Review Article

Wideband Acoustic Immittance Patterns in Enlarged Vestibular Aqueduct: A Systematic Review and Meta-Analysis

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Short running title: Wideband Acoustic Immittance Patterns in…

Highlights:
- EVA results in a mixed hearing loss profile and altered WAI metrics
- Significant difference in RF values indicate a diagnostic potential for EVA
- WAI can be used as a non-invasive tool for assessment in adjunction to imaging

ABSTRACT

Background and Aim: Wideband Acoustic Immittance (WAI) is shown to have superior accuracy in diagnosis of middle ear diseases compared to conventional audiometric measurements. Recent studies have focused on investigating its utility in diagnosis of Enlarged Vestibular Aqueduct (EVA). However, the findings have been different across studies. This study pools the existing evidence on WAI findings in patients with EVA.
Recent Findings: A comprehensive search was performed in different databases up to October, 2025. A total of eight studies, including 645 ears, met the inclusion criteria, and seven studies were included in the meta-analysis. Ears with EVA had a significantly lower resonance frequency Mean Difference (MD):-174.7; 95% Confidence Interval (95%CI):-221.3,-128.0; $p<0.001$), and a variable wideband absorbance curve configuration. Significant but narrow differences were identified in the absorbance values at middle and high frequencies. Absorbance at 8000 Hz under ambient pressure presented the most evident difference in EVA compared to controls (MD:0.13; 95% CI:0.06-0.19; $p<0.001$). In children, absorbance at 8000 Hz under peak pressure was significantly different between EVA and healthy ears (MD:0.08; 95%CI:0.05-0.12; $p<001$), but the data on ambient pressure was insufficient in this age group. Despite statistical differences, the clinical significance of these findings warrants further investigations with larger sample size.
Conclusion: WAI provides useful information about EVA-related changes in middle and inner-ear mechanics and presents significant differences between EVA and control, but additional studies are needed before it can be recommended as a screening or diagnostic tool.
Keywords: Enlarged vestibular aqueduct; large vestibular aqueduct; wideband tympanometry; wideband acoustic immittance; resonance frequency

Introduction

Enlarged Vestibular Aqueduct (EVA) is one of the most common inner ear malformations and an important cause of congenital Sensorineural Hearing Loss (SNHL). Mutations in the *SLC26A4* gene are the primary known genetic cause of non-syndromic EVA, but other unidentified genetic loci may also be involved [1, 2]. Biallelic variants in the *SLC26A4* gene cause Pendred syndrome. EVA can also occur as a part of multiorgan syndromes, including branchio-oto-renal syndrome, Waardenburg's syndrome and distal renal tubular acidosis [3]. EVA is predominantly bilateral and may be associated with incomplete partition of the cochlea [4]. EVA is characterized by childhood-onset progressive SNHL and/or sudden drops in hearing, with or without fluctuations [5-7]. A subset of patients may also experience vestibular symptoms, including episodic vertigo, dizziness and/or imbalance [6].
Temporal bone Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) are typically used for a definitive diagnosis of EVA. Additionally, some criteria are used for the diagnosis of EVA: 1) Classic Valvassori criteria defines a midpoint width of >1.5 mm as diagnostic for EVA; 2) Cincinnati criteria include a midpoint width of ≥1 mm or an opercular width of ≥2 mm as diagnostic for EVA; and 3) 45° oblique plane considered a midpoint width of >0.5 mm as EVA [8-11]. Also, air-bone gaps with normal tympanogram and acoustic reflexes can be suggestive of EVA. However, there is a main problem with employing classic audiological measurements to diagnose EVA. They cannot differentiate EVA from other causes of SNHL such as Superior Canal Dehiscence Syndrome (SCDS), Meniere's disease, and so on [7, 8, 10, 11]. It has been shown that Vestibular Evoked Myogenic Potentials (VEMP) can support the findings of imaging in patients with EVA and can even reduce the time required to clarify the diagnosis [12]. The severity of hearing loss in patients with EVA ranges from mild to profound [13]. However, the association between Vestibular Aqueduct (VA) width and severity of hearing loss is inconsistent [5, 14-16].
Wideband Acoustic Immittance (WAI or Wideband tympanometry) measures middle-ear absorbance over a wide range of stimuli frequencies (typically 226-8000 Hz) and pressures. Additionally, WAI measures Resonance Frequency (RF), which is defined as the frequency at which the mass and stiffness effects of the tympanic membrane are equal [17]. WAI is shown to have superior accuracy in the diagnosis of middle ear diseases compared to conventional audiometric measurements, and is being evaluated for the diagnosis of inner ear pathologies recently [18-20]. It is proposed that the increased inner ear pressure in EVA functions as a "pathologic third window" in the

