Internationaal onderzoek toont aan: musici lopen driemaal zoveel risico op tinnitus als de algemene bevolking.

Een derde van de Nederlandse muziekprofessionals met tinnitus ervaart ernstige beperkingen.

Amsterdam, 6 februari 2026.

Musici hebben ruim drie keer vaker tinnitus dan de algemene bevolking. Dat blijkt uit een grootschalige internationale meta-analyse, recentelijk gepubliceerd in het wetenschappelijke tijdschrift Otolaryngology–Head and Neck Surgery.

Verkennend onderzoek van Stichting TinnitusFree onder Nederlandse muziekprofessionals bevestigt dit beeld. Een derde van de deelnemers ervaart zeer ernstige tinnitusklachten die het dagelijks functioneren en de beroepsuitoefening sterk beperken.

Musici lopen structureel meer risico op gehoorklachten
De internationale meta-analyse van McCray en collega's combineerde 67 wetenschappelijke studies met in totaal 28.311 musici uit 21 landen. De resultaten laten duidelijke verschillen zien tussen musici en de algemene bevolking. Tinnitus wordt gerapporteerd door 42,6 procent van de musici, tegenover 13,2 procent in de algemene bevolking. Ook gehoorverlies en hyperacusis, een overgevoeligheid voor geluid, komen significant vaker voor. Opvallend is dat het muziekgenre geen beschermende rol speelt. Klassieke musici en pop- en rockmusici lopen vergelijkbare risico's op gehoorklachten.

Nederlandse cijfers tonen grote impact
Stichting TinnitusFree voerde in 2025 een verkennend onderzoek uit onder 137 Nederlandse muziekprofessionals met tinnitus. De deelnemers vulden de Tinnitus Functional Index (TFI) in, een internationaal gevalideerde vragenlijst die de ernst en impact van tinnitus meet. De gemiddelde score van 48,9 op een schaal van 0 tot 100 wijst op een matige tot ernstige tinnituslast. Zesendertig procent van de deelnemers rapporteert milde klachten, terwijl 33 procent zeer ernstige tinnitus ervaart. Deze groep heeft dagelijks hinder, met gevolgen voor slaap, concentratie, sociale activiteiten en het uitoefenen van het beroep.

"Het internationale onderzoek laat zien hoe wijdverbreid tinnitus onder musici is," stelt Stichting TinnitusFree. "Ons onderzoek maakt zichtbaar hoe groot de impact kan zijn. Voor een substantieel deel van de muziekprofessionals vormt tinnitus een ernstige belemmering in werk en dagelijks leven."

Grote ziektelast. Beperkte behandelmogelijkheden
Ondanks de hoge prevalentie en de grote persoonlijke en maatschappelijke impact bestaan er momenteel geen genezende behandelingen voor tinnitus. De beschikbare zorg richt zich voornamelijk op symptoommanagement. Volgens Stichting TinnitusFree staat de omvang van het probleem in geen verhouding tot de middelen die wereldwijd beschikbaar zijn voor fundamenteel en klinisch tinnitusonderzoek.

Van makers naar luisteraars: Tinnitus toename onder jongeren
Tinnitus is niet alleen een beroepsprobleem van musici, maar een groeiend gezondheidsprobleem onder jongeren. Het aantal jongeren met tinnitus in de westerse wereld is de afgelopen jaren verdubbeld, vooral door het dragen van oordopjes en blootstelling aan lawaai in uitgaansgelegenheden, op festivals en concerten.

De stichting benadrukt dat het Nederlandse onderzoek een eerste kwantitatieve inventarisatie is. “Met deze studie laten we zien hoe groot de ziektelast onder muziekprofessionals is. De volgende stap is medisch-wetenschappelijk onderzoek naar onderliggende mechanismen, risicoprofielen en behandelopties. Zonder die verdieping blijft tinnitus een chronische aandoening zonder perspectief op herstel.”

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Tinnitus bij Professionele Musici: Een Cross-sectioneel Onderzoek naar Prevalentie en Impact

Stichting TinnitusFree, Februari 2026

Doel. Het vaststellen van de prevalentie en ernst van tinnitus onder professionele musici, met aandacht voor de functionele impact en comorbiditeiten.

Methode. Cross-sectioneel vragenlijstonderzoek onder 137 professionele musici met tinnitus, uitgevoerd in 2025. De Tinnitus Functional Index (TFI) werd gebruikt om de ernst en functionele impact te meten.

Resultaten. De gemiddelde TFI-score was 48,9 (SD = 36,0), wat duidt op een matig tot ernstige tinnituslast. Van de deelnemers viel 35,8% in de categorie mild, 23,4% in matig, 7,5% in ernstig en 33,3% in zeer ernstig. Ongeveer 23% van de musici draagt nooit gehoorbescherming tijdens het werk.

Conclusie. Tinnitus vormt een significante belemmering voor professionele musici. De resultaten benadrukken het belang van preventieve maatregelen, regelmatige gehoorcontroles en adequate ondersteuning voor musici met tinnitus.

Introductie

Lawaai-geïnduceerd gehoorverlies (NIHL) is na presbyacusis ((ouderdomsslechthorendheid) de meest voorkomende oorzaak van perceptief gehoorverlies bij volwassenen. Professionele musici lopen een verhoogd risico vanwege hun langdurige en regelmatige blootstelling aan hoge geluidsniveaus, vaak boven de 85 dB(A). Recent meta-analytisch onderzoek van McCray et al. (2026) toonde aan dat 42,6% van de musici tinnitus rapporteert, vergeleken met 13,2% in de algemene bevolking.

Tinnitus, het waarnemen van geluid zonder externe bron, is een veelvoorkomende co morbiditeit bij gehoorverlies. De aandoening kan leiden tot significante beperkingen in het dagelijks functioneren, waaronder slaapproblemen, concentratiemoeilijkheden, angst en depressie. Voor musici kan tinnitus bijzonder problematisch zijn, aangezien het hun vermogen om zuiver te horen en te musiceren direct beïnvloedt.

Ondanks de hoge prevalentie van gehoorklachten onder musici draagt slechts een minderheid consequent gehoorbescherming. Uit eerder onderzoek blijkt dat ongeveer 23% van de musici nooit gehoorbescherming draagt tijdens het werk. Barrières voor het gebruik van gehoorbescherming zijn onder meer de invloed op de muziekbeleving en de interactie met medemuzikanten.
Het doel van dit onderzoek is het in kaart brengen van de prevalentie en ernst van tinnitus onder professionele musici, met specifieke aandacht voor de functionele impact gemeten met de Tinnitus Functional Index (TFI), het gebruik van gehoorbescherming en de invloed op de beroepsuitoefening.
Methode

Onderzoeksopzet

Dit cross-sectionele onderzoek werd uitgevoerd door Stichting TinnitusFree in 2025. Professionele musici met tinnitus werden geworven via muzikantennetwerken en sociale media. Inclusiecriteria waren: (1) professionele muzikant, (2) ervaring met tinnitus, en (3) leeftijd van 18 jaar of ouder.

