# Prevalence, Classification, and Severity of Hearing Loss in Patients with Type 2 Diabetes Mellitus

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## Objectives

- To synthesize high-quality data reporting the prevalence of hearing loss in patients with type 2 diabetes mellitus (T2DM).
- To characterize hearing loss in T2DM patients by classifications (types), laterality, and severity (degrees).
- To perform a systematic review and meta-analysis according to PRISMA guidelines.

## Introduction

- Hearing loss is the most common sensory deficit worldwide; sensorineural hearing loss (SNHL) is the most prevalent subtype.[1, 2]
- By 2050, an estimated 2.45 billion people will experience hearing loss globally.[3]
- Type 2 diabetes mellitus (T2DM) is a growing global health burden and is associated with multiple microvascular complications (retinopathy, nephropathy, neuropathy).[4]
- Emerging evidence links T2DM with hearing loss, with proposed mechanisms including: cochlear microvascular damage, oxidative stress and metabolic dysregulation, and auditory neuropathy.[5-7]
- Reported prevalence rates of hearing loss in T2DM vary widely due to differences in methodology, populations, and diagnostic criteria.
- A comprehensive synthesis is lacking to clarify the true association between T2DM and hearing loss, which may impact screening guidelines and early intervention strategies.

## Methods and Materials

- **Design:** Systematic review and meta-analysis conducted according to **PRISMA guidelines**.
- **Databases searched:** PubMed, SCOPUS, CINAHL, and Cochrane Library (through October 14, 2024).
- **Inclusion criteria:** Studies of adults (≥18 years) with T2DM, cross-sectional or cohort studies evaluating hearing loss.
- **Exclusion criteria:** Non-English, animal studies, case reports, reviews, and studies without full text.
- **Data extraction:** Patient demographics, prevalence, type, laterality, and degree of hearing loss.
- **Quality assessment:** ROBINS-E tool, JBI critical appraisal checklist, Oxford Centre for Evidence-Based Medicine levels of evidence assigned.
- **Statistical analysis:** Meta-analysis of proportions, means, and relative risks (RR) with 95% confidence intervals.
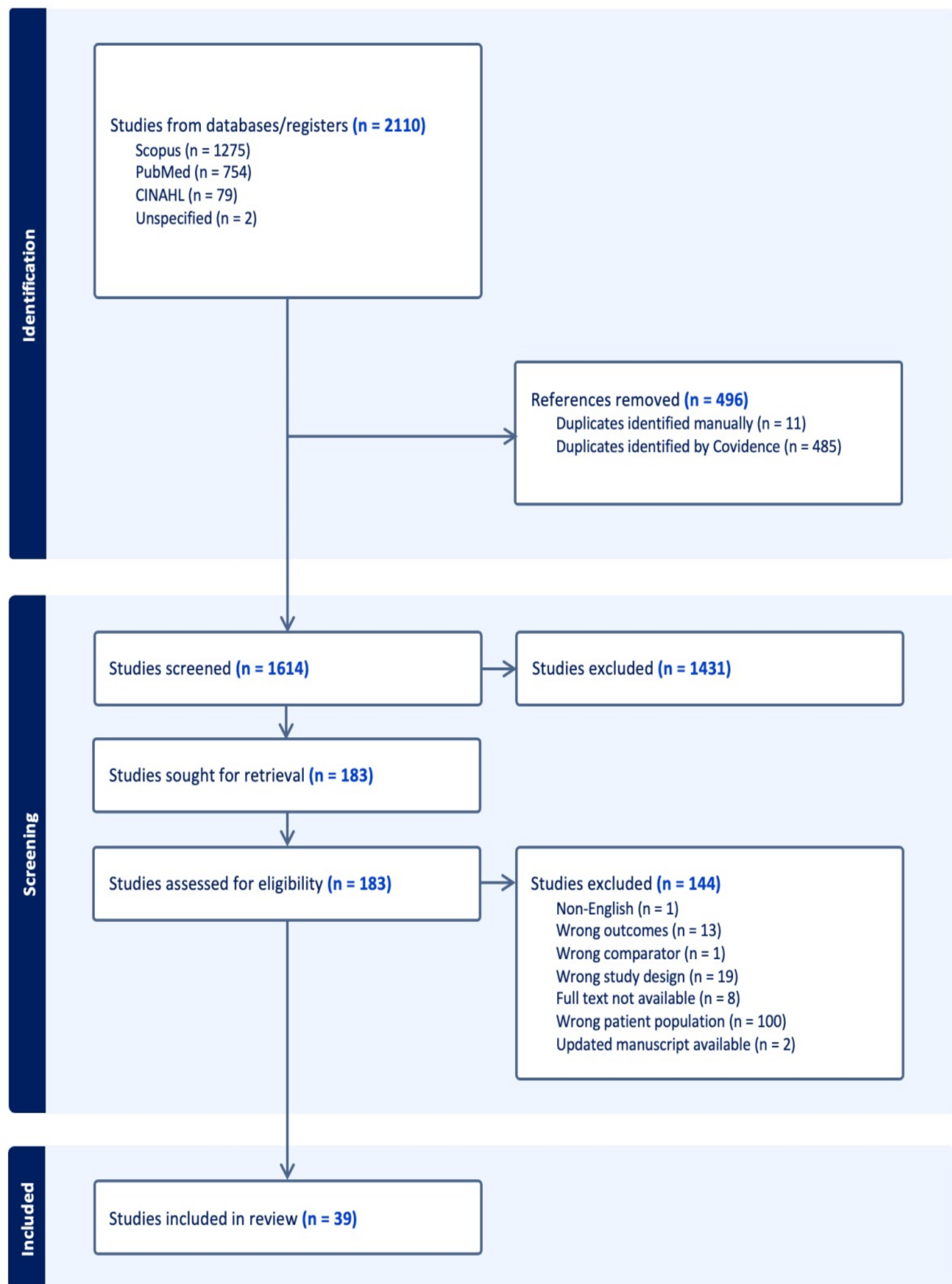


