National Institute for Health and Care Excellence

Final

Tinnitus: assessment and management

[I] Evidence review for psychoacoustic measures

NICE guideline NG155

Intervention evidence review

March 2020

Final

This evidence review was developed by the National Guideline Centre

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Local commissioners and providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

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ISBN 978-1-4731-3711-0

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1.1 Review question: Are psychoacoustic measures a clinically and cost-effective method of assessing tinnitus?

1.2 Introduction

Psychoacoustic measures of tinnitus have sometimes been used historically as part of a comprehensive assessment of the experience of tinnitus alongside otoscopy and pure tone audiometry. Psychoacoustic measures commonly include tinnitus pitch and loudness matching, minimal masking levels and residual inhibition and have been used as part of the evaluation of a person's tinnitus, forming a baseline measure against which to monitor the success of the management plan.

Pitch matching has been used to establish the frequency characteristics of tinnitus, which is then adjusted in intensity to match the loudness of the tinnitus. Minimal masking levels have been used as the lowest level at which the tinnitus can be masked by a stimulus, often narrow band noise, broad band noise or a pure tone. Finally, residual inhibition is a phenomenon whereby tinnitus is temporarily reduced after the presentation of masking noise for a short period of time. However, the reliability, validity and usefulness of the clinical data obtained from these psychoacoustic tests are questionable and there are no standardised protocols.

This review was therefore carried out to inform recommendations about whether psychoacoustic measurements are clinically and cost effective for assessing tinnitus.

1.3 PICO table

For full details see the review protocol in appendix A.

Table 1: PICO characteristics of review question

Population	People presenting to a healthcare setting with tinnitus Strata: children/young people and adults
Interventions	Psychoacoustic measures of tinnitus: • Tinnitus pitch matching • Tinnitus loudness matching • Minimal masking level • Residual inhibition
Comparison	No psychoacoustic measures
Outcomes	• Tinnitus severity (critical) Impact of tinnitus (critical): • Tinnitus distress • Tinnitus annoyance Health related QoL(critical): • QoL (tinnitus) • QoL

	Tinnitus percept (important): • Tinnitus loudness Other co-occurring complaints (important): • Depression • Anxiety • Anxiety and depression • Sleep Adverse events (important): • Safety • Tolerability • Side effects
Study design	• Systematic review of RCTs • RCT • If there is an inadequate amount of RCT data, non-randomised comparative studies will be considered.

1.4 Clinical evidence

1.4.1 Included studies

No relevant randomised controlled trial evidence comparing psychoacoustic measures versus no psychoacoustic measures were identified. Consequently, non-randomised comparative studies were also assessed. However, no relevant studies were identified for inclusion.

1.4.2 Excluded studies

See the excluded studies list in appendix I.

1.5 Economic evidence

1.5.1 Included studies

No relevant health economic studies were identified.

1.5.2 Excluded studies

No health economic studies that were relevant to this question were excluded due to assessment of limited applicability or methodological limitations.

See also the health economic study selection flow chart in appendix G.

1.5.3 Unit costs

Most psychoacoustic tests can be performed with a standard audiometer and this equipment will be available in all audiology setting. The unit costs for equipment are listed in Table 2 and the costs for staff requirements in Table 3.

Table 2: UK costs of intervention

Equipment to assess tinnitus	Costs
Audiometer[(a)]	£3068.04
Automated Equipment[(b)]	Costs not found

Source[s]: NHS Supply Chain Catalogue [14]

(a) Primus audiometer, TDH-39 headphones, bone conductor and headphone inserts. GC advised that this equipment was used the most readily in routine practice.

(b) Advised by the committee that this equipment to their knowledge has only been used in research. No price could be found in the NHS Supply Chain catalogue or other data sources.

Table 3: UK cost of staff

Staff Costs[(a)(b)]	Costs
Band 6 Audiologist	£44.00
Band 7 Audiologist	£53.00

Source[s]: Personal Social Service Research Unit [3]

(a) The staff costs are provided as staff time per patient per hour to carry out the assessment by an audiologist. The GC advised that 30 minutes would be an appropriate length of time to conduct a pitch and loudness matching and another 30minutes for residual inhibition, resulting in a total time of 60 minutes.

(b) The costs were derived from the unit costs of community based health care professionals

1.6 Evidence statements

1.6.1 Clinical evidence statements

- No relevant published evidence was identified.

1.6.2 Health economic evidence statements

- No relevant economic evaluations were identified.

1.7 The committee's discussion of the evidence

1.7.1 Interpreting the evidence

1.7.1.1 The outcomes that matter most

Tinnitus distress, annoyance and tinnitus severity were critical outcomes as they were thought to be common factors for people with tinnitus and impact their quality of life. Quality of life (tinnitus-related) and general quality of life were also critical outcomes due to their impact on the person with tinnitus.

Tinnitus loudness, anxiety, depression, sleep, safety, tolerability and side effects were thought to be important outcomes.

We looked for studies that examined whether performing psychoacoustic measures affects the onward management of the person, as measured by the tinnitus related outcomes above. The hypothesis being that with the results of psychoacoustic tests, clinicians may be able to provide the best tailored treatments and therefore improve outcomes for people with tinnitus.