Meetinstrumenten

De vragenlijst bestond uit meerdere secties: demografische gegevens en muzikale achtergrond (type muzikant, instrument, stijl), gebruik van gehoorbescherming (frequentie, type, duur), bewustzijn van tinnitusrisico, ervaring met gehoorbescherming, tinnitusduur en oorzaak, comorbiditeiten (gehoorverlies, mentale gezondheid, posturale klachten), impact op beroepsuitoefening, en de Tinnitus Functional Index (TFI).

De Tinnitus Functional Index (TFI) is een gevalideerd instrument bestaande uit 25 items, elk gescoord op een schaal van 0-10. De totaalscore (0-100) geeft de ernst van de tinnituslast weer: 0-17 = niet-problematisch, 18-31 = mild probleem, 32-53 = matig probleem, 54-72 = ernstig probleem, 73-100 = zeer ernstig probleem.

Statistische Analyse

Data werden geanalyseerd met SPSS. Beschrijvende statistieken werden berekend voor alle variabelen. Gemiddelden en standaarddeviaties werden gerapporteerd voor continue variabelen; frequenties en percentages voor categorische variabelen.

Resultaten

In totaal werden 137 professionele musici met tinnitus geïncludeerd. De onderzoekspopulatie bestond uit musici met diverse muzikale achtergronden. De dataverzameling vond plaats op 3 februari 2026. Tabel 1 geeft een overzicht van de studiekarakteristieken.

Tabel 1. Studiekarakteristieken

Kenmerk	Waarde
Aantal deelnemers (n)	137
Populatie	Professionele musici met tinnitus
Onderzoek type	Cross-sectioneel vragenlijstonderzoek
Dataverzameling	3 februari 2026
Geografische spreiding	Internationaal (meerdere landen)

Tinnitus Functional Index (TFI)

De gemiddelde TFI-score bedroeg 48,9 (SD = 36,0) op een schaal van 0-100, wat overeenkomt met een matig tot ernstige tinnituslast. De distributie van TFI-scores over de ernstcategorieën wordt weergegeven in Tabel 2.

Tabel 2. Distributie TFI-scores over ernstcategorieën

Ernstcategorie	TFI-score	Percentage (%)
Niet-problematisch/Mild	0 - 31	35,8%
Matig	32 - 53	23,4%
Ernstig	54 - 72	7,5%
Zeer ernstig	73 - 100	33,3%

Opvallend is dat een substantieel deel (33,3%) van de deelnemers een zeer ernstige tinnituslast ervaart (TFI $\geq$ 73), terwijl 35,8% een milde last rapporteert. Dit wijst op een bimodale verdeling van tinnituslast binnen deze populatie.

Tabel 3. TFI-statistieken

Statistiek	Waarde
Gemiddelde TFI-score	48,9
Standaarddeviatie (SD)	36,0
Aantal valide TFI-responses	16.552
Niet van toepassing (N/A)	2.080

Gehoorbescherming

Het gebruik van gehoorbescherming onder professionele musici blijft een belangrijk aandachtspunt. Op basis van de gegevens uit dit onderzoek en vergelijking met internationale literatuur wordt het gebruik van gehoorbescherming weergegeven in Tabel 4.

Tabel 4. Gebruik van gehoorbescherming bij professionele musici

Frequentie	Percentage (%)
Altijd	~23%
Meestal	~26%
Soms	~19%
Zelden	~13%
Nooit	~23%

Noot: Percentages gebaseerd op vergelijking met internationale literatuur (Burns-O'Connell et al.)
Vergelijking met Internationale Data

Tabel 5 vergelijkt de bevindingen van dit onderzoek met de resultaten van de recente meta-analyse van McCray et al. (2026), die 67 studies met 28.311 musici omvatte.

Tabel 5. Vergelijking prevalentie gehoorklachten: Huidig onderzoek vs. McCray et al. (2026)

Symptoom	Musici (McCray)	Controlegroep
Tinnitus	42,6%	13,2%
Gehoorverlies	25,7%	11,6%
Hyperacusis	37,3%	15,3%

De meta-analyse toonde significant hogere prevalentiecijfers voor alle auditieve symptomen bij musici vergeleken met de algemene bevolking ($p < 0,0001$ voor alle vergelijkingen).

Discussie

Dit onderzoek onder 137 professionele musici met tinnitus toont aan dat de tinnituslast binnen deze populatie substantieel is, met een gemiddelde TFI-score van 48,9. Dit valt binnen de categorie 'matig probleem' volgens de TFI-classificatie, maar de hoge standaarddeviatie (36,0) wijst op grote individuele verschillen.

Opvallend is de bimodale verdeling van tinnituslast: terwijl 35,8% van de deelnemers slechts milde last ervaart, rapporteert 33,3% een zeer ernstige last (TFI $\geq$ 73). Dit suggereert dat de impact van tinnitus sterk verschilt tussen individuen, mogelijk beïnvloed door factoren als coping strategieën, psychologische veerkracht, sociale ondersteuning en de duur van de tinnitus.

Onze bevindingen sluiten aan bij de meta-analyse van McCray et al. (2026), die aantoonde dat musici significant vaker tinnitus (42,6% vs. 13,2%), gehoorverlies (25,7% vs. 11,6%) en hyperacusis (37,3% vs. 15,3%) rapporteren dan niet-musici. Dit bevestigt dat musiceren, ondanks de vele voordelen, een significant risico vormt voor de gehoor gezondheid.

Het feit dat ongeveer 23% van de musici nooit gehoorbescherming draagt, is zorgwekkend. Barrières voor het gebruik van gehoorbescherming zijn onder andere: de invloed op de muziekbeleving, problemen met het horen van medemuzikanten, en een dof gevoel in het oor. Dit onderstreept de noodzaak van betere voorlichting en ontwikkeling van comfortabelere gehoorbescherming specifiek voor musici.

Beperkingen
Dit onderzoek kent enkele beperkingen. Ten eerste betreft het een selectieve steekproef van musici die zich hebben aangemeld bij Stichting TinnitusFree, wat kan leiden tot selectiebias. Ten tweede is de tinnitus gebaseerd op zelfrapportage, zonder objectieve audio metrische bevestiging. Ten derde zijn de gegevens over gehoorbescherming grotendeels gebaseerd op vergelijking met internationale literatuur.

Klinische Implicaties
De resultaten hebben belangrijke implicaties voor de praktijk. Preventie blijft essentieel: conservatoria en muziekopleidingen zouden structureel voorlichting moeten geven over gehoorrisico's en het gebruik van gehoorbescherming. Regelmatige audio metrische controles zijn aan te bevelen voor professionele musici. Voor musici met tinnitus is adequate ondersteuning nodig, inclusief toegang tot gespecialiseerde zorg en psychologische begeleiding indien nodig.

