

# Hearing Impairment: Another Microvascular Complication of Diabetes?

Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment in the United States: audiometric evidence from the National Health and Nutrition Examination Survey, 1999 to 2004. *Ann Intern Med* 2008;149:1–10.

## Study Overview

**Objective.** To determine whether diabetes is related to hearing impairment.

**Design.** Cross-sectional study.

**Setting and participants.** 5140 participants aged 20 to 69 years who had audiometric testing and completed a diabetes questionnaire as part of the National Health and Nutrition Examination Study (NHANES) from 1999 to 2004. A diagnosis of diabetes was assessed with the question, “Other than during pregnancy (for women), have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?” 2259 participants were randomly assigned to fasting blood glucose testing; of these participants, 146 had diabetes. A total of 399 participants in the cohort had diabetes (either self-reported or confirmed by blood glucose testing).

**Main outcome measure.** Mild or greater severity hearing loss at low or mid and high frequencies in the worse ear as measured by audiometric testing.

**Main results.** Of participants with diabetes, 21.3% (95% confidence interval [CI], 15%–27.5%) had mild or greater severity hearing loss at low or mid frequency in the worse ear as compared with 9.4% (95% CI, 8.2%–10.5%) of those without diabetes. Similarly, 54.1% (95% CI, 45.9%–62.3%) of participants with diabetes versus 32% (95% CI, 30.5%–33.5%) of those without diabetes had mild or greater severity hear-

ing loss at high frequencies in the worse ear. Results were significant ( $P < 0.001$ ) and were adjusted for other factors that might explain hearing loss, such as age, use of ototoxic medications, smoking status, military history, sex, race/ethnicity, education, and noise exposure (adjusted odds ratio for low-/mid-frequency and high-frequency impairment of mild or greater severity, 1.82 [95% CI, 1.27–2.60] and 2.16 [95% CI, 1.47–3.18], respectively). Similar results were found for moderate or greater severity hearing impairment and for hearing impairment in the better ear. In a subset of participants with measured fasting glucose level, results were consistent and demonstrated a dose-response, such that hearing impairment was more common in participants who met diagnostic criteria for diabetes or had impaired fasting glucose as compared with participants with normal glucose levels (48.4% and 40.5% vs. 30.4%, respectively).

**Conclusion.** Diabetes is associated with hearing impairment.

## Commentary

Extensive research has documented a strong link between microvascular disease (eg, nephropathy, retinopathy, neuropathy) and diabetes [1,2], and studies have shown that the risk for microvascular disease can be lowered with intensive glucose control [3,4]. Hearing impairment has not been considered a microvascular complication of diabetes, but the results of this study could compel an eventual change if future research confirms the findings of this study by Bainbridge and colleagues.

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Linking diabetes and hearing impairment is plausible for the same reasons that diabetes is known to cause microvascular disease. Glycosylation of the microvasculature, such as in the retina, peripheral nerves, and kidney, progressively damages the vessels and disrupts the function of the tissues that these vessels supply. Similarly, prior research has documented pathologic changes consistent with glycosylation in the nerves of the inner ear in diabetic patients [5,6]; however, observational evidence of an association between hearing loss and diabetes has been weak. Dalton et al [7] found slightly higher rates of age-related hearing loss (presbycusis) among diabetic patients. Hearing loss was more common among patients who had already been diagnosed with neuropathy. Results of a similar evaluation in the Framingham Heart Study showed more equivocal results; an association between low-frequency hearing loss and increasing glucose level was present for women only [8].

In this study by Bainbridge et al, a large divergence in hearing loss was found between participants with and without diabetes using data from the NHANES surveys from 1999 to 2004. The association was seen for all frequencies of hearing loss, in better and worse ears, and for different severities of hearing loss, even after adjusting for clearly recognized potential confounders (eg, noise exposure, ototoxic medications, smoking). The authors assessed this relationship in multiple ways by including assessments of measured and self-reported hearing loss and diabetes, finding associations in each.

The study had several limitations. First, authors were unable to distinguish between patients with type 1 and type 2 diabetes, so there is no way to discern if the relationship differs by diabetes type. Second, diabetes was self-reported in the main analysis. Although the study included a subsample of participants who underwent fasting blood glucose testing, this subset comprised less than half of the total study population. Also, data are cross-sectional and a temporal association cannot be established. Finally, no measurements of diabetes control were provided, and concomitant microvascular diagnoses were not evaluated. If hearing impairment is indeed a microvascular complication of diabetes, then one would expect hearing impairment to coincide with retinopathy, neuropathy, or nephropathy. Extensive measurements of potential microvascular complications of diabetes are provided in the NHANES surveys, and the authors should have been able to compare hearing loss with these complications.

Future research should examine hearing impairment

and diabetes in a longitudinal study assessing the relationship with degree of diabetes control and the coexistence of microvascular complications. Clinical trials ultimately could provide concrete evidence of an association between hearing impairment and diabetes, similar to what has been established with diabetes and microvascular disease [1,2].

### Applications for Clinical Practice

Based on data from this large, cross-sectional, nationally representative study, diabetes appears to be associated with hearing impairment. If this association is confirmed in future studies, aggressive glucose control might be an effective strategy for preventing hearing impairment. Clinicians should also be aware that diabetic patients might be more likely to develop hearing impairment so that early audiometric testing can be pursued in patients at risk.

—Review by Jason P. Block, MD, MPH

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