There was no evidence for any outcomes.

1.7.1.2 The quality of the evidence

Randomised controlled trials (RCTs) and systematic reviews of RCTs were searched for and assessed for eligibility but no relevant RCT evidence was identified which matched the review protocol. Consequently, non-randomised comparative studies were also searched for and assessed for eligibility. No relevant non-randomised comparative studies were identified.

1.7.1.3 Benefits and harms

No evidence was identified on psychoacoustic measures. The committee made a consensus recommendation based on their experience, that there is no benefit in performing psychoacoustic measures in addition to standard hearing assessment. The committee believed that the outcome of the tests have little or no impact on routine tinnitus management. The committee noted that psychoacoustic testing is mainly used as a tool in research rather than in clinical practice.

Pitch matching is difficult if there is no tonal element of the tinnitus. Pitch may also vary with fluctuations in severity. Loudness is only one component of severity and is only a snap-shot in time. ‘Masking’ is a terminology and practice that is outdated as studies indicate that successful tinnitus management will be compromised if habituation cannot occur through avoidance by simply covering up one sound with another.

The committee noted the possibility of harm to the person. The tests can cause distress by encouraging a focus on the loudness and pitch of their tinnitus. Continued focus on tinnitus can prevent a person from habituating to it. This can also promote unhelpful self-monitoring and attention on the tinnitus. Many management strategies involve taking away the focus from tinnitus so this may counteract their effectiveness and potentially worsen patient outcomes.

As the information gathered by the tests is not integral to determining the management pathway, these measures were not considered worthwhile. In the rare occasions where the person is very keen to know the characteristics of their tinnitus, psychoacoustic measures may be useful.

These tests are not currently used very often for children and the committee thought that the reasons above and the recommendation were applicable to both adults and children.

1.7.2 Cost effectiveness and resource use

The tests use standard hearing assessment equipment and require staff time. There were no economic evaluations available for this review question. The view of the committee was that psychoacoustic measures would not result in a change in the management of tinnitus. The committee were not aware of any NHS providers that were conducting these tests. However, the committee noted if providers of these tests were to exist there is a potential for modest cost savings. The committee also discussed that in many cases the psychoacoustic measures can result in increased distress for people. With no change in the person’s management and a potential for clinical distress, the committee accepted this intervention would not be cost-effective.

1.7.3 Other factors the committee took into account

The recommendation reflects current best practice where psychoacoustic measures are not used except in cases where the person is particularly focused on discovering the characteristics of their tinnitus. If some departments are using this test routinely it will mean some change in standard practice for these sites, freeing up staff time spent on the tests.

People generally do not wish to undertake tests which do not inform management strategies. A hearing test can be stressful especially when trying to ignore tinnitus. Additional tests focussing on their tinnitus may add to the stress.

These tests are not currently used for children and therefore there is no change in current practice for paediatric services.

References

1. Cahani M, Paul G, Shahar A. Tinnitus pitch and acoustic trauma. Audiology. 1983; 22(4):357-363

2. Chang JE. Using sounds to match and manage tinnitus. Irvine, CA. University of California, Irvine. 2013.

3. Curtis L, Burns A. Unit costs of health and social care 2017. Canterbury. Personal Social Services Research Unit University of Kent, 2017. Available from: https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2017/

4. De Ridder D, Congedo M, Vanneste S. The neural correlates of subjectively perceived and passively matched loudness perception in auditory phantom perception. Brain and Behavior. 2015; 5(5):e00331

5. Hall DA, Mehta RL, Fackrell K. How to choose between measures of tinnitus loudness for clinical research? A report on the reliability and validity of an investigator-administered test and a patient-reported measure using baseline data collected in a phase IIa drug trial. American Journal of Audiology. 2017; 26(3):338-346

6. Hallam RS, Jakes SC, Chambers C, Hinchcliffe R. A comparison of different methods for assessing the 'intensity' of tinnitus. Acta Oto-Laryngologica. 1985; 99(5-6):501-508

7. Harada M, Tamaki K, Ohta F. Loudness matching for tinnitus with constant method: Experiment for reliability of this method using stimulation of tinnitus. Audiology Japan. 1990; 33(3):203-209

8. Henry JA, Fausti SA, Flick CL, Helt WJ, Ellingson RM. Computer-automated clinical technique for tinnitus quantification. American Journal of Audiology. 2000; 9(1):36-49

9. Henry JA, McMillan GP, Thielman EJ, Galvez G, Zaugg TL, Porsov E et al. Evaluating psychoacoustic measures for establishing presence of tinnitus. Journal of Rehabilitation Research and Development. 2013; 50(4):573-584

10. Huang CY, Wu JL, Cheng CC, Sher YJ, Chung KC. Evaluation of the mixing point in tinnitus sound therapy by a psychoacoustic matching protocol with a digital tinnitus evaluation system. journal of oto-rhino-laryngology and its related specialties. 2006; 68(2):110-114

11. Kim TS, Yakunina N, Ryu YJ, Chung IJ, Nam EC. Self-administered tinnitus pitch matching versus a conventional audiometric procedure. Audiology and Neurotology. 2017; 22(1):1-8