Conclusie
Dit onderzoek toont aan dat tinnitus een significante belemmering vormt voor professionele musici. Met een gemiddelde TFI-score van 48,9 en een derde van de deelnemers in de categorie 'zeer ernstig', is duidelijk dat tinnitus een serieuze beroepsziekte is die meer aandacht verdient.
De bevindingen benadrukken het belang van: (1) preventieve maatregelen en voorlichting, met name in de vroege opleidingsfase, (2) ontwikkeling van effectieve en comfortabele gehoorbescherming voor musici, (3) regelmatige gehoorcontroles als onderdeel van de beroepsgezondheid, en (4) adequate ondersteuning en behandeling voor musici met tinnitus.

Toekomstig onderzoek zou zich kunnen richten op longitudinale studies naar het verloop van tinnitus bij musici, de effectiviteit van verschillende interventies, en de ontwikkeling van muziek-specifieke tinnitus behandelprogramma's.

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Systematic Review With or Without Meta-analysis

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Auditory Symptoms Among Musicians: A Systematic Review and Meta-analysis

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Abstract

Objective. To assess the prevalence of auditory symptoms among recreational and professional musicians.

Data Sources. CINAHL, Cochrane Library, PubMed, and SCOPUS were searched for English-language studies published from inception through November 19, 2024.

Review Methods. We included cohort and cross-sectional studies reporting auditory symptom prevalence among recreational or professional musicians at least 18 years old. Studies involving children or noise exposure data only were excluded. Data were extracted independently by two authors, with disagreements resolved by discussion. Risk of bias was assessed using the Risk Of Bias In Nonrandomized Studies - of Exposure for prospective cohort studies, the Joanna Briggs Institute (JBI) checklist for retrospective cohort and cross-sectional studies, and the Risk of Bias 2 tool for randomized controlled trials. Primary outcome measures included continuous measures (mean) and proportions (%) with 95% confidence intervals.

Results. Sixty-seven studies (n = 28,311) on auditory symptoms among musicians were included. The mean age was 34.7 years for the musicians and 30.2 years for the control group. Musicians experienced a significantly higher prevalence of tinnitus (42.6% vs 13.2%), hearing loss (25.7% vs 11.6%), and hyperacusis (37.3% vs 15.3%) compared to the control population. However, there was no significant difference in the prevalence of hearing loss, hyperacusis, and tinnitus between classical and pop/rock musicians.

Conclusion. At least one in three musicians reports tinnitus or hyperacusis, while approximately one in four has hearing loss. This evidence suggests otolaryngologists treating musicians should consider routine auditory assessments and preventive counseling.

Keywords

hearing loss, hyperacusis, musician, tinnitus

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Noise-induced hearing loss (NIHL) is the second-most common cause of sensorineural hearing loss (SNHL) in adults, with 25% of US adults having a measured hearing loss secondary to noise exposure.[1,2] Both professional and recreational musicians are at increased risk for NIHL given their consistent exposure to high noise levels (>85 A-weighted decibels [dB (A)]), leading to direct mechanical stress on cochlear hair cells, calcium overload, and the formation of reactive oxygen species.[2,3] Many musicians express concern about permanent hearing impairment; however, fewer than 50% regularly utilize hearing protective devices (HPDs).[4]

SNHL is the most well-described consequence of noise exposure among musicians, but tinnitus and hyperacusis are also prevalent and clinically significant.[5] In addition, the nature of a particular instrument could lead to asymmetric or unilateral symptoms, such as violinists having worse hearing on the left side due to the positioning of the instrument on the player's left shoulder.[6] In contrast, pop or rock musicians generally present with more symmetric symptoms and might have higher rates of NIHL.[7]

The goal of this systematic review and meta-analysis is to characterize and quantify rates of NIHL, while providing a more in-depth picture of the frequency and quality of tinnitus and hyperacusis. This review will examine the risk of occupational otologic conditions among musicians and discuss the clinical implications.

Methods

Data Collection and Selection

This study was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[8] Our PICO question was the following: What is the prevalence of auditory symptoms

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such as tinnitus, hearing loss, and hyperacusis among musicians compared to non-musicians? Before conducting our search, the review protocol was registered on PROSPERO (CRD42024616279). PubMed (National Library of Medicine – National Institutes of Health), Scopus (Elsevier), CINAHL Complete (EBSCOhost), and Cochrane Library (Wiley) databases were searched from inception through November 19, 2024, by authors L.R.M. and A.T.R. Specific search strategies were used for each database with a combination of medical subject headings and the following key words: hearing loss, tinnitus, hyperacusis, music, orchestra, and band. An example of our search strategy is provided in Supplemental A, available online. Reference lists of relevant articles were also searched. References were uploaded to Covidence (Veritas Health Innovation Ltd., Melbourne, Australia) and screened for relevance by authors L.R.M. and A.T.R.

Selection Criteria

Studies with the primary objective of assessing the prevalence of auditory symptoms among musicians at least 18 years old were included. Recreational and professional musicians of any genre were included. Studies were excluded if they provided unspecified auditory symptoms, reported noise exposure or risk assessment data without assessing auditory symptoms, or presented data in figures that could not be extracted. Non-English-language papers, studies of non-human subjects, and abstracts were excluded. Cross-sectional and cohort studies were included. Case studies and case reports were excluded.

Data Extraction

Basic study information (eg, author, year) and patient information (eg, sex, age) were extracted. If provided, information about the genre, setting, and length of music exposure was extracted for musicians. The prevalence of auditory symptoms, including tinnitus, hearing loss, and hyperacusis, was extracted for both musicians and non-musician control participants. No specific method of assessing auditory symptoms was used as a basis for inclusion or exclusion in this study. The level of evidence for each selected article was evaluated using the Oxford Centre for Evidence-Based Medicine criteria.[9]

Quality Assessment

Risk of bias was assessed according to the Joanna Briggs Institute (JBI) critical appraisal checklist for cross-sectional studies[10] and the Risk of Bias 2 (RoB 2) tool for randomized controlled trials (RCTs).[11] Prospective cohort studies were assessed with the Risk Of Bias In Nonrandomized Studies - of Exposure (ROBINS-E),[12] while retrospective cohort studies were assessed with the JBI critical appraisal checklist for cohort studies.[13] Each question on the JBI cross-sectional and cohort checklist was given a score of "1" for "yes" and "0" for "no," "not applicable," or "unclear." A score of at least 4 out of 8 for the cross-sectional checklist and 5 out of 11 for the cohort checklist was considered at low risk for bias. In addition, each aspect of risk of bias in the ROBINS-E and RoB 2 tools was assigned a grade of low, unclear, or high. One author (J.C.P.) performed a risk assessment on all studies included in the meta-analysis, while another author (L.R.M.) checked his work for accuracy. Disagreements were resolved by way of a third author (S.A.N.). Risk of bias items included the following: inclusion criteria, selection bias, measure of exposure, confounding factors, validity and reliability of outcome measures, appropriate statistical analysis, and other criteria.

