ARIC Manuscript Proposal Form

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Publication Committee Review Date: **12/26/23**
ARIC Manuscript Proposal Number: **# H4371**

1.a. Full Title: Effects of Hearing Intervention on Falls: Findings from the ACHIEVE study

b. Abbreviated Title (Length 26 characters): ACHIEVE hearing and falls

2. Writing Group [please provide a middle initial if available; EX: Adam L Williams]:
Writing group members:
Adele M. Goman (first author), Wuyang Zhang (analyst), Michelle L. Arnold, Sheila Burgard, Theresa H. Chisolm, Jennifer A. Deal, Nancy W Glynn, Lisa Gravens-Mueller, Kathleen, M. Hayden, Alison R. Huang, Pablo Martinez Amezcua, Christine M. Mitchell, James S. Panow, James R. Pike, Nicholas S. Reed, Victoria A. Sanchez, Jennifer A. Schrack, Kevin Sullivan, Josef Coresh, Frank R. Lin (senior author), for the ACHIEVE Collaborative Research Group
Other authors are also welcome.

I, the first author, confirm that all the coauthors have given their approval for this manuscript proposal. AMG **[please confirm with your initials electronically or in writing]**

First author [please provide a middle initial; EX: Adam L Williams]:

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ARIC author to be contacted if there are questions about the manuscript and the first author does not respond or cannot be located (The ARIC author should be involved enough in ARIC to be able to point the lead author to appropriate ancillary study PIs and to be able to search ARIC manuscript proposals if the lead author doesn't have the access needed to do such a search).

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3. Timeline:

Proposal timeline	Oct-Nov 2023	Dec 2023-Jan 2024	Jan-Feb 2024
Proposal approval	X		
Data Analysis		X	
Manuscript preparation and submission			X

4. Rationale:

In the United States, falls are the leading cause of non-fatal injuries[1] and mortality rates from falls among older adults aged 75+ have more than doubled in the last two decades[2]. Hearing loss is highly prevalent among older adults and has been associated with an increased likelihood of falling[3]. Potential causal explanations for an association between hearing loss and falling include poor awareness of the auditory and spatial environment, concomitant cochlear and vestibular dysfunction, or mediation through the effects of hearing loss on cognitive load and attention[4]. However, few studies have examined whether hearing aid use can reduce the likelihood of falling among those with hearing loss.

Studies examining the relationship between hearing aid use and falls have found conflicting results. Some studies have found hearing aid use is associated with a reduced risk of falls[5,6], other studies have found no differences[7,8] and one longitudinal study has found hearing aid use to be associated with an increased risk of falls[9]. Furthermore, aspects of hearing aid use such as the duration or consistency of hearing aid use may have an impact: In one cross-sectional study of adults aged 60+ the effect of a reduced risk of falls was found to be stronger for individuals who self-reported using hearing aids for ≥4 hours per day[5]. The reasons for these differences between studies could be due to cohort differences, analytic approaches[10], the measurement of falls, or the measurement of hearing aid use. Critically, studies to date examining the relationship between hearing aid use and falls outcomes have compared participants who are already hearing aid users to participants who do not use hearing aids. It is likely that these participants differ in both the perceived impact of their hearing loss and their ability to seek out and obtain hearing aids. To date, no large-scale randomized controlled trial has examined the relationship between hearing aid use and falls. The Aging and Cognitive Health Evaluation in Elders (ACHIEVE) study is a randomized controlled trial of older adults with hearing loss randomized to a best-practice hearing intervention versus a successful aging health education control that collected data on falls outcomes for three years.

5. Main Hypothesis/Study Aims:

Study Question:

To determine the effect of a hearing rehabilitative intervention versus a successful aging health education control intervention on falls in older adults with hearing loss.

Main Hypotheses:

Hearing intervention (versus successful aging health education control) is associated with reduced odds of falling over three years of follow up among older adults with hearing loss.

6. Design and analysis - please address the following aspects:

a) inclusion/exclusion

All eligible participants enrolled at baseline in the ACHIEVE study.

- Inclusion criteria: 1) age 70-84 years, 2) community-dwelling adults, 3) mild–to-moderate audiometric hearing impairment, defined as a better-hearing ear pure tone average (PTA) ≥30 and <70 dB hearing level, 4) MMSE ≥23 for those with high school degree or less, and ≥25 for those with some college education or more, 5) Word Recognition in Quiet score ≥60% correct in the better-hearing ear, 6) fluent English-speaker, 7) older adults who plan to remain in the area during the study period.
- Exclusion criteria: 1) self-reported difficulty in ≥2 activities of daily living, 2) prior dementia diagnosis, 3) vision impairment, 4) medical contraindication to hearing treatment, 5) untreatable conductive hearing impairment, 6) unwillingness to regularly wear hearing aids, 7) self-reported hearing aid use in the past year.

b) study design

Randomized trial of 977 participants enrolled in the ACHIEVE trial from 2018-2019 and followed for 3 years. Participants were from four U.S. sites (Forsyth County, NC; Jackson, MS; Minneapolis, MN; Washington County, MD). 238 participants were recruited from the ongoing Atherosclerosis Risk in Communities Neurocognitive (ARIC-NCS) Study and the remaining 739 participants were recruited *de novo* from the community.

c) outcome and other variables of interest with specific reference to the time of their collection

Outcomes:

Fall outcomes were assessed annually. The primary outcome is falls (Any falls/No falls) assessed with the question '*In the past 12 months did you fall?'*. Responses are categorized as 'Yes' or 'No'.