12. Kostek B, Poremski T. A new method for measuring the psychoacoustical properties of tinnitus. Diagnostic Pathology. 2013; 8:209

13. National Institute for Health and Care Excellence. Developing NICE guidelines: the manual [Updated October 2018] London. National Institute for Health and Care Excellence, 2014. Available from: https://www.nice.org.uk/process/pmg20/chapter/introduction-and-overview

14. NHS Supply Chain Catalogue. 2018. Available from: http://www.supplychain.nhs.uk/ Last accessed: 05/09/2018

15. Pinkl J, Wilson MJ, Billingsly D, Munguia-Vazquez R. Detailed analysis of high frequency auditory brainstem response in patients with tinnitus: A preliminary study. International Tinnitus Journal. 2017; 21(1):35-43

16. Prestes R, Gil D. Impact of tinnitus on quality of life, loudness and pitch match, and high-frequency audiometry. International Tinnitus Journal. 2009; 15(2):134-138

17. Schecklmann M, Vielsmeier V, Steffens T, Landgrebe M, Langguth B, Kleinjung T. Relationship between audiometric slope and tinnitus pitch in tinnitus patients: insights into the mechanisms of tinnitus generation. PloS One. 2012; 7(4):e34878

18. Tyler RS, Baker LJ. Difficulties experienced by tinnitus sufferers. Journal of Speech and Hearing Disorders. 1983; 48(2):150-4

Appendices

Appendix A: Review protocols

Table 4: Review protocol: Psychoacoustic measures of tinnitus

ID	Field	Content
0.	PROSPERO registration number	Not registered
1.	Review title	Clinical and cost-effective psychoacoustic measures of tinnitus
2.	Review question	What are the most clinically and cost-effective psychoacoustic measures of tinnitus?
3.	Objective	The review aims to evaluate the clinical effectiveness and cost-effectiveness of different methods of psychoacoustic measures of tinnitus that are utilised by different healthcare professionals.
4.	Searches	The following databases will be searched: • Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE • CINAHL, • PsycINFO, Current Nursing and Allied Health Literature Searches will be restricted by: • English language • Human studies • Letters and comments are excluded. Other searches:

		• Inclusion lists of relevant systematic reviews will be checked by the reviewer. The searches may be re-run 6 weeks before final committee meeting and further studies retrieved for inclusion if relevant. The full search strategies will be published in the final review.
5.	Condition or domain being studied	Tinnitus
6.	Population	Inclusion: People presenting to a healthcare setting with tinnitus Strata: • Children/young people (up to 18 years) • Adults Exclusion: None
7.	Intervention/Exposure/Test	Psychoacoustic measures of tinnitus: • Tinnitus pitch matching • Tinnitus loudness matching • Minimal masking level • Residual inhibition
8.	Comparator/Reference standard/Confounding factors	• No psychoacoustic measures
9.	Types of study to be included	• Systematic reviews • RCTs • If there is an inadequate amount of RCT data, non-randomised comparative studies will be considered.
10.	Other exclusion criteria	• Non-English language studies • Studies will only be included if they report one or more of the outcomes listed above • Descriptive (non-comparative) studies will be excluded

11.	Context	N/A
12.	Primary outcomes (critical outcomes)	• Tinnitus severity Impact of tinnitus: • Tinnitus distress • Tinnitus annoyance Health related QoL: • QoL (tinnitus) • QoL
13.	Secondary outcomes (important outcomes)	Tinnitus percept: • Tinnitus loudness Other co-occurring complaints: Depression • Anxiety • Anxiety and depression • Sleep Adverse events: • Safety • Tolerability • Side effects
14.	Data extraction (selection and coding)	EndNote will be used for reference management, sifting, citations and bibliographies. Titles and/or abstracts of studies retrieved using the search strategy and those from additional sources will be screened for inclusion. The full text of potentially eligible studies will be retrieved and will be assessed for eligibility in line with the criteria outlined above. 10% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer. An in-house developed database; EviBase, will be used for data extraction. A standardised form is followed to extract data from studies (see Developing NICE guidelines: the manual section

		6.4) and for undertaking assessment of study quality. Summary evidence tables will be produced including information on: study setting; study population and participant demographics and baseline characteristics; details of the intervention and control interventions; study methodology' recruitment and missing data rates; outcomes and times of measurement; critical appraisal ratings. A second reviewer will quality assure the extracted data. Discrepancies will be identified and resolved through discussion (with a third reviewer where necessary).
15.	Risk of bias (quality) assessment	Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual. For Intervention reviews the following checklist will be used according to study design being assessed: • Systematic reviews: Risk of Bias in Systematic Reviews (ROBIS) • Randomised Controlled Trial: Cochrane RoB (2.0) Disagreements between the review authors over the risk of bias in particular studies will be resolved by discussion, with involvement of a third review author where necessary.
16.	Strategy for data synthesis	Where possible, data will be meta-analysed. Pairwise meta-analyses will be performed using Cochrane Review Manager (RevMan5) to combine the data given in all studies for each of the outcomes stated above. A fixed effect meta-analysis, with weighted mean differences for continuous outcomes and risk ratios for binary outcomes will be used, and 95% confidence intervals will be calculated for each outcome. Heterogeneity between the studies in effect measures will be assessed using the I^2 statistic and visually inspected. We will consider an I^2 value greater than 50% indicative of substantial heterogeneity. Sensitivity analyses will be