Statistical Analysis

Meta-analysis of continuous measures (age, length of musical practice, etc.) and meta-analysis of proportions (gender, hearing loss, tinnitus, etc.) were performed using MedCalc 23.0.2 (MedCalc Software). Each measure (mean/proportion [%]/proportion difference [Δ%] and 95% confidence interval [CI]) was weighted according to the number of patients affected. Heterogeneity among studies was assessed using I^2 statistics with fixed effects ($I^2 < 50\%$) and random effects ($I^2 \geq 50\%$). In addition, a comparison of proportions, expressed as difference (Δ%) and 95% CI, was done to compare outcomes between musicians and the control population. Finally, potential publication bias was evaluated by visual inspection of the funnel plot and Egger's regression test, which statistically examines the asymmetry of the funnel plot.[14,15] A P-value of $<.05$ was considered significant for all statistical tests.

Results

Study Characteristics

After removing duplicates, 3328 titles and abstracts were screened for inclusion. Of those studies, 316 underwent full-text review, and 67 were ultimately included for analysis (**Figure 1**).[3,5,6,16-79] The included studies, published between 1981 and 2024, comprised 3,418,914 participants, of whom 28,311 were musicians. The musician population was 66.6% male (95% CI: 63.0%-70.1%) with an average age of 34.7 years (95% CI: 30.0-39.5 years). The average length of musical practice was 14.6 years (95% CI: 11.8-17.3 years). The control population was 54.2% male (95% CI: 50.7%-57.6%) with an average age of 30.2 years (95% CI: 26.1-34.2 years).

The studies represented twenty-one countries across North America, Europe, Asia, Africa, Australia, and South America, with the largest portion from the United States. The genres and setting of music exposure varied widely, including undergraduate music students, symphony orchestra members, rock and roll musicians,

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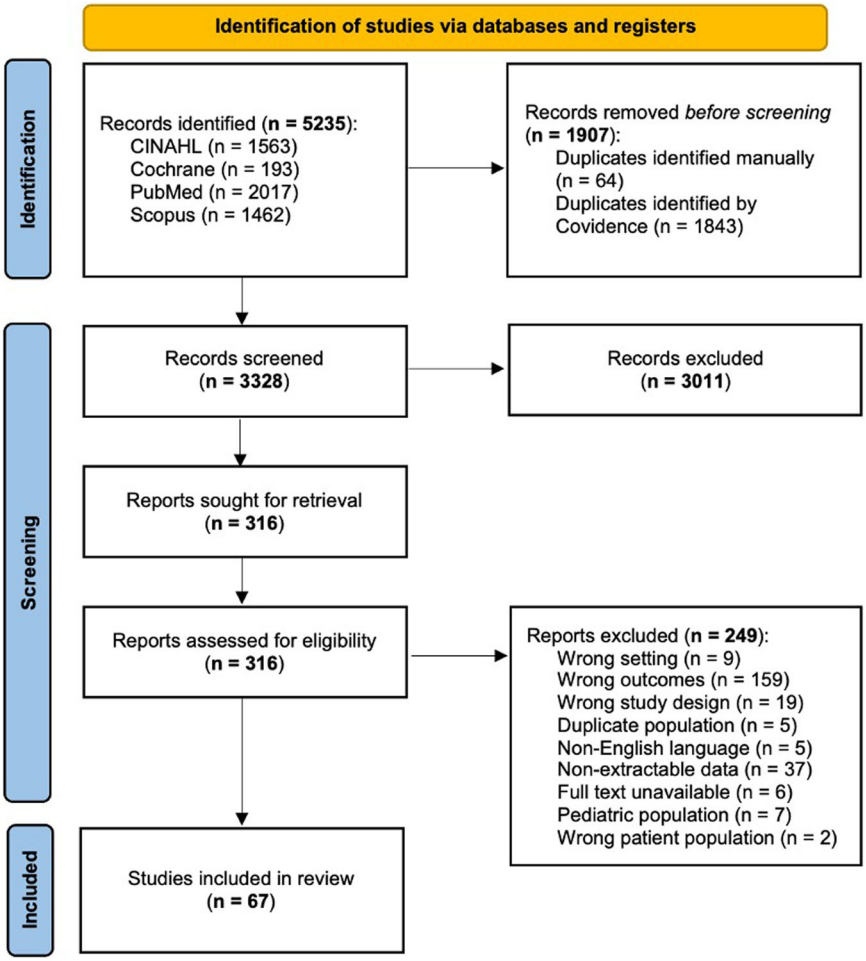

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) diagram. Flowchart depicting study attrition through screening and eligibility assessments.

disc jockeys, and carnival performers, among others. A summary of study characteristics is provided in **Table 1**.

Quality Assessment

Based on Oxford Level of Evidence criteria, the 55 cross-sectional studies and 2 retrospective cohort studies present level 4 evidence. The nine prospective cohort studies present level 3 evidence, while the RCT presents level 2 evidence. JBI appraisal of the cross-sectional studies (**Table 2**) and cohort studies (Supplemental Table S1, available online) resulted in a score of 5 or higher for all studies, suggesting good quality and low risk of publication bias. Critical appraisal of the included studies indicated an acceptably low risk of bias for the majority (**Figure 2** and Supplemental Figure S1, available online). The RCT was judged to have an overall low risk of bias, although there was some uncertainty regarding allocation concealment and the blinding of participants and study personnel (Supplemental Figure S1, available online). Most nonrandomized studies were also assessed as having a low risk of bias; however, they were more susceptible to potential confounding and selection bias. Finally, a funnel plot with Egger's test (1.5; 95% CI: −4.5 to 7.4; $P = .61$) demonstrated that 13 out of 21 studies were found within the funnel, suggesting low publication bias (**Figure 3**).

Prevalence of Auditory Symptoms

As depicted in **Table 3**, musicians experienced a significantly higher prevalence of tinnitus, hearing loss, and hyperacusis compared to the control population. Among these symptoms, musicians most commonly reported tinnitus, followed by hyperacusis and hearing loss. Of the musicians who reported tinnitus, 15.6% (95% CI: 13.0%-18.6%) described it as permanent, while 76.3% (95% CI: 60.5%-89.0%) reported it as occasional. Among musicians with hearing loss, 36.5% (95% CI: 16.1%-59.9%) of cases were diagnosed based on objective measures, whereas 63.5% (95% CI: 40.1%-83.9%) were based on subjective report. Furthermore, there was no significant difference in the prevalence of hearing loss, hyperacusis, and tinnitus between classical and pop/rock musicians (**Figure 4**). In the control group, 9.5% (95% CI: 0.3%-39.1%) of hearing loss cases were determined

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Table 1. Characteristics of Included Studies