**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses ('PRISMA') diagram
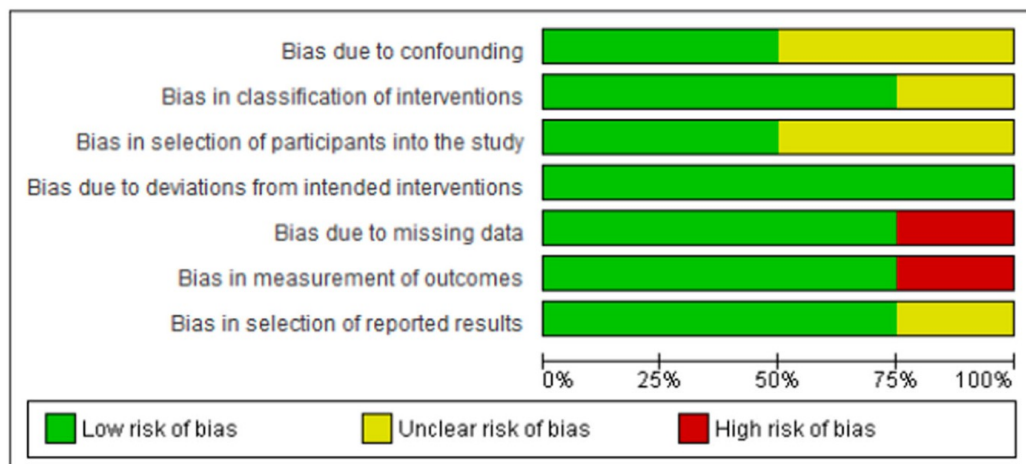


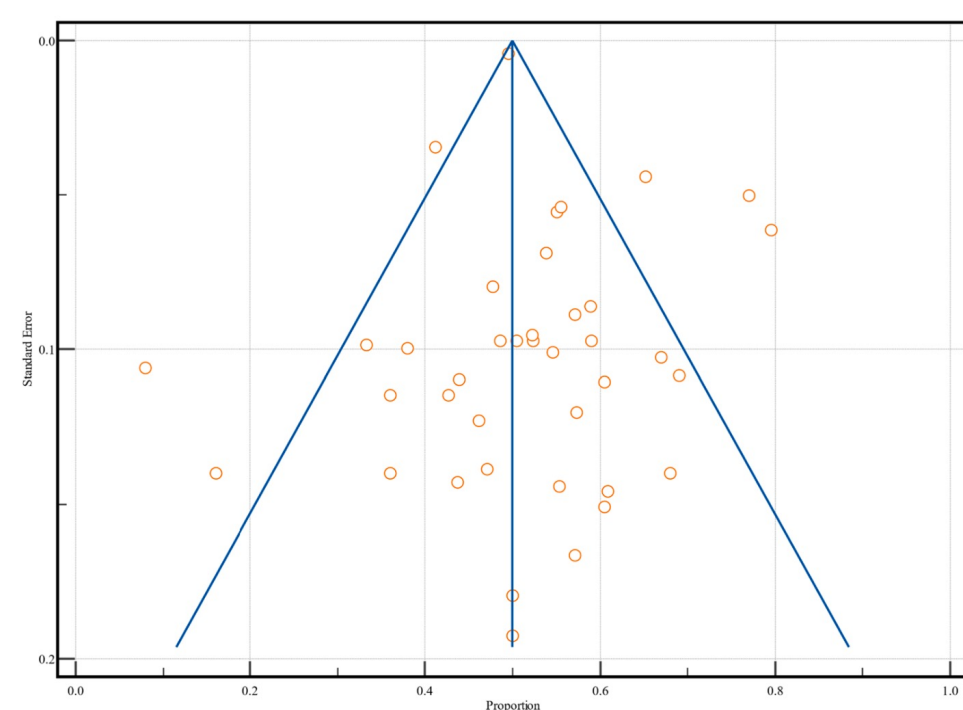**Figure 2.** Critical appraisal of non-randomized studies



**Figure 3.** Funnel plot for publication bias

## Results

- Thirty-nine studies pertaining to hearing loss (HL) in adults with or without T2DM were included (**n=88,395 with T2DM; n=20,337 controls**). Mean age for T2DM and control groups were 50.3 and 46.7; proportions of females were 63.8% and 64.3%, respectively. Mean HbA1c in T2DM group was **8.4%**; control group had **4.8%**. Mean diabetes duration in T2DM group was **9.1 years**.
- The T2DM group had significantly higher prevalence and relative risk than the control group of hearing loss in either ear (53.0% vs. 25.2%, **Δ=27.7%**, $p<0.0001$; **relative risk (RR) = 2.3**, 95% CI: 1.1-4.8).
- The **sensorineural** and **bilateral HL** were the most prominent classification and laterality of HL in the T2DM group; statistical significance ($p<0.0001$) in difference were detected when compared to the control group (46.2% vs. 18.1%; 29.6% vs. 6.9%, respectively).
- According to WHO criteria, T2DM group showed the most prominent severity of HL in **mild (26-40dB)** and **moderate (41-60dB)** degrees; statistical significance ($p<0.0001$) in difference were detected when compared to the control group (22.1% vs. 8.2%; 25.5% vs. 9.3%, respectively).