		conducted based on pre-specified subgroups using stratified meta-analysis to explore the heterogeneity in effect estimates. If this does not explain the heterogeneity, the results will be presented using random-effects. GRADE pro will be used to assess the quality of each outcome, taking into account individual study quality and the meta-analysis results. The 4 main quality elements (risk of bias, indirectness, inconsistency and imprecision) will be appraised for each outcome. Publication bias is tested for when there are more than 5 studies for an outcome. Other bias will only be taken into consideration in the quality assessment if it is apparent. Where meta-analysis is not possible, data will be presented and quality assessed individually per outcome. If sufficient data is available to make a network of treatments, WinBUGS will be used for network meta-analysis.
17.	Analysis of sub-groups	• People with learning disability or cognitive impairment • Hearing loss • Hyperacusis
18.	Type and method of review	☒ Intervention ☐ Diagnostic ☐ Prognostic ☐ Qualitative ☐ Epidemiologic ☐ Service Delivery ☐ Other (please specify)
19.	Language	English
20.	Country	England
21.	Anticipated or actual start date	27/06/18
22.	Anticipated completion date	11/03/20

23.	Stage of review at time of this submission	**Review stage**	**Started**	**Completed**
		Preliminary searches	☐	☑
		Piloting of the study selection process	☐	☑
		Formal screening of search results against eligibility criteria	☐	☑
		Data extraction	☐	☑
		Risk of bias (quality) assessment	☐	☑
		Data analysis	☐	☑
24.	Named contact	**5a. Named contact** National Guideline Centre **5b Named contact e-mail** Tinnitus@nice.org.uk **5e Organisational affiliation of the review** National Institute for Health and Care Excellence (NICE) and the National Guideline Centre		
25.	Review team members	From the National Guideline Centre: • Dr Jennifer Hill [Guideline lead] • Ms Sedina Lewis/Ms Julie Neilson		

		[Senior systematic reviewers] • Dr Richard Clubbe [Systematic reviewer] • Mr David Wonderling [Health economist lead] • Mr Emtiyaz Chowdhury [Health economist] • Ms Jill Cobb [Information specialist] • Dr Giulia Zuodar [Project manager]
26.	Funding sources/sponsor	This systematic review is being completed by the National Guideline Centre which receives funding from NICE.
27.	Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.
28.	Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: [NICE guideline webpage].
29.	Other registration details	N/A
30.	Reference/URL for published protocol	N/A
31.	Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: • notifying registered stakeholders of publication

		• publicising the guideline through NICE's newsletter and alerts • issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.
32.	Keywords	Tinnitus, psychoacoustic measures, tinnitus matching
33.	Details of existing review of same topic by same authors	N/A
34.	Current review status	☐ Ongoing ☒ Completed but not published ☐ Completed and published ☐ Completed, published and being updated ☐ Discontinued
35..	Additional information	N/A
36.	Details of final publication	www.nice.org.uk

Table 5: Health economic review protocol

Review question	All questions – health economic evidence
Objectives	To identify health economic studies relevant to any of the review questions.
Search criteria	• Populations, interventions and comparators must be as specified in the clinical review protocol above. • Studies must be of a relevant health economic study design (cost–utility analysis, cost-effectiveness analysis, cost–benefit analysis, cost–consequences analysis, comparative cost analysis). • Studies must not be a letter, editorial or commentary, or a review of health economic evaluations. (Recent reviews will be ordered although not reviewed. The bibliographies will be checked for relevant studies, which will then be ordered.) • Unpublished reports will not be considered unless submitted as part of a call for evidence. • Studies must be in English.
Search strategy	A health economic study search will be undertaken using population-specific terms and a health economic study filter – see appendix B below.
Review	Studies not meeting any of the search criteria above will be excluded. Studies

strategy

published before 2003, abstract-only studies and studies from non-OECD countries or the USA will also be excluded.

Each remaining study will be assessed for applicability and methodological limitations using the NICE economic evaluation checklist which can be found in appendix H of Developing NICE guidelines: the manual (2014).[13]

Inclusion and exclusion criteria

- If a study is rated as both 'Directly applicable' and with 'Minor limitations' then it will be included in the guideline. A health economic evidence table will be completed and it will be included in the health economic evidence profile.
- If a study is rated as either 'Not applicable' or with 'Very serious limitations' then it will usually be excluded from the guideline. If it is excluded then a health economic evidence table will not be completed and it will not be included in the health economic evidence profile.
- If a study is rated as 'Partially applicable', with 'Potentially serious limitations' or both then there is discretion over whether it should be included.

Where there is discretion

The health economist will make a decision based on the relative applicability and quality of the available evidence for that question, in discussion with the guideline committee if required. The ultimate aim is to include health economic studies that are helpful for decision-making in the context of the guideline and the current NHS setting. If several studies are considered of sufficiently high applicability and methodological quality that they could all be included, then the health economist, in discussion with the committee if required, may decide to include only the most applicable studies and to selectively exclude the remaining studies. All studies excluded on the basis of applicability or methodological limitations will be listed with explanation in the excluded health economic studies appendix below.