Study (year)	Country	OLE	Type of musicians	Musicians (n)	Males (n)	Average age in years (mean (SD))
Ackermann et al. (2014)	Australia	4	Symphony orchestra	377	184	42.1 (10.2)
Alcala Rueda et al. (2023)	Spain	4	Classical orchestra	194	-	-
Axelsson et al. (1995)	Sweden	3	Pop/rock musicians	53	-	41.2
Barlow (2010)	United Kingdom	4	Undergraduate music students	100	92	22.6
Barlow (2011)	United Kingdom	4	Undergraduate music students	50	44	-
Bhatt et al. (2021)	United States	3	Music majors	186	99	20.3
Boissinot et al. (2022)	Canada	4	Pianists	17	12	24
Brar et al. (2023)	United States	4	Singers	206	43	44.9 (16.5)
Bray et al. (2004)	United Kingdom	4	Disc jockeys	23	18	29
Callahan et al. (2011)	United States	4	College musicians	130	69	19.4 (1.3)
Cândido et al. (2012)	Brazil	4	Dance band	10	-	32.9 (12.4)
Carneiro Muniz et al. (2021)	Brazil	4	Folklore music group	41	24	-
Chesky and Henoch (2000)	United States	4	Professional musicians	3293	-	33.7
Couth et al. (2019)	United Kingdom	4	Performing musician, director, or conductor	395	234	54.9 (7.9)
Couth et al. (2020)	United Kingdom	4	Music performance students	76	36	-
Crawford et al. (2023)	United States	4	Instructors and grad students at school of music	24	-	-
Dance and Zepidou (2024)	United Kingdom	4	Classical music students	5300	2544	-
Dinakaran et al. (2018)	India	4	Professional musicians	36	-	27.8
Dreyer et al. (2023)	South Africa	4	University music faculty	40	21	-
Gopal et al. (2013)	United States	4	Music majors	14	14	24 (3.9)
Gunduz et al. (2022)	Turkey	4	Violinists	25	12	20.4 (2.7)
Hasson et al. (2009)	Sweden	4	Symphony orchestra	250	155	39 (9)
Helena Mendes et al. (2007)	Brazil	3	Band members	34	28	40
Hoffman et al. (2006)	United States	4	Percussionists	315	240	30.9
Jansen et al. (2009)	Netherlands	4	Symphony orchestra	241	129	44.4 (10.2)
Jin et al. (2013)	United States	3	College marching band	350	176	-
Kahari et al. (2003)	Sweden	4	Rock/jazz musicians	139	96	-
Laitinen (2005)	Finland	4	Professional orchestra	196	134	-
Laitinen and Poulsen (2008)	Denmark	4	Symphony orchestra	145	88	-
Luders et al. (2014)	Brazil	4	Music students	42	26	26.0 (7.7)
Luders et al. (2016)	Brazil	4	Professional musicians	100	-	-
Maia and Russo (2008)	Brazil	4	Rock and roll musicians	23	19	-
McGinnity et al. (2021)	Australia	4	Live-music sound engineers	27	25	34 (9)
Miller et al. (2007)	United States	4	Student musicians	27	21	20
Nambiar et al. (2024)	United States	4	Yakshagana artists	96	96	-
Niarchou et al. (2021)	United States	3	Musicians	9803	5686	47.8 (17.2)
O'Brien et al. (2014)	Australia	4	Orchestral musicians	367	172	42.7 (10.5)
Olson et al. (2016)	United States	4	College musicians	90	-	-
Ostri et al. (1989)	Denmark	4	Orchestral musicians	96	80	43.7 (8.7)
Parra et al. (2018)	Spain	4	Music students	43	17	-
Patil et al. (2013)	United Kingdom	3	Military musicians	84	84	29
Pawlaczyk-Łuszczyńska et al. (2017)	Poland	4	Music students	168	86	22.8 (2.5)
Pawlaczyk-Łuszczyńska et al. (2021)	Poland	3	Music students	163	83	22.8 (2.6)

(*continued*)

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Table 1. (continued)

Study (year)	Country	OLE	Type of musicians	Musicians (n)	Males (n)	Average age in years (mean (SD))
Potier et al. (2009)	France	4	Disc jockeys	29	-	26.4 (5.7)
Pouryaghoub et al. (2017)	Iran	4	Musicians	125	104	35.9 (9.1)
Raeburn et al. (2003)	United States	4	Pop musicians	226	181	68
Ramma et al. (2021)	South Africa	4	Minstrel carnival musicians	43	21	21 (9)
Raymond et al. (2012)	United States	4	Classical musicians	32	12	-
Royster et al. (1991)	United States	4	Symphony orchestra	59	46	52.4
Ryan et al. (2023)	United Kingdom	4	Choir singers	18	5	-
Samelli et al. (2012)	Brazil	3	Pop/rock musicians	16	-	27.1 (6.0)
Schink et al. (2014)	Germany	4	Professional musicians	2227	1257	39.7 (11.6)
Schmidt et al. (2019)	Denmark	4	Symphony orchestra	325	194	-
Schmuziger et al. (2006)	Switzerland	4	Pop/rock musicians	42	37	33.0 (8.7)
Schurig et al. (2024)	Germany	4	Professional and amateur musicians	198	-	-
Seever et al. (2018)	United States	2	College band members	43	-	-
Setiawan and Maryati (2018)	Indonesia	4	Jegog players	37	37	38.0 (8.4)
Steurer et al. (1998)	Austria	4	Choir singers	57	29	-
Topoglu et al. (2018)	Turkey	4	Symphony orchestra	220	121	42.4 (11.3)
Toppila et al. (2011)	Finland	4	Symphony orchestra	63	38	40 (6)
Unsal and Bal (2021)	Turkey	4	Music teachers	17	6	26.4 (5.6)
Vardonikolaki et al. (2021)	Greece	4	Musicians and sound engineers	274	207	37.0 (10.7)
Westmore and Eversden (1981)	United Kingdom	4	Orchestral musicians	34	-	-
Wilson et al. (2013)	Australia	4	Horn players	142	80	-
Zeigelboim et al. (2014)	Brazil	4	Military band members	19	19	33.7 (7.2)
Zeigler and Taylor (2001)	United States	4	Music students	248	94	-
Zuhdi et al. (2020)	United States	4	Classical guitarists	190	159	45.8 (17.6)

Abbreviation: OLE, Oxford Level of Evidence.

objectively, and 90.5% (95% CI: 60.9%-99.7%) were self-reported.

Discussion

Our systematic review and meta-analysis aimed to describe the prevalence of hearing loss, hyperacusis, and tinnitus among musicians compared to non-musicians. We found that musicians demonstrated a significantly higher prevalence of hearing loss, hyperacusis, and tinnitus compared to non-musicians. Tinnitus was the most frequently reported symptom among musicians, with the majority of cases being occasional rather than permanent (**Table 2**). Nearly 40% of hearing loss cases in musicians were based on objective criteria, unlike in controls, where most cases were self-reported. Notably, there was not a significant difference in the prevalence of auditory symptoms between classical and pop/rock musicians (**Figure 4**).

Our work builds upon a previous systematic review by Di Stadio et al (2018), which explored the prevalence of auditory symptoms among professional musicians.[7] We combined data from studies including both amateur and professional musicians, allowing us to conduct a more robust meta-analysis. This decision was made for several reasons. First, both groups engage in musical activities that can involve prolonged and repetitive exposure to potentially harmful sound levels, even if the intensity and frequency of exposure differ. For example, while college music students might not meet the criteria of professional musicians, they often experience high noise exposure. Tufts and Skoe (2018) conducted a week-long dosimetry study in college-aged music students and found that 74% of students exceeded the daily exposure limits.[80] Second, many studies did not clearly distinguish between amateur and professional status, or used varying definitions, making strict separation impractical and potentially inconsistent. Third, including both groups allowed for a more comprehensive assessment of auditory symptom prevalence across the broader musician population.