middle ear and reduces the mobility of the stapes footplate [21, 22]. This may explain the conductive hearing loss component in EVA and highlights the potential of impedance and transfer function studies, such as WAI, in the non-invasive diagnosis of EVA [22].

Recent studies have focused on investigating the utility of WAI in the diagnosis of inner ear pathologies, including EVA. However, the findings of WAI in patients with EVA have been different across studies. This systematic review and meta-analysis aimed to systematically review and quantitatively synthesize the evidence on RF and WBA patterns in EVA compared to controls, in children and adults, and guide future studies on their diagnostic performance.

Methods

Study design and selection criteria

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [23]. The Population, Intervention, Comparison, and Outcome (PICO) statement was used to define the main question of this review as follows: Population: Patients with EVA; Intervention: None; Comparison: Healthy control; Outcome: WAI parameters. A comprehensive search was conducted in PubMed/Medline, Scopus, Embase, Google Scholar, Cochrane Central Register of Controlled Trials and Web of Science (Search term examples are provided in Table 1). Titles and abstracts were screened by two independent investigators and any disagreement was resolved through consensus. Reference lists of relevant studies were manually screened to ensure literature saturation. Full-texts were carefully evaluated and studies were included if they met all of the following criteria: 1) cross-sectional or case control studies reporting on children or adults with EVA diagnosed with CT or MRI and appropriate criteria; and 2) reported at least one WAI-related outcome of interest, including Wideband Absorbance at Peak Pressure (WBA-PP), WBA at Ambient pressure (WBA-A), resonance frequency, or absorbance curve characteristics. Studies were considered eligible for the meta-analysis if a control group with healthy ears was recruited. No restrictions regarding geographical locations, age brackets, or publication date were considered. Non-English studies, single-arm studies, studies of EVA patients without WAI data, review studies, animal studies, letters, conference abstracts, case series with fewer than five patients, books, personal opinions, and case reports were excluded. A summary of the selection process is provided in Figure 1. If multiple studies enrolled the same population, the most comprehensive one was chosen, prioritizing those with larger sample size and data collected over a longer period.

Risk of bias assessment and data extraction

All included studies were evaluated for risk of bias using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool for the quality assessment of diagnostic accuracy studies [24]. The QUADAS-2 checklist consists of four domains; patient selection, index test, reference standard and flow and timing. Each section has estimation of risk of bias and concerns regarding applicability. Relevant information including sample size, country, patients' demographics, hearing level, radiologic criteria and diagnosis, and WAI measures were extracted by two independent reviewers. WAI parameters of interest were WBA-PP, WBA-A at six frequencies, maximum absorbance, and RF. Absorbance curve patterns were also included for qualitative synthesis.

Statistical analysis

Categorical variables are reported with number and frequencies, and continuous variables are reported with mean±Standard Deviation (SD) or median and Interquartile Range (IQR). Ambient and peak pressure absorbance at these six frequencies were compared between EVA and control using ten separate random-effects models. Another random-effects model was fitted to estimate the mean difference of RF between the two groups. Where not directly provided in manuscript, mean and SD values were estimated from absorbance curves with digitization methods by two independent reviewers. A subgroup analysis was performed for peak pressure absorbance only including studies on the pediatric population. Heterogeneity was evaluated using the restricted maximum likelihood estimator of τ^2, Cochran's Q and I^2 statistics. Publication bias was assessed via funnel plots and Egger's test. Sensitivity analyses were performed via sequential omission of studies and assessing the residual heterogeneity and pooled effect size.