| | Prevalence of hearing loss (95% CI) | Conductive hearing loss (95% CI) | Sensorineural hearing loss (95% CI) | Mixed hearing loss (95% CI) | Unilateral hearing loss (95% CI) | Bilateral hearing loss (95% CI) |
|---|---|---|---|---|---|---|
| T2DM group | 53.0% (38.7%-67.0%) | 5.0% (2.3%-9.3%) | 46.2% (19.5%-74.1%) | 10.4% (7.7%-13.7%) | 15.0% (7.0%-25.4%) | 29.6% (21.6%-38.2%) |
| Control group | 25.2% (11.8%-41.7%) | - | 18.1% (3.0%-42.0%) | 7.2% (1.7%-16.3%) | 7.5% (4.1%-12.6%) | 6.9% (0.5%-20.1%) |
| Δ; P value | 27.8%; P < .0001 | - | 28.1%; P < .0001 | 3.2%; P = .1931 | 7.5%; P = .0083 | 22.7; P < .0001 |

Abbreviations: CI, confidence interval; T2DM, type 2 diabetes mellitus.

**Figure 4.** Prevalence, classification, and laterality of hearing loss in T2DM group compared to control

| | WHO criteria | | | |
|---|---|---|---|---|
| | Mild (26-40 dB) (95% CI) | Moderate (41-60 dB) (95% CI) | Severe (61-80 dB) (95% CI) | Profound (>80 dB) (95% CI) |
| T2DM group | 22.1% (5.4%-45.7%) | 25.5% (14.5%-38.3%) | 8.5% (6.2%-11.3%) | 1.7% (0.04%-7.8%) |
| Control group | 8.2% (1.2%-20.7%) | 9.3% (3.8%-17.0%) | 4.1% (3.3%-5.1%) | - |
| Δ; P-value | 13.9%; P < .0001 | 16.2%; P < .0001 | 4.4%; P = .0001 | - |

Abbreviations: CI, confidence interval; T2DM, type 2 diabetes mellitus; WHO, World Health Organization.