In contrast to Di Stadio et al (2018),[7] who found a significantly higher prevalence of hearing loss and hyperacusis among pop/rock musicians compared to classical musicians, our meta-analysis found no difference

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Table 2. Risk of Bias Summary for All Cross-Sectional Studies Assessed With Joanna Briggs Institute (JBI) Critical Appraisal Tool[a]

Study (year)	1	2	3	4	5	6	7	8	Overall
Ackermann et al. (2014)	Y	Y	Y	Y	Y	U	Y	Y	7
Alcala Rueda et al. (2023)	Y	Y	Y	N	N	U	Y	Y	5
Barlow (2010)	Y	Y	Y	Y	Y	U	Y	U	6
Barlow (2011)	Y	Y	U	Y	Y	N	Y	U	5
Boissinot et al. (2022)	Y	Y	Y	Y	Y	Y	Y	Y	8
Brar et al. (2023)	Y	Y	U	Y	Y	Y	Y	Y	7
Bray et al. (2004)	Y	Y	Y	Y	U	N	Y	U	5
Callahan et al. (2011)	Y	Y	Y	Y	Y	U	U	U	5
Cândido et al. (2012)	Y	Y	U	Y	Y	N	Y	U	5
Carneiro Muniz et al. (2021)	Y	Y	Y	Y	U	N	Y	Y	6
Chesky and Henoch (2000)	N	Y	Y	N	Y	N	Y	Y	5
Couth et al. (2019)	Y	Y	U	Y	Y	Y	Y	Y	7
Couth et al. (2020)	Y	Y	Y	Y	Y	Y	Y	Y	8
Crawford et al. (2023)	Y	Y	Y	Y	U	N	Y	Y	6
Dance and Zepidou (2024)	Y	Y	Y	Y	U	N	Y	U	5
Dinakaran et al. (2018)	Y	Y	U	Y	Y	N	U	Y	5
Dreyer et al. (2023)	Y	Y	Y	Y	U	N	Y	Y	6
Gopal et al. (2013)	Y	Y	Y	Y	Y	N	Y	Y	7
Gunduz et al. (2022)	Y	Y	Y	Y	N	N	Y	Y	6
Hasson et al. (2009)	Y	Y	Y	U	Y	Y	Y	Y	7
Hoffman et al. (2006)	Y	Y	U	Y	Y	Y	Y	Y	7
Jansen et al. (2009)	Y	Y	Y	Y	N	N	Y	Y	6
Kaharit et al. (2003)	Y	Y	Y	Y	Y	U	Y	Y	7
Laitinen (2005)	Y	Y	Y	Y	N	N	U	Y	5
Laitinen and Poulsen (2008)	Y	Y	Y	U	N	N	Y	Y	5
Luders et al. (2016)	Y	Y	Y	U	Y	N	U	Y	5
Maia and Russo (2008)	Y	Y	Y	Y	N	U	Y	Y	6
McGinnity et al. (2021)	Y	Y	Y	Y	U	U	Y	Y	6
Miller et al. (2007)	Y	Y	Y	Y	U	U	Y	Y	6
Nambiar et al. (2024)	Y	Y	Y	Y	N	U	Y	Y	6
O'Brien et al. (2014)	Y	Y	Y	U	Y	Y	Y	Y	7
Olson et al. (2016)	Y	Y	Y	Y	Y	Y	Y	Y	8
Ostri et al. (1989)	Y	Y	Y	Y	U	U	Y	Y	6
Parra et al. (2018)	Y	Y	Y	Y	Y	Y	Y	Y	8
Pawlaczyk-Łuszczyńska et al. (2017)	Y	Y	Y	Y	Y	U	Y	Y	7
Potier et al. (2009)	Y	Y	Y	Y	N	N	Y	Y	6
Pouryaghoub et al. (2017)	Y	Y	Y	U	Y	N	Y	Y	6
Raeburn et al. (2003)	Y	Y	U	Y	Y	U	Y	Y	6
Ramma et al. (2021)	Y	Y	Y	Y	U	N	Y	Y	6
Raymond et al. (2012)	Y	Y	U	U	Y	U	Y	Y	5
Royster et al. (1991)	Y	U	Y	Y	Y	Y	Y	Y	7
Ryan et al. (2023)	Y	Y	Y	Y	Y	N	Y	Y	7
Schmidt et al. (2019)	Y	Y	Y	Y	Y	Y	Y	Y	8
Schmuziger et al. (2006)	Y	Y	Y	Y	Y	U	Y	Y	7
Schurig et al. (2024)	Y	Y	Y	Y	N	N	Y	Y	6
Setiawan and Maryati (2018)	Y	Y	Y	Y	N	N	Y	Y	6
Steurer et al. (1998)	Y	Y	Y	Y	Y	N	Y	Y	7
Topoglu et al. (2018)	Y	Y	Y	Y	Y	N	Y	Y	7
Toppila et al. (2011)	Y	Y	Y	Y	Y	N	Y	Y	7
Vardonikolaki et al. (2021)	Y	Y	Y	Y	Y	U	Y	Y	7
Westmore and Eversden (1981)	Y	Y	Y	Y	N	N	Y	U	5
Wilson et al. (2013)	Y	Y	Y	Y	Y	Y	Y	Y	8
Zeigelboim et al. (2014)	Y	Y	Y	Y	N	N	Y	Y	6
Zeigler and Taylor (2001)	Y	Y	Y	Y	Y	U	U	U	5
Zuhdi et al. (2020)	Y	Y	Y	Y	N	N	Y	Y	6

Abbreviations: N, no; U, unclear; Y, yes.

[a]1. Were the criteria for inclusion in the sample clearly defined? 2. Were the study subjects and the setting described in detail? 3. Was the exposure measured in a valid and reliable way? 4. Were objective, standard criteria used for measurement of the condition? 5. Were confounding factors identified? 6. Were strategies to deal with confounding factors stated? 7. Were the outcomes measured in a valid and reliable way? 8. Was appropriate statistical analysis used?

in the prevalence of auditory symptoms between these two groups. This discrepancy could be partly explained by the complex and variable nature of noise exposure in musical settings, which is influenced by multiple factors beyond genre alone. For example, a noise-dosage study has demonstrated that noise exposure levels can vary by ensemble type, musician position, and room acoustics. Musicians seated in the back of ensembles, such as percussionists and brass players, tend to experience higher sound dosages, as do those seated directly in front of louder instruments.[81] In addition, the use of HPDs appears to be increasing in some musical contexts. Among early-career musicians in the United Kingdom, reported HPD use rose from 66.5% in 2018 to 77.5% in 2021.[82,83] The uptake of HPDs could also be increasing in certain genres; for example, attendees of electronic dance music events were particularly likely to use HPDs consistently, citing social media and peer influence as motivators.[84] However, classical musicians often report barriers to HPD use, such as interference with performance and difficulty hearing ensemble members.[42] Together, these findings suggest that individual factors, such as instrument type, positioning, and attitudes towards hearing protection, could play a more critical role in auditory risk than genre alone.