The health economist will be guided by the following hierarchies.

Setting:

- UK NHS (most applicable).
- OECD countries with predominantly public health insurance systems (for example, France, Germany, Sweden).
- OECD countries with predominantly private health insurance systems (for example, Switzerland).
- Studies set in non-OECD countries or in the USA will be excluded before being assessed for applicability and methodological limitations.

Health economic study type:

- Cost–utility analysis (most applicable).
- Other type of full economic evaluation (cost–benefit analysis, cost-effectiveness analysis, cost–consequences analysis).
- Comparative cost analysis.
- Non-comparative cost analyses including cost-of-illness studies will be excluded before being assessed for applicability and methodological limitations.

Year of analysis:

- The more recent the study, the more applicable it will be.
- Studies published in 2003 or later but that depend on unit costs and resource data entirely or predominantly from before 2003 will be rated as 'Not applicable'.
- Studies published before 2003 will be excluded before being assessed for applicability and methodological limitations.

Quality and relevance of effectiveness data used in the health economic analysis:

- The more closely the clinical effectiveness data used in the health economic analysis match with the outcomes of the studies included in the clinical review the

	more useful the analysis will be for decision-making in the guideline.

Appendix B: Literature search strategies

The literature searches for this review are detailed below and complied with the methodology outlined in Developing NICE guidelines: the manual.[13]

For more detailed information, please see the Methodology Review.

B.1 Clinical search literature search strategy

Searches were constructed using a PICO framework where population (P) terms were combined with Intervention (I) and in some cases Comparison (C) terms. Outcomes (O) are rarely used in search strategies for interventions as these concepts may not be well described in title, abstract or indexes and therefore difficult to retrieve. Search filters were applied to the search where appropriate.

Table 6: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline (OVID)	1946 – 02 April 2019	Exclusions
Embase (OVID)	1974 – 02 April 2019	Exclusions
The Cochrane Library (Wiley)	Cochrane Reviews to 2019 Issue 4 of 12 CENTRAL to 2019 Issue 4 of 12 DARE, and NHSEED to 2015 Issue 2 of 4 HTA to 2016 Issue 4 of 4	None
CINAHL, Current Nursing and Allied Health Literature (EBSCO)	Inception – 02 April 2019	Exclusions
PsycINFO (ProQuest)	Inception – 02 April 2019	Exclusions

Medline (Ovid) search terms

1.	Tinnitus/
2.	tinnit*.ti,ab.
3.	1 or 2
4.	letter/
5.	editorial/
6.	news/
7.	exp historical article/
8.	Anecdotes as Topic/
9.	comment/
10.	case report/
11.	(letter or comment*).ti.
12.	or/4-11
13.	randomized controlled trial/ or random*.ti,ab.
14.	12 not 13
15.	animals/ not humans/
16.	exp Animals, Laboratory/
17.	exp Animal Experimentation/

18.	exp Models, Animal/
19.	exp Rodentia/
20.	(rat or rats or mouse or mice).ti.
21.	or/14-20
22.	3 not 21
23.	limit 22 to English language

Embase (Ovid) search terms

1.	tinnitus/
2.	tinnit*.ti,ab.
3.	1 or 2
4.	letter.pt. or letter/
5.	note.pt.
6.	editorial.pt.
7.	Case report/ or Case study/
8.	(letter or comment*).ti.
9.	or/4-8
10.	randomized controlled trial/ or random*.ti,ab.
11.	9 not 10
12.	animal/ not human/
13.	Nonhuman/
14.	exp Animal Experiment/
15.	exp Experimental animal/
16.	Animal model/
17.	exp Rodent/
18.	(rat or rats or mouse or mice).ti.
19.	or/11-18
20.	3 not 19
21.	limit 20 to English language

Cochrane Library (Wiley) search terms

#1.	MeSH descriptor: [Tinnitus] explode all trees
#2.	tinnit*:ti,ab
#3.	#1 or #2

CINAHL (EBSCO) search terms

S1.	(MH "Tinnitus")
S2.	(MH "Tinnitus Retraining Therapy")
S3.	tinnit*
S4.	S1 OR S2 OR S3
S5.	PT anecdote or PT audiovisual or PT bibliography or PT biography or PT book or PT book review or PT brief item or PT cartoon or PT commentary or PT computer program or PT editorial or PT games or PT glossary or PT historical material or PT interview or PT letter or PT listservs or PT masters thesis or PT obituary or PT pamphlet or PT pamphlet chapter or PT pictorial or PT poetry or PT proceedings or PT “questions and answers” or PT response or PT software or PT teaching materials or PT website
S6.	S4 NOT S5

PsycINFO (ProQuest) search terms

1.	((MAINSUBJECT.EXACT.EXPLODE("Tinnitus") OR tinnit*) NOT (su.exact.explode("rodents") OR su.exact.explode("mice") OR (su.exact("animals") NOT (su.exact("human males") OR su.exact("human females"))) OR ti(rat OR rats OR mouse OR mice))) AND la.exact("ENG")Limits applied

B.2 Health Economics literature search strategy

Health economic evidence was identified by conducting a broad search relating to the tinnitus population in NHS Economic Evaluation Database (NHS EED – this ceased to be updated after March 2015) and the Health Technology Assessment database (HTA) with no date restrictions. NHS EED and HTA databases are hosted by the Centre for Research and Dissemination (CRD). Additional searches were run on Medline and Embase for health economics and quality of life studies.

