Hearing impairment and objectively measured physical activity: A systematic review

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INTRODUCTION

Physical activity (PA) is a fundamental and modifiable component of healthy aging [1].

Hearing impairment (HI) is a common condition at older ages. Several consequences of HI are hypothesized to be mediated by lower PA. However, whether older adults with HI have lower levels of PA is not well-understood.

METHODS

We conducted a systematic review of the association between HI and objectively measured PA among adults older than 50.

Using controlled vocabulary for HI and PA concepts, we conducted a literature search in Medline (Ovid), Embase, and Cochrane Library (supplemental materials).

The results were merged using EndNote (Clarivate Analytics) and imported into Covidence (Veritas Health Innovation). We followed a dual blinded review process for screening; a

third reviewer resolved discrepancies. The final decision to include/exclude was based on the pre-specified criteria.

RESULTS

Of 1,127 unique studies; nine were selected by reviewers, and four were excluded after a full-text review (different outcome=3, different exposure=1), leaving five studies (Supplementary Materials S1).

The included studies (Table 1) had between 184 and 1,669 participants; all were cross-sectional and used the same data source—the National Health and Nutrition Examination Survey (NHANES) 2003–2006 cycle. One study included only participants with diabetes.

Hearing assessment

Audiometry was performed by trained NHANES examiners[2]. Hearing was defined by the speech-frequency (500, 1000, 2000, and 4000 Hz) pure-tone average of the better hearing ear and categorized into normal hearing (<25 dB HL), mild HI (25–39 dB HL), and moderate or greater HI (40 dB HL).

Physical activity assessment

PA was assessed, for seven consecutive days, using a hip-worn accelerometer (AM-7164, Actigraph, Pensacola, FL.), only removed during sleep and water-based activities. PA was summarized into counts per minute (CPM).

Studies calculated the time spent at different activity intensities, using predefined CPM thresholds: sedentary (<100), light (100– 2,019), moderate (2,020–5,998), and vigorous (5,999)[3].

Two studies used moderate and vigorous (MVPA) minutes per day as an integer variable for their outcome; two studies used MVPA minutes to categorize participants into inactive (0 MVPA minutes/week), insufficiently active (1–149 MVPA minutes/week), and sufficiently active (150 MVPA minutes/week)[1]. Finally, one study used log-transformed sedentary minutes.

Findings

The studies' findings are summarized in Table 1

Time spent in MVPA

One study[4] investigated the association between hearing and vision impairments and time spent in MVPA. Neither mild nor moderate or greater HI were associated with PA.

Another study[5] investigated the association between HI and MVPA minutes among participants with diabetes. Mild and moderate or greater HI were associated with fewer MVPA minutes vs. normal hearing.

Meeting the physical activity guidelines

Of the two studies that used this metric, one[6] found increased odds of being in the next lower activity group (e.g., inactive vs. insufficiently active) for those with moderate or greater HI vs. normal hearing. However, after BMI adjustment, the association was no longer significant. The second study[7] also found increased odds of being in the next lower PA group for those with moderate or greater HI, vs. normal hearing. Both studies found no significant association between mild HI and PA.

Sedentary time

The last study used log-transformed sedentary minutes (LTSM)[8] and found that participants aged >65 years with normal hearing engaged in 0.07 (95% CI: −0.12, −0.01) fewer LTSM per day .

DISCUSSION

Five studies analyzed the association of HI with objectively measured PA, all using NHANES data. The studies suggest that older adults with HI, particularly moderate or greater, may have lower PA levels and spend more time sedentary. However, two studies found no statistically significant associations[4,6]. Moreover, the PA metrics used in these studies have limitations. First, the validity of the CPM thresholds to classify PA intensities for older adults is unknown. Second, MVPA may be unattainable in the study population due to limited functional status. Third, using only MVPA minutes ignores differences in light intensity activity—the most common form of PA among older adults. Finally, emerging research suggests that novel PA metrics such as total PA volume, diurnal patterns, and fragmentation of activity may provide more discriminatory power in older populations than traditional PA measures[9]. A study published after our search was completed investigated the association between HI and these novel PA metrics, finding that HI was associated with lower total PA volume and more PA fragmentation[10].

