting list control group. A significant reduction in tinnitus severity in both VAS and TBF-12 was found in the relaxation participants group. More pronounced effect of relaxation was seen in patients with somatosensory tinnitus. The findings of the study suggested relaxation intervention to be a useful complement to the therapeutic management of tinnitus.

Weise et al.⁵² investigated the efficacy of a biofeedback-based cognitive behavioural treatment for tinnitus. The treatment was provided to 130 patients for 12 sessions over a 3-month period. The results showed clear improvements in tinnitus annoyance, diary ratings of loudness, feelings of controllability, coping cognitions as well as in depressive symptoms. Improvement was maintained over a 6 months follow-up with medium-to-large effect sizes. The results showed that the treatment leads to clear and stable improvement and is well accepted.

Jakes et al.⁵³ reported the effects of psychological therapy on tinnitus distress in a three factor experiment: (1) progressive muscles relaxation therapy was compared to progressive muscles relaxation therapy combined with "attention-switching" training; (2) comparing of immediate therapy to delayed therapy, (3) comparison of two therapists. The results were discussed in relation to a model of tinnitus-annoyance. The annoyance of tinnitus decreased more rapidly at the beginning of treatment than during orientation period, and continued to decline during therapy. The loudness and the intrusiveness of the tinnitus did not decline during therapy. However, the distress due to tinnitus declined during treatment and also during the orientation phase.

Assessment of subjective tinnitus severity, sleep difficulties, depression and anxiety was done on 30

tinnitus patients receiving either relaxation training with counter demand instructions and no treatment by Ireland et al.⁵⁴ Results showed no significant effect for relaxation training on any measure. Beck Depression Inventory also showed degree of changes to be equivalent for both treated and untreated groups. The study suggests that relaxation training is not an effective treatment for tinnitus.

Review studies

The review studies include seven narrative reviews, one scoping review and one systematic review with meta-analysis. These studies show that research in tinnitus care has been going on for many years and is a challenging task and also there are too few studies to conclusively determine the efficacy of most of the tinnitus interventions recommended for clinical practices. The review studies presented here provide only medium levels of evidence which is largely due to lack of power and incomplete data reporting. It can be observed from the studies that the interventions which needs high-level evidence for establishing their efficacy are tinnitus masking, tinnitus retraining therapy, hearing aids and counselling, excluding cognitive behaviour therapy. Hobson et al.⁵⁵ after reviewing six randomized controlled studies reported that tinnitus masking with hearing aids had a positive impact on a hearing handicap and overall quality of life; however, the role of each approach could not be evaluated effectively. Jastreboff⁵⁶ stressed on the effectiveness of sound therapy in tinnitus intervention, and also on the importance of hearing aids in providing sound therapy. Henry et al.³⁰ focused on the assessment guidelines and the use of Audiologic Tinnitus Management by audiologist in the clinical management of tinnitus.

DISCUSSION

For tinnitus intervention, tinnitus masking, tinnitus retraining therapy, counselling, cognitive therapy and relaxation approaches have been the popular choices of audiologists and psychologists. This scoping review is an attempt to find out evidence to support these approaches for tinnitus management. The studies reported differ based on methodology used, selection of control group, sample size, study design and instruments used to measure treatment outcome. The authors explore the differences in studies to explain why some strategies showed stronger effects compared to others. Thus it represents an evidence based guideline to improve quality of study in future tinnitus research.

Systematic review studies can be rejected based on research methodology; however, in scoping review studies the weakness and areas for improvement can be discussed. Adequate sample size is important in an effective study otherwise small sample sizes may limit generalization of the findings. In this scoping review, sample size was wide ranging: Fourteen studies had between 10 to 50 participants, ten studies had 56 to 150 participants, five studies had 162 to 270, only one study had 2153 participants. Appropriate control group to compare changes of intervention program were

omitted in 22 studies. Randomized and blindness trial are important for evaluation of clinical treatments. There were only 9 randomized control trials, one cluster randomized trial, and 20 blinded trials²⁰⁻⁵⁹.

There is now a reasonable consensus in the tinnitus research community on which validated measures to use. In this review, the most widely used tinnitus questionnaires were the TRQ, QOL, TQ, TSQ, TFL, THI, THQ, VAS, MML, RI, ADS and NTQ. However, there is still little evidence for the efficacy of most recommended treatment strategies. It is striking that many authors ascribed null results for changes in depression and anxiety to the fact that participants have low baseline scores, often quoting floor effects. It may well be that, more distressed individuals are less likely to put themselves forward for clinical trials. However, it may equally be that major depression, sleep disturbance or other co-morbidities are less common than anecdotally suggested. Given that the screening and management of anxiety and depression is high-lighted in the general practitioner guidance, more routine clinical assessment of anxiety and depression at baseline and outcome is needed to explore this observation.