All analyses were conducted in R version 4.1.2. (Vienna, Austria) using the *metafor* package [25]. A two-sided p-value of less than 0.05 was deemed significant.

Results

Characteristics of included studies

After screening, a total of eight studies, including 351 participants and 645 ears (294 with EVA and 351 control), remained in the study. They were from China, USA, and Japan from 2019 to 2025. Their sample size ranged from 13 (n=24 ears) to 88 (n=159 ears). One study on children lacked a control group and was thus excluded from the meta-analysis [26]. Of the remaining seven studies, three were performed on the pediatric population [27-29], two focused on adults [30, 31], and two included both age groups [32, 33]. The majority of ears with EVA across all included studies had severe to profound hearing loss (>70 dB). Baseline characteristics and findings of these studies are summarized in Table 1. All studies were estimated to have a low overall risk of bias using the QUADS-2 checklist.

Wideband acoustic immittance findings

Resonance frequency

Four studies (n=438 ears) compared the mean RF between EVA and control [27, 29, 31, 33]. Meta-analysis of these studies indicated that the mean RF of EVA was 174.7 Hz lower than control (95% CI:128-221.3), which was statistically significant ($p<0.001$). No significant heterogeneity or publication bias was identified (Figure 2A, Figure 1).

Wideband absorbance

Almost all studies reported visually different absorbance curves between EVA and control subjects. The most consistent finding was the lower absorbance of ears with EVA at middle frequencies (~1000-2000 Hz) and higher absorbance at high frequencies (>6000 Hz) compared to control. Absorbance curves of each study and the pooled curve in peak and ambient pressure is illustrated in Figure 2.

Absorbance rates were statistically compared between EVA and control at 226, 500, 1000, 2000, 4000 and 8000 Hz. Small but significant differences were found in WBA-PP at 226, 2000, and 8000 Hz, and in WBA-A at 2000 and 8000 Hz (Table 2). The pooled absorbance curve at peak pressure showed that absorbance of ears with EVA is higher than control at extreme frequencies, but lower at middle frequencies (Figure 2B). The same pattern was observed for ambient pressure, with less pronounced differences at low and middle frequencies, and more pronounced differences at high frequencies (Figure 2C). Nonetheless, a significant difference in between-study heterogeneity was observed in the analysis of middle and high frequencies. No significant publication bias was identified, except for WBA-A at 500 Hz (Figure 1).

Wideband absorbance in children

Three studies focused on pediatric subjects and compared WBA between EVA and control. WBA-PP of EVA was higher in lower and upper ends of the frequency range, and the difference was significant at 8000 Hz (Figure 2D). Considerable heterogeneity was observed with no publication bias. Only two studies presented WBA-A in children, therefore no meta-analysis was performed for this subgroup. Both studies demonstrated a pattern similar to WBA-PP, with higher absorbance of EVA at low and high frequencies.

Discussion

This systematic review and meta-analysis are the first comprehensive synthesis to evaluate the diagnostic utility of WAI in patients with EVA. Our pooled results demonstrate that WAI parameters, particularly RF, are significantly altered in ears with EVA compared to healthy controls. While absorbance curves show visible variation, the size of the difference is rather small and may not have clinical significance.

RF is largely determined by the mass and stiffness effects of the inner ear. A higher RF could be a result of increased stiffness or decreased mass [34]. EVA creates a connection between the endolymph and the Cerebrospinal Fluid (CSF), a "third window", which shunts the acoustic energy away from the cochlea. This third window decreases the