Secondary outcome is injurious fall: Categorized as 'Yes' if participant responded, 'Yes' to either *'Did you have to limit your activities because you were injured from this fall'* or '*From this fall, did you have an injury that required you to see your doctor'*. Categorized as 'No' if responses to these two questions are 'No', or if the participant did not report any fall.

Participants who responded that they had fallen in the past 12 months were asked how many times they fell. Assuming there are sufficient responses we will explore ordinal outcomes of frequency and severity. The frequency outcome will be (0) no falls, (1) one fall, and (2) two or more falls. The severity outcome will be (0) no falls, (1) one or more non-injurious falls, and (2) one or more injurious falls.

Exposure variables:
Intervention group (hearing intervention or successful aging health education) assigned at baseline randomization.

Other variables:
Analyses may include adjustments for baseline hearing loss (defined as the better ear pure-tone average), demographic and recruitment variables (Recruitment source (ARIC/de novo), race, center, age (years), sex (male/female), education (less than high school/high school or equivalent/greater than high school)), health variables (hypertension, smoking (never/former/current), stroke, and diabetes), self-reported hearing difficulty, balance (SPPB score), cognitive functioning (global cognitive score), and depressive symptomatology (CES-D score).

Compliance with the hearing intervention (≥4 hours hearing aid use per day on average) will be based on self-report (International Outcome Inventory for Comprehensive Intervention Q1: *'Did you use your hearing aids or hearing assistive technology during the past two weeks?'* & Q2: *'Over the past two weeks, how many hours per day, on average, did you use your hearing aids?'*) and based on hearing aid data logging.

d) summary of data analysis

A statistical analysis plan (SAP) for the primary analysis of the ACHIEVE study was previously developed by the CC in conjunction with ACHIEVE investigators and approved by the NIA and ACHIEVE DSMB in June 2022. The analysis for this proposal is considered additional to the primary for the study but the analytic process will adhere to guidelines detailed in the SAP. Wuyang Zhang will be the analysis lead for this manuscript.

The odds of falling at three years will be analyzed using logistic mixed effects models. We will test the proportional odds assumption but assuming there are sufficient responses we will explore ordinal outcomes of frequency and severity. If necessary and appropriate based on the distribution we will explore these outcomes in longitudinal multinomial logistic regression (severity) and longitudinal negative binomial (frequency) models. We will also explore complier average causal effect (CACE) analysis using inverse probability weights to explore whether there is a potential dose response relationship between hearing aid use and falls by taking into account compliance with the hearing intervention.

Analyses may include adjustments for baseline hearing loss (defined as the better ear pure-tone average), demographic and recruitment variables (Recruitment source (ARIC/de novo), race, center, age (years), sex (male/female), education (less than high school/high school or equivalent/greater than high school)), health variables (hypertension, smoking (never/former/current), stroke, and diabetes), self-reported hearing difficulty, balance (SPPB score), cognitive functioning (global cognitive score), and depressive symptomatology (CES-D score). In sensitivity analyses we will explore whether there is a potential dose response relationship between hearing aid use and falls stratifying the hearing intervention group by consistency of hearing aid use (regular/not regular).

e) Any anticipated methodologic limitations or challenges if present
No

f) Will the author need Limited data to complete the proposed manuscript? ☐ Yes, Limited data is needed (Provide a brief (2-3 sentences) justification for requesting PHI data) . ☒ No, De-identified data will be sufficient.

*Please note, Limited dataset access is strict and rarely provided. Limited data includes identifiable information such as dates (birthdays, visit dates, etc.). CMS, Genomic, Geocoded, Proteomics/Somalogic, and other -omic data all fall under the limited data category. De-identified data does not include dates. All dates are date adjusted to "Days since Visit 1".

7.a. Will the data be used for non-ARIC analysis or by a for-profit organization in this manuscript? (Non-ARIC analysis means that the authors are not regarded as ARIC investigators and the "ARIC author" is essentially just a facilitator rather than an integral part of the writing group.) ☐ Yes ☒ No

b. If Yes, is the author aware that the current derived consent file ICTDER05 must be used to exclude persons with a value RES_OTH and/or RES_DNA = "ARIC only" and/or "Not for Profit" ? ☐ Yes ☐ No
(The file ICTDER is distributed to ARIC PIs annually, and contains the responses to consent updates related to stored sample use for research.)