In a scoping review, effects size is an important parameter to explore strength of the study. It was possible to calculate effects size for 30 studies in this scoping review (Table 1). To interpret the effect size, guidelines developed by Cohen²¹ were used. Small to large effects sizes (0.3 to 1.25) were reported for the use of hearing aids along with masking, low to medium for tinnitus matching and masking (0.2 to 0.5), medium to large effects size for cognitive behavioural therapy (0.5 to 1.44), low to medium for attention diversion and counselling therapy (0.2 to 0.5). Therefore, based on these findings it can be drawn that the efficacy of CBT appears reasonably established and the audiologist requires combined approach for better tinnitus management in future.

Although many authors reported clinically as well as statistically significant changes, some limited their reports to the statistical changes only, which may have no real meaning in the clinic. In similar terms, it is also important to note the significance of nonspecific effects. For example, Rief et al.⁶⁰ reported a 5-point reduction in TQ score as a significant improvement compared to waiting-list controls. However, elsewhere in the literature a 5-point reduction in TQ score was observed between two repeated measures, suggesting that this reduction is within the expected variability or test-retest value of the measure. More thorough reporting of clinical and statistical significance, or the provision of individual scores, is recommended for transparency and to facilitate future analyses.

It is difficult to determine the benefits of masking versus counselling versus CBT provided. However, CBT studies showed large effects size. As the 8 studies in the present review involved combined approaches^{22,28,31,33,35,36,38,40} therefore, making it difficult to extract the role of individual intervention approach.

Although counselling with masking with attention diversion appears an appropriate combination for clinical practice.

As reported by Haider et al.⁶¹ and Ralli et al.⁶² somato-sensory modulation of tinnitus is a common feature in tinnitus patients. Here, tinnitus can be evoked or modulated by inputs from the somato-sensory, somato-motor and visual-motor systems, and of somatic tinnitus. In fact, somatic modulation of tinnitus may be associated with underlying somatic disorders. When tinnitus appears to be preceded or strictly linked to a somatic disorder therefore related to problems of the musculoskeletal system rather than that of the ear, it is thereby defined as somatic tinnitus. The identification of those patients who are able to modulate with an underlying somatic disorder playing a role in their tinnitus onset and persistence is important while approaching tinnitus patients. Patients with somatic tinnitus could benefit from further multidisciplinary investigation and intervention and physical therapy too. Therefore, recognition and management of somatic tinnitus plays an important role in tinnitus treatment. In these cases, it is important to seek the cooperation of other specialists, such as dentists, gnathologists, osteopaths, orthopaedics, physiotherapists too. It is required for a second-level evaluation of a possible disorder which might be affecting the non-auditory regions^{43,63}.

This scoping review explores the mechanism by which these approaches are beneficial to participants with tinnitus. The mechanism of TRT suggests the role of limbic and autonomous nervous system in tinnitus. The rationale of TRT is sound habituation through directive counseling to remove any negative thoughts and secondly to remove tinnitus from conscious perception. Sound therapy uses constant low level background noise⁶⁴. The habituation method relies heavily on brain plasticity and the ability of the brain to learn and relearn⁶⁵. A cognitive mechanism increases an adaptive cognition. This may occur through restructuring of maladaptive thought patterns towards tinnitus, correction of misinterpretations, changes in attention focus, and development of adaptive coping thoughts⁶⁶. On tinnitus masking, noise maskers exert an effect through a neural suppression mechanism i.e. interrupting abnormal synchronous activity among networks of neurons in the auditory cortical regions, giving rise to sensation of tinnitus⁶⁷. A combination approach (masking plus counselling plus attention diversion) may be appropriate to tinnitus management by different, potentially complementary, effects.

CONCLUSION

Although the evidence and reviews for tinnitus care and research have been going on for long, there is lack of conclusive data for determining efficacy of most tinnitus management procedures. To provide evidence based conclusion regarding this continues to be a challenge. Cognitive behaviour therapy studies provide high to medium levels of evidence whereas masking, counselling

and TRT stress the need for further research with stronger methodology, randomized control trials and large sample sizes for tinnitus intervention. Audiologists may require new multi-dimension investigation, combined approaches (masking + counselling + attention diversion) in order to deliver specific effective therapy for reduction of tinnitus and its impact.

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