inner ear impedance and increases the endolymphatic volume [35]. On the other hand, increased endolymphatic pressure limits the mobility of the stapes and increases stiffness, which should theoretically increase RF. The robust finding of a lower RF in EVA demonstrated in this meta-analysis supports the hypothesis that increased volume and shunting of acoustic energy exerts a stronger impact compared to increased pressure and stiffness. A decreased RF is also reported in SCDS, another third window pathology of the inner ear [20, 36]. Many studies have found a decreased RF in Ménière's disease, as well; however, a meta-analysis found no statistical significance in this difference [37-39]. This could be explained via the different pathophysiology of Ménière's disease and EVA/SCDS. Ménière's disease is associated with endolymphatic hydrops and increased pressure in a closed lumen, while EVA and SCDS are characterized by a pathological opening and shunting of energy [22, 40]. Nonetheless, RF is result of complex mechanics of inner and middle ears, and a combination of different factors are most likely implicated in the observed difference. Regardless of the mechanism, the considerable reduction of RF in ears with EVA could be a valuable diagnostic tool. Ganaha et al. have shown that RF, with a cut-off value of 888 Hz can diagnose EVA in adults and children with good sensitivity and specificity [33]. Nonetheless, its accuracy in differentiating EVA from other inner ear diseases remains unknown.

Unlike RF, the results of WBA in EVA are inconsistent, and mostly insignificant. The pooled WBA curves revealed lower absorbance of ears with EVA at middle frequencies and higher absorbance at the extreme ends of the spectrum. The pattern was similar but more pronounced in peak pressure. The middle ear is stiffness-controlled below the RF, and mass-controlled above the RF [34]. Ears with EVA are relatively more mass-dominated, which could partly explain the increased absorbance at high frequencies. While air conduction is reduced, bone conduction is improved due to the decreased impedance of the inner ear, creating the air-bone gap observed in patients with EVA [40]. WAI in Ménière's disease have shown decreased absorbance at low and middle frequencies, and no significant difference at high frequencies [37, 39]. A recent study by Jiang et al. demonstrated that WBA-PP is significantly different between EVA and Ménière's disease at middle to high (1000-1260, 3175-4000 Hz) frequencies [31]. Studies on SCDS have also illustrated different absorbance configurations with reduced absorbance at lower frequencies [20, 36]. Janky et al. have shown that ears with EVA are more likely to present with a "low frequency peak" in WBA curves [32]. The differences between WBA curves in EVA with SCDS and Ménière's disease suggests that other factors may be involved in the altered transfer function of the middle ear besides the third window phenomenon. Pooled absorbance curves showed significant differences in absorbance at 8000 Hz in both peak and ambient pressure. Zhang et al. have also demonstrated that absorbance at 8000 Hz is significantly different regardless of the probe pressure [30]. Another study on children showed that absorbance patterns in high frequencies are even significantly different between EVA and incomplete partition of the cochlea [27]. Although not replicated in many studies, these findings may indicate a potential diagnostic value for high frequency tympanometry, which warrants further investigation.

Despite these significant findings, WBA results showed considerable between-study heterogeneity and should be interpreted cautiously. This could be primarily attributed to the differing age groups and variable severity of conductive and SNHL among studies, as well as minor differences in inclusion criteria, imaging modalities, VA size and measurement protocols. The characteristics and calibration of WAI probes and variable analysis software, as well as differences in middle ear and ear canal acoustic properties between children and adults are among the potential contributors to the heterogeneity. Importantly, most studies pooled ears rather than individuals, overlooking potential correlations between ears in bilateral disease.

There are some main challenges with employing the imaging modalities to diagnose malformations including cost, availability, radiation exposure of CT, and requiring sedation or even general anesthesia in most young children. Therefore, some efforts have been made to find novel, non-invasive and widely available alternatives for the diagnosis of inner ear malformations. WAI and VEMP are the most commonly investigated tools, with generally inconsistent results [41-43]. Future studies are warranted to determine the clinical and diagnostic value of WAI patterns in EVA and calculate optimal cut-off values. With the current evidence, WAI is not a comparable alternative to CT/MRI, but may serve as potentially valuable tool for early non-invasive screening and selection of patients for definitive radiologic diagnosis. Given the progressive and fluctuating nature of EVA, WAI could also be used in monitoring of patients and determining the optimal timing of cochlear implantation [44]. Implementation of machine learning algorithms and scoring systems might be useful to detect the complex and diverse patterns of wideband absorbance and combine them with clinical information to optimize the diagnostic accuracy.