**Figure 5.** Severity of hearing loss in T2DM group compared to control according to the WHO criteria
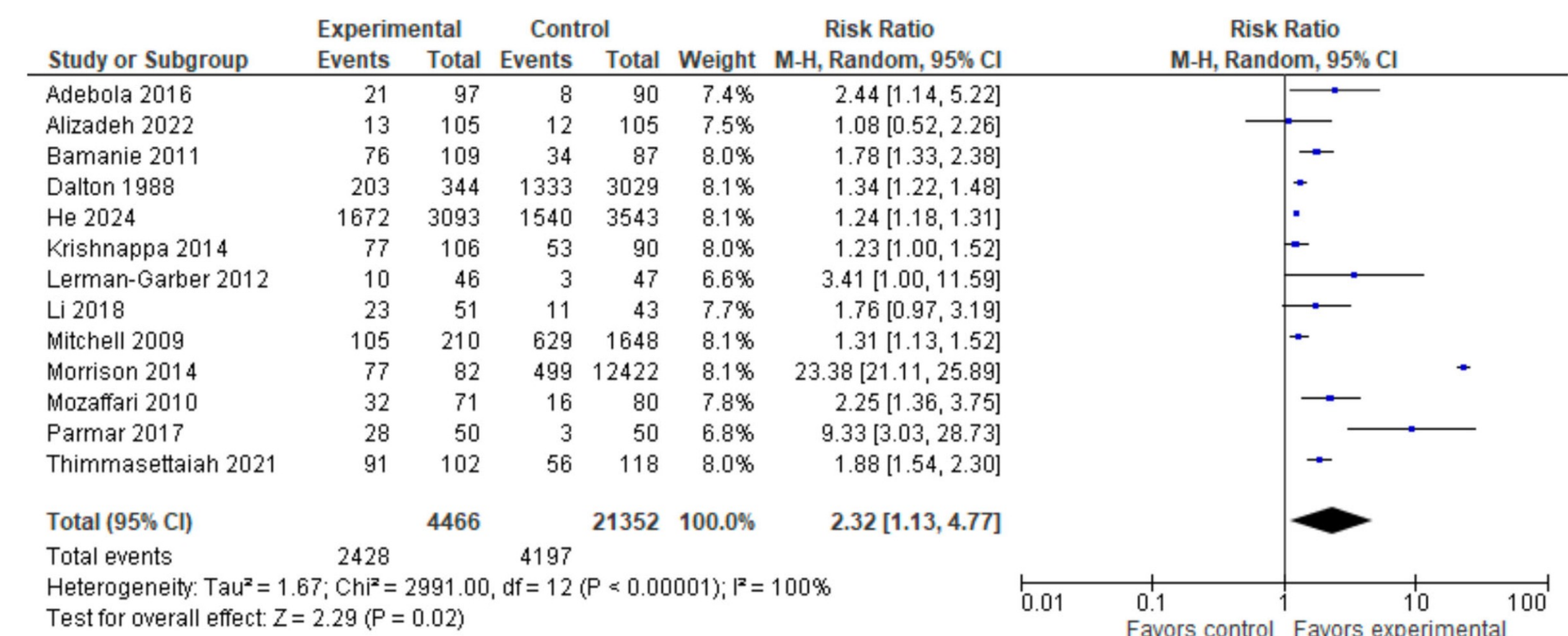


**Figure 6.** Relative risk for prevalence of hearing loss in T2DM group compared to control

## Discussion

- Patients with T2DM show a **significantly higher prevalence and risk of hearing loss**, especially sensorineural and bilateral, confirming diabetes as an independent risk factor.
- **Experimental evidence in diabetic mouse models** demonstrates cochlear microangiopathy, mitochondrial dysfunction, and synaptopathy, supporting biological mechanisms underlying hearing loss in T2DM.[8]
- Findings emphasize the need for **routine hearing screening and early intervention** in patients with T2DM to reduce long-term quality-of-life and healthcare burden.

## Conclusions

- Patients with type 2 diabetes mellitus have a significantly higher risk of sensorineural, often bilateral, hearing loss—most commonly mild to moderate—underscoring the need for routine screening and early intervention.

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