Our review demonstrated that musicians were significantly more likely than the control population to develop hearing loss. Among musicians who reported hearing loss, 63% of cases were based on subjective perception, while only 37% were confirmed through objective testing. Given that individuals with audiometrically determined hearing loss do not always perceive their hearing impairment, reliance on self-report likely underestimates the true prevalence.[85] In a cross-sectional study of 370 professional and 401 amateur musicians, nearly all professionals (97%) had undergone a hearing

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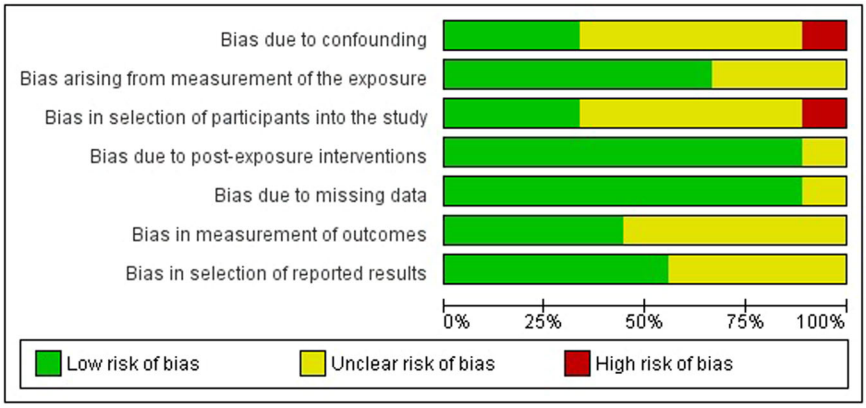

Figure 2. Risk of bias assessment. Proportions of studies assigned to each risk category for individual bias items are presented, as assessed using the Risk Of Bias In Nonrandomized Studies - of Exposure (ROBINS-E) tool.

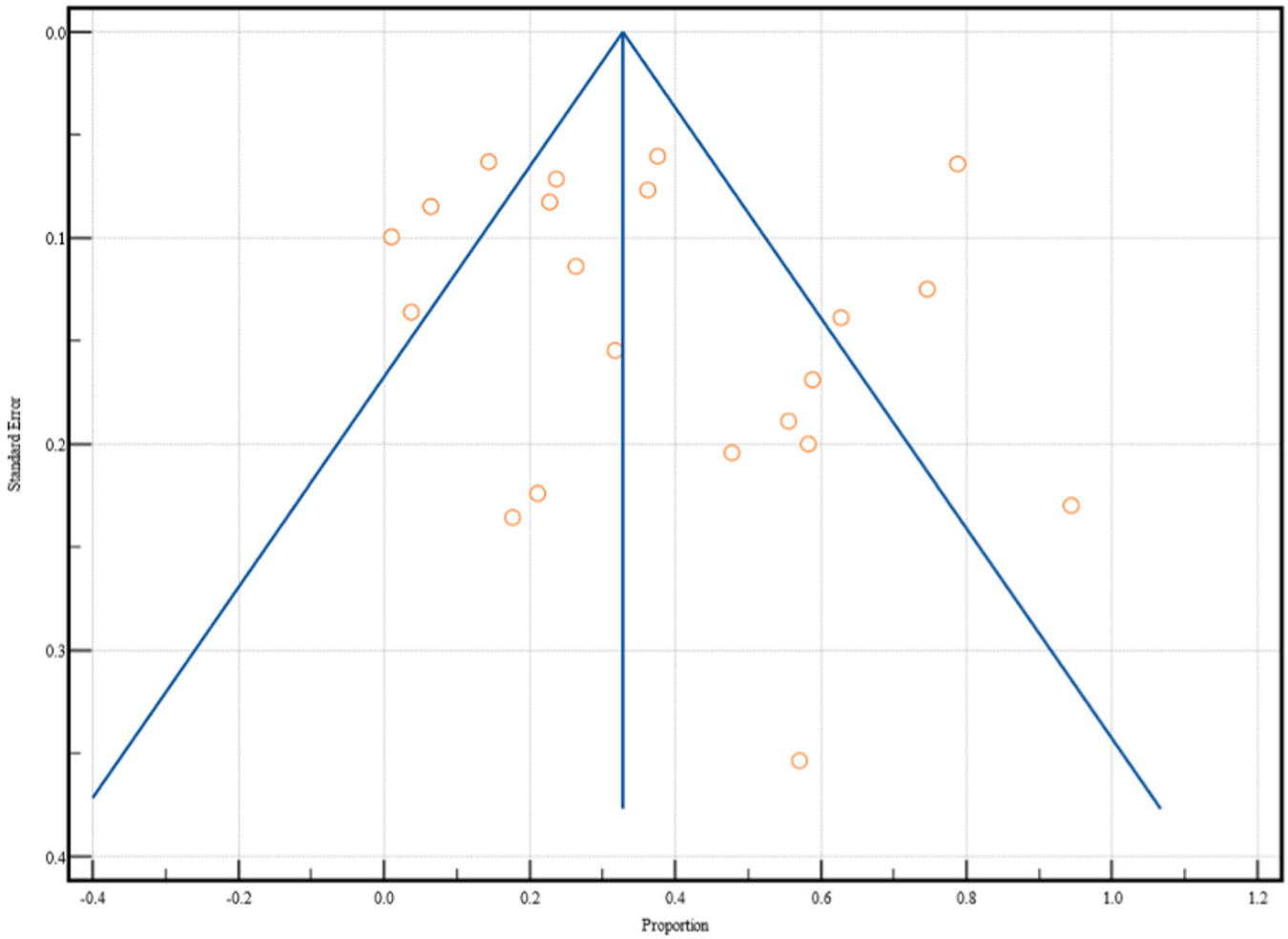

Figure 3. Funnel plot of studies included for analysis of the overall prevalence of hyperacusis among musicians.

evaluation, compared to only 72% of amateurs. On average, the most recent evaluation occurred 2.7 years ago (SD = 3.8) for professionals and 5.2 years ago (SD = 6.0) for amateurs.[86] Early detection is critical, as even a 10-dB threshold shift at 2000, 3000, and 4000 Hz is considered an early indicator of permanent hearing loss.[87] In some cases, extended high-frequency audiometry (12-16 kHz) might be warranted, particularly for instruments like the violin, where early noise-induced changes are often more evident at higher frequencies.[36,88] These findings highlight the importance of individualized audiologic monitoring, with hearing assessments tailored to the specific exposure patterns and risks associated with each instrument.