This study had some limitations that need to be considered. First, baseline characteristics of the included population was highly variable, resulting in statistically significant heterogeneity. The most important source of heterogeneity is probably the differing age groups and degrees of hearing loss severity as well as differences in technical and analytical aspects of measurement, including a variability in utilized diagnostic modality and criteria. Second, we were not able to perform subgroup analyses due to the small sample sizes of studies and lack of individual-level data. Third, estimation of absorbance values from digitalized curves may be associated with less accuracy and possible changes in pooled estimates. Finally, the value of WAI for the screening or diagnosis of EVA should be quantified in diagnostic accuracy studies with determining the sensitivity and specificity, and be compared to other non-radiologic diagnostic measures.

Conclusion

This meta-analysis demonstrates that Wideband Acoustic Immittance (WAI) is an objective and non-invasive tool for identifying the biomechanical signature of Enlarged Vestibular Aqueduct (EVA) in the middle ear. EVA alters the impedance and mass-stiffness effects of the middle ear via creating a third window, which results in a mixed hearing loss profile and altered WAI metrics. Significant difference in resonance frequency values, indicate a diagnostic potential, if replicated in future studies. While WAI cannot be considered as an alternative to imaging studies or a standalone diagnostic modality, it can be used as a non-invasive tool for assessment in adjunction to imaging as well as disease monitoring. Moreover, WAI could be used to investigate other inner ear diseases and differential diagnoses. Further investigations are needed to determine the sensitivity, specificity and optimal cut-off values of WAI parameters in EVA, and other inner ear malformations.

Ethical Considerations

Funding

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Authors' contributions

SA: Conceptualization, methodology, investigation, data curation, writing-original draft, project administration, and approving final draft; ZR: Data curation, formal analysis, writing-original draft, and approving final draft; BJR: Conceptualization, writing-review and editing, supervision, and approving final draft; YHM: Investigation, data curation, and approving final draft; SS: Investigation, data curation, and approving final draft; YN: Writing-review and editing, and approving final draft; KA: Conceptualization, methodology, writing-review and editing, supervision, and approving final draft.

Data availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Conflict of interest

No potential conflict of interest was reported by the author(s).

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Table 1. Characteristics of the included studies

Study	Year	Country	Ears (N)	% female	Age group	EVA hearing level (dB)	Results
Jiang et al. [31]	2026	China	EVA: 9 (18) Control: 9 (18)	11.1%	Adults	All>70	Propensity score matching for baseline characteristics was performed. EVA group had lower WBA-PP at 1000-2520 Hz. WBA-PP were comparable at the extremes of the frequency range. EVA had significantly lower RF compared to controls. WAI is able to distinguish EVA and controls with ROC=0.932.
Janky et al. [32]	2025	USA	EVA: 10 (14) Control: 15 (29)	EVA: 50 Control: 73.3	All	52.4 (range: 8.75–118.75)	Ears with EVA had lower absorbance at 250–397 and 1260–2000 Hz; but higher absorbance at 6349 Hz. There were no significant differences in absorbance of the ears with and without incomplete partition type II. Ears with EVA are more likely to present a low-frequency peak in WAI which could be detected using an automated algorithm.
Ganaha et al. [33]	2024	Japan	EVA: 25 (40) Control: 28 (39)	EVA: ~50 Control: ~41	All	80±22.2	WBA-PP at 226-917 Hz was significantly higher in EVA group WBA-PP at 2520-4896 Hz significantly higher in control group Mean RF was significantly lower in EVA RF can detect EVA with 93% sensitivity in adults (AUC 0.83) and 80% in children (AUC 0.8) WBA-PP at 3776 Hz can detect EVA with an AUC of 0.771 (sensitivity 69% and specificity 78%) RF is significantly correlated with VA width