Conclusion

Five studies investigated the association between HI and objectively measured PA in NHANES. Overall, hearing impairment was associated with lower levels of PA. The analyses and interpretation of some accelerometry metrics had limitations. Studies that use novel accelerometry-derived PA metrics are warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Characteristics, physical activity (PA) metrics, and findings of the included studies.

Study	Study Population	Hearing Assessment (Pure-tone audiometry)	Physical Activity Metric (Accelerometry-derived)	Confounders	Findings
Gispen (2014)[6]	N=706 NHANES 2005–06 participants, age 70+	HI categories: normal hearing, mild, and moderate or greater impairment	Meeting PA guidelines (Inactive, 0 MVPA min/week; insufficiently active, 1–149 MVPA min/week; sufficiently active, 150 MVPA min/week)	Age, sex, race, education, and income; cardiovascular disease (defined as history of coronary artery disease, congestive heart failure, angina pectoris, or myocardial infarction), hypertension, stroke, and smoking status	Mild hearing impairment not associated with PA category. Moderate hearing impairment associated with greater odds of being in the next lower PA category (OR=1.85 [95% CI:1.01 to 3.41]) but no longer in a model that included BMI (OR=1.70 [95% CI: 0.99 to 2.91])
Choi (2016)[7]	N=1,669 NHANES 2005–06 participants, age 70+	1. HI categories: normal hearing, mild, and moderate or greater impairment 2. Normal hearing vs. any hearing impairment 3. BPTA, continuously	Meeting PA guidelines (inactive, 0 MVPA min/week; insufficiently active, 1–149 MVPA min/week; sufficiently active, 150 MVPA min/week)	Age, sex, race, education, income, hypertension, cardiovascular disease, stroke, and smoking status	Any hearing impairment, and moderate or greater impairment associated with greater odds of being in the next lower activity category (Any: OR=2.2 [95% CI: 1.1, 4.3], Moderate: OR=1.9 [95% CI: 1.0 to 3.4])
Loprinzi (2013a)[4]	N=1,445 NHANES 2003–06 participants, age 70+	HI categories: normal hearing vs. any hearing impairment	Time spent in MVPA (minutes/day)	Age, BMI, race/ethnicity, sex, comorbidities, education, cotinine levels, c-reactive protein, valid accelerometry days, and wear time.	Hearing not associated with MVPA minutes: IRR 0.97 [95% CI: 0.88, 1.08] Significant interaction term (hearing impairment * vision impairment)
Loprinzi (2014)[5]	N=184 NHANES 2003–06 with diabetes, mean age=58.5	HI categories: normal hearing, mild, and moderate or greater impairment	Time spent in MVPA (minutes/day)	Age, BMI, race-ethnicity, sex, education, marital status, number of comorbidities, c-reactive protein, cotinine, HDL cholesterol, HbA1c, microalbuminuria, noise exposure, vision impairment	Mild hearing impairment associated with 0.07 [95% CI: 0.01, 0.60] times fewer MVPA minutes. Moderate or greater hearing impairment associated with 0.06 [95% CI: 0.01, 0.54] times fewer MVPA minutes
Loprinzi (2013b)[8]	N=682, age 55+ and N=502, age 65+	HI categories: normal hearing, mild, and moderate or greater impairment	Time spent sedentary (minutes/day)	Age, sex, race-ethnicity, poverty-to-income ratio, self-report arthritis and coronary heart disease, BMI, diabetes, hypertension, homocysteine, c-reactive protein, disability, wear time/day, days of wear	Normal hearing associated with fewer log-transformed sedentary minutes (β=−0.07 [95% CI: −0.12, −0.01]) only among participants 65 years

Abbreviations: NHANES, National Health and Nutrition Examination Survey; WHO, World Health Organization; MVPA, moderate-vigorous physical activity; BMI, body mass index; HDL, high-density lipoprotein.