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Table 3. Prevalence of Auditory Symptoms Among Musicians Compared to the Control Population

Symptom	Musician:control (n)	Prevalence (95% CI) among musicians	Prevalence (95% CI) among control population	*P*-value for comparison of proportions
Hearing loss	15,602:3,340,846	25.7% (21.0%-30.6%)	11.6% (6.5%-18.1%)	*P* < .0001
Hyperacusis	1964:114	37.3% (25.5%-49.9%)	15.3% (9.3%-23.2%)	*P* < .0001
Tinnitus	7570:3,340,866	42.6% (34.6%-50.7%)	13.2% (0.5%-38.7%)	*P* < .0001

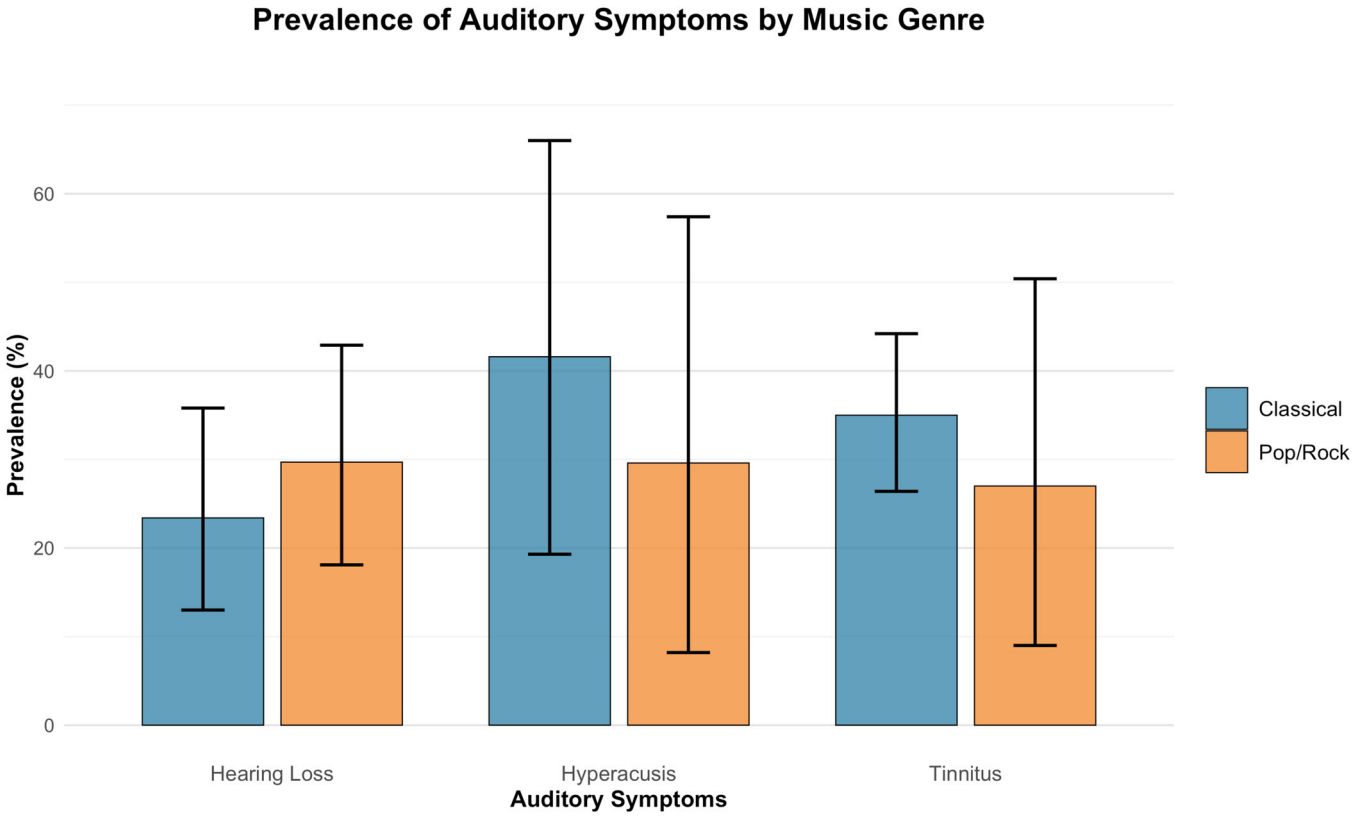

Figure 4. Proportion of classical and pop/rock musicians experiencing hearing loss, hyperacusis, and tinnitus, respectively. Error bars represent the 95% confidence interval.

The prevalence of tinnitus was also significantly higher among musicians compared to the control population. The etiology of tinnitus is not well understood, but risk factors include noise exposure and age-related hearing loss.[89] Although tinnitus is associated with noise-induced hearing loss, its severity correlates with total sound exposure rather than audiometric thresholds alone.[65] Notably, a significant subset of patients with tinnitus or hyperacusis have normal hearing thresholds,[90] suggesting that early cochlear damage can occur without detectable hearing loss and contribute to tinnitus or hyperacusis.[91] Furthermore, an audiometric study of patients with hyperacusis found reduced loudness discomfort levels across all tested frequencies, regardless of the pattern or degree of hearing loss, suggesting that hyperacusis could reflect central auditory gain rather than hearing loss itself.[92] These findings suggest that tinnitus and hyperacusis could arise from early auditory dysfunction not captured by standard audiometry, emphasizing the importance of routine auditory screening and monitoring for musicians, particularly those with high exposure to sound.

Limitations and Future Directions

Our meta-analysis was limited by heterogeneity in genre, setting, instrument played, and length of exposure. Additionally, most studies did not assess confounding factors such as leisure noise exposure, age, preexisting medical conditions, and use of hearing protection. Another limitation lies in potential underreporting of musician status, as many amateur or part-time musicians might primarily identify by their main occupation rather than as musicians, leading to possible misclassification bias in the included studies. Furthermore, there was a lack of consistency in subjective versus objective reports of hearing loss. The majority of symptoms, particularly

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tinnitus and hyperacusis, were self-reported, which is susceptible to recall bias and reporting bias. Finally, exposure to other sources of music, such as frequent headphone or speaker use, might further confound the relationship between musicianship and hearing outcomes but could not be adequately controlled for in this analysis. Future research could aim to provide an individualized risk assessment for musicians by exploring factors such as instrument type, performance setting, and additional sources of auditory exposure.

Conclusion

Our meta-analysis found that musicians experience significantly higher rates of hearing loss, hyperacusis, and tinnitus than non-musicians, with tinnitus being the most common symptom. At least one in three musicians reports tinnitus or hyperacusis, while approximately one in four has hearing loss. Symptom prevalence did not differ between classical and pop/rock musicians, highlighting that risk extends across genres. These findings are relevant for otolaryngologists, who play an important role in identifying early signs of auditory dysfunction. Tailored strategies, including regular auditory assessments, education on safe listening practices, and guidance regarding instrument- or performance-specific risk factors, might help reduce the burden of auditory symptoms in this high-risk population.

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The authors have nothing to report.

Author Contributions

Lauren R. McCray: Conception/design, data acquisition, data analysis, manuscript preparation; **Asher T. Ripp**: Conception/design, data acquisition, data analysis, manuscript preparation; **Shaun A. Nguyen**: Data analysis, software and tools, manuscript preparation; **Justin C. Pelic**: Data acquisition, manuscript preparation; **Robert F. Labadie**: Manuscript preparation, critical revision; **Ted A. Meyer**: Manuscript preparation, critical revision.

Disclosures

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Supplemental Material

Additional supporting information is available in the online version of the article.

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