Jiang et al. [29]	2024	China	EVA: 41 (82) Control: 41 (82)	EVA: 63.4 Control: 63.4	Children	91.6±14.9	Propensity score matching for baseline characteristics was performed. WBA-PP and WBA-A were significantly lower in EVA group than in the control group at 1259–2000 Hz and higher at >4000 Hz. Mean RF was significantly lower in EVA WBA-A at 1587 Hz can detect EVA with 57% sensitivity and 91% specificity (cut-off=0.565, AUC=0.81) WBA-PP at 6349 Hz can detect EVA with 68% sensitivity and 82% specificity (cut-off=0.317, AUC=0.77)
Li et al. [28]	2023	China	EVA: 21 (38) Control: 27 (45)	EVA: 38.1 Control: 48.1	Children	NA	The maximum absorbance was significantly higher in EVA The absorbance at each pressure sampling point in the was significantly higher in EVA than that in the control group. WBA-PP at 343-1124 Hz was significantly higher in EVA group WBA-PP at 1943-2448 Hz significantly higher in control group
Zhang et al. [30]	2023	China	EVA: 10 (19) Control: 14 (38)	EVA: 20 Control: NA	Adults	93.6±16.6	WBA-PP and WBA-A was higher in EVA at frequencies <1000 and >6000. WBA-PP and WBA-A was higher in control group at 1000–2500 Hz At 8000 Hz, WBA was significantly higher in EVA, regardless of pressure.
Zhao et al. [27]	2024	China	EVA: 38 (59) Control: 50 (100)	EVA: 57.9 Control: 50	Children	Moderate: 6 Severe: 11 Profound: 42	Mean RF was significantly lower in EVA WBA-PP of EVA was higher at <1000Hz and 6500-8000, and lower at 2378–5339 Hz. EVA has similar absorbance patterns with incomplete partition of cochlea at middle frequencies, but significant differences are found at high frequencies.

Zhang et al. [26]	2020	China	EVA: 13 (24)*	EVA: 46.2	Children	Moderate: 1 Severe: 11 Profound: 12	Absorbance of children with EVA was compared to the normative data for age. WBA in children with EVA was lower than normative data between 700 and 2000 Hz. WBA-PP and WBA-A of EVA was higher above 4000 Hz and WBA-A was higher below 500 Hz.

N; numbers, EVA; enlarged vestibular aqueduct, WBA-PP; wideband absorbance under peak pressure, RF; resonance frequency, WAI; wideband acoustic immittance, ROC;……, AUC; area under the curve, VA; vestibular aqueduct; WBA-A; wideband absorbance under ambient pressure, NA;……

* Normative data was used as control. This study was not included in the meta-analysis due to a lack of appropriate control group.

Table 2. Results of the meta-analysis under random-effects models

		Studies (N)	Ears EVA/control (N)	Mean difference (95%CI)	p	I2 (%)	Q (p)	Egger's p
RF		4	199/239	-174.67 (-221.33 – –128.01)	<.001	0.0	1.40 (0.71)	0.52
Absorbance (peak pressure)	226 Hz	5	197/222	0.01 (0.0-0.01)	0.049	23.00	6.70 (0.15)	0.72
	500 Hz	6	256/322	0.04 (-0.00-0.09)	0.072	91.10	26.20 (0.00)	0.89
	1000 Hz	6	256/322	-0.01 (-0.08-0.04)	0.565	93.00	35.50 (0.00)	0.60
	2000 Hz	6	256/322	-0.09 (-0.14 – –0.03)	0.002	89.00	29.50 (0.00)	0.53
	4000 Hz	6	256/322	-0.04 (-0.18-0.08)	0.493	94.50	68.40 (0.00)	0.69
	8000 Hz	6	256/322	0.08 (0.00-0.15)	0.047	88.20	51.90 (0.00)	0.31
Absorbance (ambient pressure)	226 Hz	3	115/149	-0.01 (-0.03-0.01)	0.631	78.40	9.20 (0.01)	0.87
	500 Hz	4	174/249	0.02 (-0.03-0.08)	0.424	96.40	50.10 (0)	0.00
	1000 Hz	4	174/249	-0.00 (-0.03-0.02)	0.786	42.40	4.60 (0.20)	0.88
	2000 Hz	4	174/249	-0.09 (-0.14 – –0.03)	0.001	89.20	28.70 (0)	0.88
	4000 Hz	4	174/249	0.01 (-0.12-0.15)	0.852	94.90	47.80 (0)	0.89
	8000 Hz	4	174/249	0.12 (0.06-0.18)	<.001	83.20	24.60 (0)	0.21

N; numbers, EVA; enlarged vestibular aqueduct; CI;……., Q;……., RF; resonance frequency

Table 3. Results of the meta-analysis on wideband absorbance at peak pressure in children.