8.a. Will the DNA data be used in this manuscript? ☐ Yes ☒ No

8.b. If yes, is the author aware that either DNA data distributed by the Coordinating Center must be used, or the current derived consent file ICTDER05 must be used to exclude those with value RES_DNA = "No use/storage DNA"? ☐ Yes ☐ No

9. The lead author or the "sponsoring" ARIC author of this manuscript proposal has reviewed the list of existing ARIC Study manuscript proposals and has found no overlap between this proposal and previously approved manuscript proposals either published or still in active status. ARIC Investigators have access to the publications lists under the Study Members Area of the website at:

https://aric.cscc.unc.edu/aric9/proposalsearch [ARIC Website□Publications□Proposal Search]

☒ Yes ☐ No

10. What are the most related manuscript proposals in ARIC (authors are encouraged to contact lead authors of these proposals for comments on the new proposal or collaboration)?

Effects of Hearing Intervention with Hearing Aids on Cognitive Decline: Findings from the ACHIEVE study.
Effects of Hearing Intervention with Hearing Aids on Physical Function (Short Physical Performance Battery, Grip Strength): Findings from the ACHIEVE study.
Development, assessment, and monitoring of audiologic treatment fidelity in the Aging, Cognition, and Health Evaluation in Elders (ACHIEVE) randomized controlled clinical trial.

11.a. Is this manuscript proposal associated with any ARIC ancillary studies or does it use current [or ongoing] ancillary study data (this includes ACHIEVE)? ☒ Yes ☐ No → Skip to question 12

11.b. If yes to 11.a., is the proposal

☒ **A. primarily the result of an ancillary study**

☐ **B. primarily based on ARIC data with ancillary data playing a minor role (usually control variables)**

11.c. If yes to 11.a., list number*2016.03 __

*ancillary studies are listed by number
https://aric.cscc.unc.edu/aric9/researchers/ancillary_studies/approved_ancillary_studies [ARIC Website□Ancillary Studies□Approved Ancillary Studies]

12a. Manuscript preparation is expected to be completed in one to three years. If a manuscript is not submitted for ARIC review at the end of the 3-years from the date of the approval, the manuscript proposal will expire.

12b. The NIH instituted a Public Access Policy in April, 2008 which ensures that the public has access to the published results of NIH funded research. It is **your responsibility to upload manuscripts to PubMed Central** whenever the journal does not and be in compliance with this policy. Four files about the public access policy from http://publicaccess.nih.gov/ are posted in https://aric.cscc.unc.edu/aric9/publications/policies_forms_and_guidelines [ARIC Website□Publications□Publication Policies, Forms, and Guidelines].
http://publicaccess.nih.gov/submit_process_journals.htm shows you which journals automatically upload articles to PubMed central.

References: ____

1. Centers for Disease Control and Prevention. WISQARS Leading Causes of Nonfatal Injury. https://wisqars.cdc.gov/lcnf/ (2020).

2. Hartholt, K. A., Lee, R., Burns, E. R. & van Beeck, E. F. Mortality from falls among US adults aged 75 years or older, 2000-2016. *JAMA* **321**, 2131–2133 (2019).
3. Jiam, N. T. L., Li, C. & Agrawal, Y. Hearing loss and falls: A systematic review and meta-analysis. *Laryngoscope* vol. 126 2587–2596 Preprint at https://doi.org/10.1002/lary.25927 (2016).
4. Lin, F. R. & Ferrucci, L. Hearing loss and falls among older adults in the United States. *Arch intern med* **172**, 369–371 (2012).
5. Campos, L. *et al.* Consistent hearing aid use is associated with lower fall prevalence and risk in older adults with hearing loss. *J Am Geriatr Soc* **71**, 3163–3171 (2023).
6. Mahmoudi, E. *et al.* Can Hearing Aids Delay Time to Diagnosis of Dementia, Depression, or Falls in Older Adults? *J Am Geriatr Soc* **67**, 2362–2369 (2019).
7. Kamil, R. J. *et al.* Association of hearing impairment with incident frailty and falls in older adults. *J Aging Health* 1–17 (2015) doi:10.1093/gerona/glu094.
8. Riska, K. M. *et al.* Impact of hearing aid use on falls and falls-related injury: Results from the Health and Retirement Study HHS Public Access. *Ear Hear* **43**, 487–494 (2022).
9. Gopinath, B., Mcmahon, C. M., Burlutsky, G. & Mitchell, P. Hearing and vision impairment and the 5-Year incidence of falls in older adults. *Age Ageing* **45**, 353–358 (2016).
10. Powell, D. S., Jiang, K., Deal, J. A. & Reed, N. S. Do hearing aids prevent falls? Commentary on study from the national health and nutrition examination survey. *American Journal of Audiology* vol. 30 1146–1147 Preprint at https://doi.org/10.1044/2021_AJA-21-00120 (2021).

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