Table 7: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline	2002 – 02 March 2019	Exclusions Health economics studies Quality of life studies
Embase	2002 – 02 March 2019	Exclusions Health economics studies Quality of life studies
Centre for Research and Dissemination (CRD)	HTA - Inception – 31 Mar 2018 NHSEED - Inception to March 2015	None

Medline (Ovid) search terms

1.	Tinnitus/
2.	tinnit*.ti,ab.
3.	1 or 2
4.	letter/
5.	editorial/
6.	news/
7.	exp historical article/
8.	Anecdotes as Topic/
9.	comment/
10.	case report/
11.	(letter or comment*).ti.
12.	or/4-11
13.	randomized controlled trial/ or random*.ti,ab.
14.	12 not 13
15.	animals/ not humans/
16.	exp Animals, Laboratory/
17.	exp Animal Experimentation/
18.	exp Models, Animal/
19.	exp Rodentia/
20.	(rat or rats or mouse or mice).ti.
21.	or/14-20

22.	3 not 21
23.	limit 22 to English language
24.	Economics/
25.	Value of life/
26.	exp "Costs and Cost Analysis"/
27.	exp Economics, Hospital/
28.	exp Economics, Medical/
29.	Economics, Nursing/
30.	Economics, Pharmaceutical/
31.	exp "Fees and Charges"/
32.	exp Budgets/
33.	budget*.ti,ab.
34.	cost*.ti.
35.	(economic* or pharmaco?economic*).ti.
36.	(price* or pricing*).ti,ab.
37.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
38.	(financ* or fee or fees).ti,ab.
39.	(value adj2 (money or monetary)).ti,ab.
40.	or/24-39
41.	quality-adjusted life years/
42.	sickness impact profile/
43.	(quality adj2 (wellbeing or well being)).ti,ab.
44.	sickness impact profile.ti,ab.
45.	disability adjusted life.ti,ab.
46.	(qal* or qtime* or qwb* or daly*).ti,ab.
47.	(euroqol* or eq5d* or eq 5*).ti,ab.
48.	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
49.	(health utility* or utility score* or disutilit* or utility value*).ti,ab.
50.	(hui or hui1 or hui2 or hui3).ti,ab.
51.	(health* year* equivalent* or hye or hyes).ti,ab.
52.	discrete choice*.ti,ab.
53.	rosser.ti,ab.
54.	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
55.	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
56.	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
57.	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
58.	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
59.	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
60.	or/41-59
61.	23 and (40 or 60)

Embase (Ovid) search terms

1.	tinnitus/
2.	tinnit*.ti,ab.

3.	1 or 2
4.	letter.pt. or letter/
5.	note.pt.
6.	editorial.pt.
7.	Case report/ or Case study/
8.	(letter or comment*).ti.
9.	or/4-8
10.	randomized controlled trial/ or random*.ti,ab.
11.	9 not 10
12.	animal/ not human/
13.	Nonhuman/
14.	exp Animal Experiment/
15.	exp Experimental animal/
16.	Animal model/
17.	exp Rodent/
18.	(rat or rats or mouse or mice).ti.
19.	or/11-18
20.	3 not 19
21.	health economics/
22.	exp economic evaluation/
23.	exp health care cost/
24.	exp fee/
25.	budget/
26.	funding/
27.	budget*.ti,ab.
28.	cost*.ti.
29.	(economic* or pharmaco?economic*).ti.
30.	(price* or pricing*).ti,ab.
31.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
32.	(financ* or fee or fees).ti,ab.
33.	(value adj2 (money or monetary)).ti,ab.
34.	or/21-33
35.	quality adjusted life year/
36.	"quality of life index"/
37.	short form 12/ or short form 20/ or short form 36/ or short form 8/
38.	sickness impact profile/
39.	(quality adj2 (wellbeing or well being)).ti,ab.
40.	sickness impact profile.ti,ab.
41.	disability adjusted life.ti,ab.
42.	(qal* or qtime* or qwb* or daly*).ti,ab.