?	?	Studies (N)	Ears EVA/Control (N)	Mean Difference (95%CI)	p	I2 (%)	Q(p)	Egger's p
Absorbance (peak pressure)	**500 Hz**	3	179/227	0.05 (–0.00–0.11)	0.070	79.30	10.10 (0.00)	0.86
	1000 Hz	3	179/227	0.02 (–0.02–0.06)	0.355	50.50	3.70 (0.15)	0.49
	2000 Hz	3	179/227	–0.05 (–0.12–0.02)	0.171	77.20	8.90 (0.01)	0.48
	4000 Hz	3	179/227	0.03 (–0.21–0.28)	0.797	94.60	47.20 (0.00)	0.68
	8000 Hz	3	179/227	**0.08 (0.04–0.12)**	**<0.001**	0.00	0.10 (0.96)	0.84

N; numbers, EVA; enlarged vestibular aqueduct; CI;……., Q;……

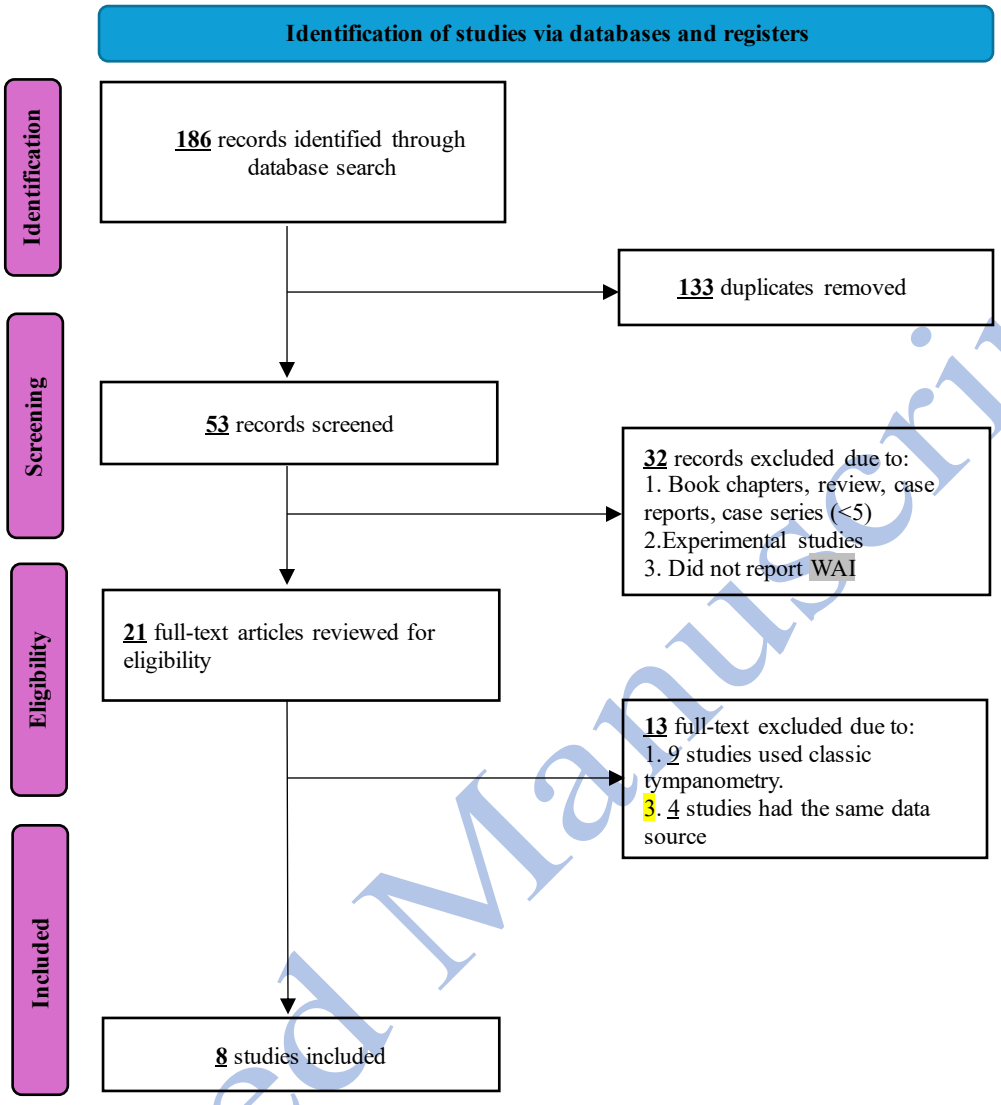