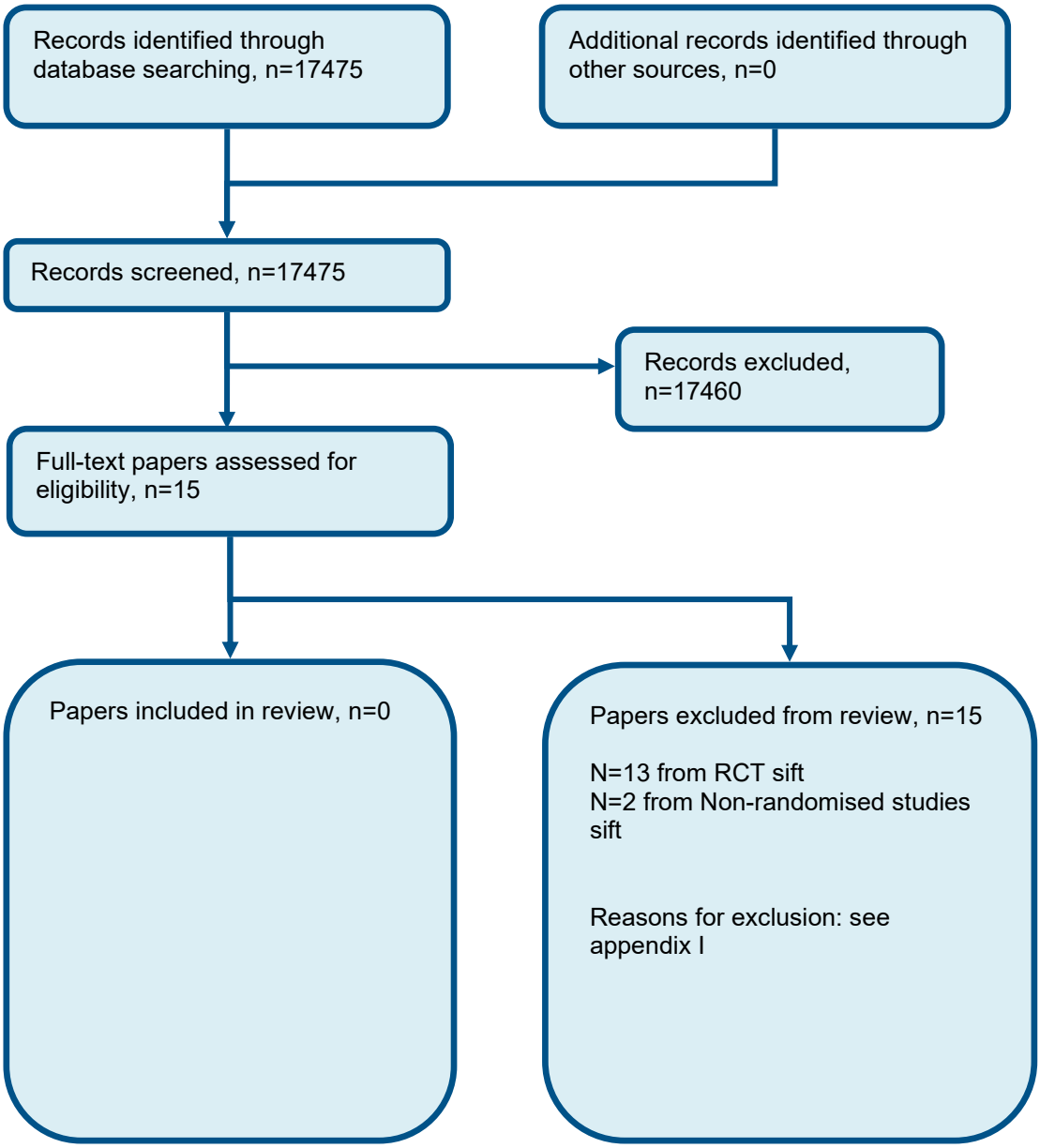
43.	(euroqol* or eq5d* or eq 5*).ti,ab.
44.	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
45.	(health utility* or utility score* or disutilit* or utility value*).ti,ab.
46.	(hui or hui1 or hui2 or hui3).ti,ab.
47.	(health* year* equivalent* or hye or hyes).ti,ab.
48.	discrete choice*.ti,ab.
49.	rosser.ti,ab.
50.	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
51.	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
52.	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
53.	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
54.	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
55.	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
56.	or/35-55
57.	20 and (34 or 56)
58.	limit 57 to English language

NHS EED and HTA (CRD) search terms

#1.	MeSH DESCRIPTOR Tinnitus EXPLODE ALL TREES
#2.	(tinnit*)
#3.	#1 OR #2

Appendix C: Clinical evidence selection

Figure 1: Flow chart of clinical study selection for the review of Psychoacoustic measures



Appendix D: Clinical evidence tables

No clinical evidence found.

Appendix E: Forest plots

E.1 Psychoacoustic measures

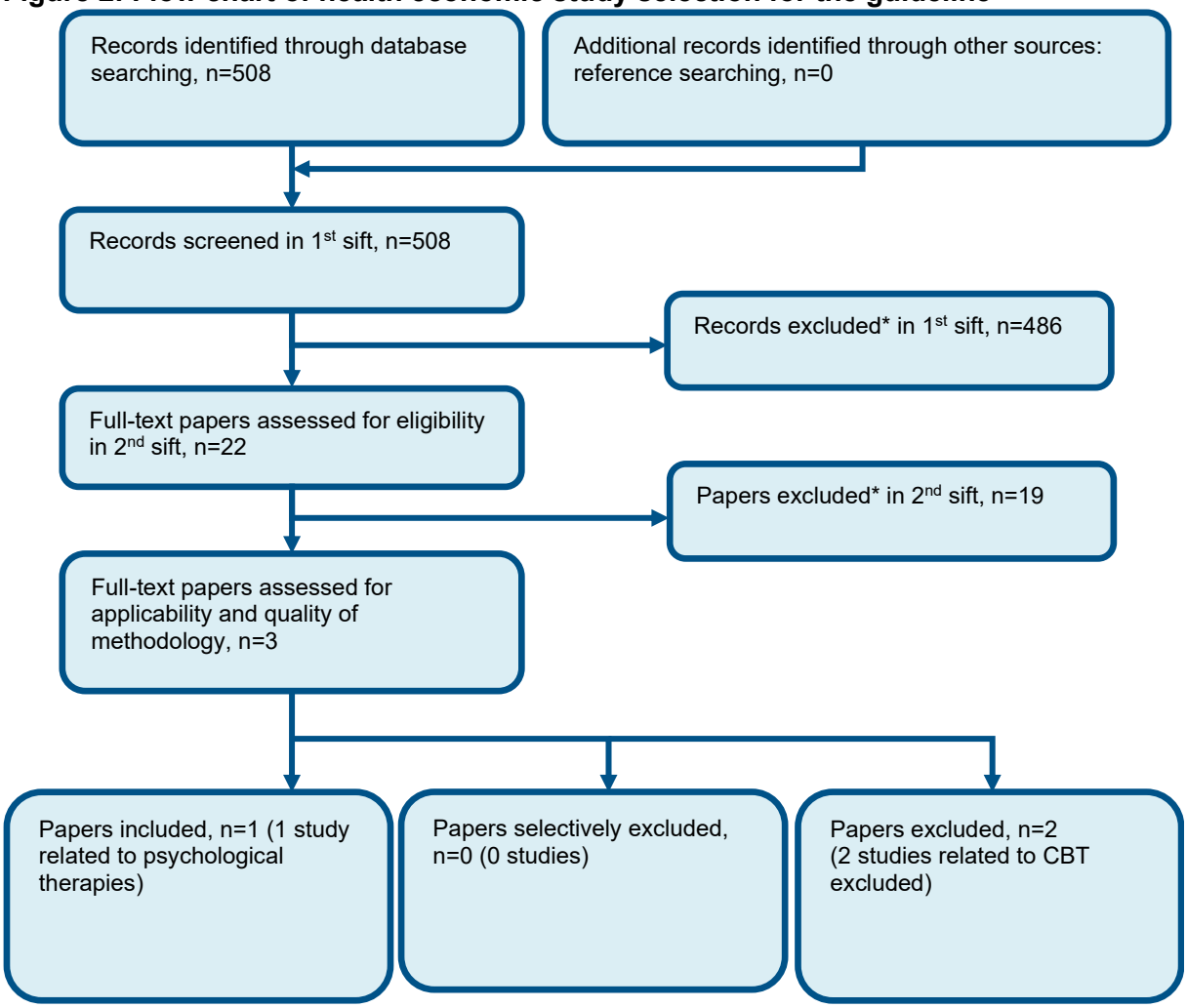
No clinical evidence.

Appendix F: GRADE tables

No clinical evidence found.

Appendix G: Health economic evidence selection

Figure 2: Flow chart of health economic study selection for the guideline



* Non-relevant population, intervention, comparison, design or setting; non-English language

Appendix H: Excluded studies

H.1 Excluded clinical studies

Table 8: Studies excluded from the clinical review

Reference	Reason for exclusion
Cahani 1983[1]	Incorrect comparison – different types of pitch matching. Non-randomised study.
Chang 2013[2]	Incorrect comparison – two different types of computer-based tinnitus matching compared to a standard 'classic' tinnitus matching method.
De Ridder 2015[4]	Incorrect comparison – compared to tinnitus loudness. Non-randomised study.
Hall 2017[5]	Incorrect comparison – tinnitus loudness rating versus tinnitus loudness matching test. Non-randomised study.
Hallam 1985[6]	Incorrect comparison – various psychoacoustic measures. Non-randomised study.
Harada 1990[7]	Not English language. Non-randomised study.
Henry 2000[8]	Incorrect comparison – tone-matching versus pitch-matching. Non-randomised study.
Henry 2013[9]	Incorrect comparison – various psychoacoustic measures. Non-randomised study.
Huang 2006[10]	Incorrect comparison - Psychoacoustic matching protocol with a digital tinnitus evaluation system. Non-randomised study.
Kim 2017[11]	Incorrect comparison – computer-based self-administered tinnitus pitch-matching versus a conventional audiometric procedure (CAP). Non-randomised study.
Kostek 2013[12]	Incorrect comparison – audiometer versus synthesiser. Non-randomised study.
Pinkl 2017[15]	Incorrect comparison – normal hearing versus hearing loss. Non-randomised study.
Prestes 2009[16]	Incorrect comparison all participants had pitch-matching, it compared those with and without hearing loss. Non-randomised study.
Schecklmann 2012[17]	Incorrect comparison - tinnitus pitch-match compared to frequency of maximum hearing loss and the edge of the audiogram. Non-randomised study.
Tyler 1983[18]	Incorrect comparison – different methods of pitch matching. Non-randomised study.

Appendix I: Excluded health economic studies

None.