Figure 1. Summary of search strategy and selection process according to the PRISMA guidelines

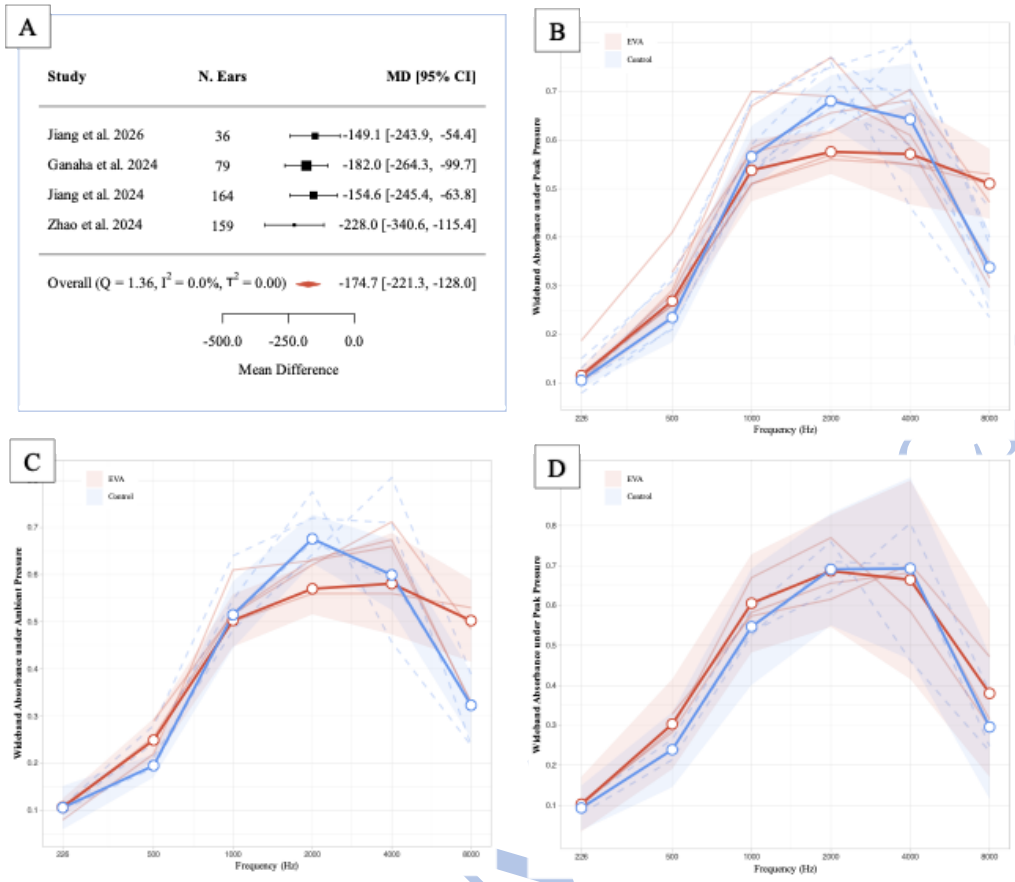

Figure 2. Forest plot of mean difference in Resonance Frequency (RF) of ears with EVA versus control (A), pooled absorbance curves of EVA and control, for the whole population in peak (B) and ambient (C) pressure and pediatric population in peak pressure (D); * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. N; numbers, MD; medical differences, CI;……, Q;……, I;……, T;……., EVA; enlarged vestibular aqueduct