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Association Between Adult-Onset Hearing Loss & Income: A Systematic Review

Audrey Mossman, B.S.[1], **Virgil K. DeMario, M.A.**[2], **Carrie Price, M.L.S.**[3], **Stella M. Seal, M.L.S.**[4], **Amber Willink, Ph.D.**[5], **Nicholas S. Reed, Au.D.**[5,6], **Carrie L. Nieman, M.D., M.P.H.**[5,7]

[1]University of Washington School of Medicine, Seattle, WA, USA

[2]University of the Incarnate Word School of Osteopathic Medicine, San Antonio, TX, USA

[3]Albert S. Cook Library, Towson University, Towson, MD, USA

[4]Welch Medical Library, Johns Hopkins University, Baltimore, MD, USA

[5]Cochlear Center for Hearing and Public Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

[6]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

[7]Department of Otolaryngology-Head and Neck Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Abstract

Introduction: Hearing loss has been shown to be associated with both negative health outcomes and low socioeconomic position, including lower income. Despite this, a thorough review of the existing literature on this relationship has not yet been performed.

Objective: To evaluate available literature on the possible association between income and adult-onset hearing loss.

Design: A search was conducted in eight databases for all relevant literature using terms focused on hearing loss and income. Manuscripts reporting the presence or absence of an association between income and hearing loss; full-text English-language access; and a predominantly adult population (≥18 years old) were eligible. The Newcastle-Ottawa quality assessment scale was used to assess risk of bias.

Results: The initial literature search yielded 2,994 references with 3 additional sources added through citation searching. After duplicate removal, 2,355 articles underwent title and abstract screening. This yielded 161 articles eligible for full-text review resulting in 46 articles that were included in qualitative synthesis. Of the included studies, 41 out of 46 articles found an association between income and adult-onset hearing loss. Due to heterogeneity among study designs, a meta-analysis was not performed.

Address for correspondence: Carrie Nieman, M.D., M.P.H. Johns Hopkins University Bloomberg School of Public Health, Cochlear Center for Hearing & Public Health, 2024 E. Monument St. Baltimore, MD USA, cnieman1@jhmi.edu.

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Conclusions: The available literature consistently supports an association between income and adult-onset hearing loss but is limited entirely to cross-sectional studies with the directionality remaining unknown. An aging population and the negative health outcomes associated with hearing loss, emphasize the importance of understanding and addressing the role of social determinants of health in the prevention and management of hearing loss.

INTRODUCTION

Over 1.5 billion people globally experience some degree of hearing loss (World report on hearing. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.). Adult-onset hearing loss, including age-related, make up the majority of hearing loss. The prevalence of hearing loss increases with age. Approximately two in three people in the United States aged 70 years and older have hearing loss, and this increases to more than 80% among individuals aged 80 years and older (Lin et al., 2011). Moreover, with an aging global population, the number of persons experiencing hearing loss of at least a mild severity is estimated to increase to nearly 2.5 billion people by 2050 (World report on hearing. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.). Considering a life course perspective, hearing loss is independently associated with a variety of negative health outcomes (Genther et al., 2013; Genther et al., 2015; Shukla et al., 2021; Uhlmann et al., 1989), including increased incident of dementia (Uhlmann et al., 1989), increased mortality risk (Genther et al., 2015), increased risk of hospitalization (Genther et al., 2013), depression (Li et al., 2014; Shukla et al., 2021) and accelerated cognitive decline (Lin et al., 2013). Hearing loss has also been associated with reduced school performance (Le Clercq et al., 2019), increased risk of unemployment or underemployment (Emmett & Francis, 2015), lower wages (He et al., 2018), and earlier retirement (Anne-Sofie Helvik et al., 2013).

Beyond hearing loss, multiple factors contribute to the health status of individuals. The Centers for Disease Control and Prevention (CDC) organizes determinants of health into five broad categories: genetics, behavior, environmental and physical influences as well as medical care and social factors. Importantly, these five categories often interconnect. Social determinants of health references the economic and social conditions that influence the health status of individuals and groups, including socioeconomic position (Social Determinants of Health | NCHHSTP | CDC). Factors that influence an individual's socioeconomic position include, but are not limited to, such individual-level factors as education, occupation, and income (Social Determinants of Health | NCHHSTP | CDC). Broadly, lower income, in particular, is associated with worse access to, utilization of, and quality of health care, which correlates to poorer health status (Andersen et al., 2002; National Academies of Sciences, Engineering, and Medicine et al., 2018; Schoen et al., 2013).

Similar to overall health, hearing health has also been associated with socioeconomic position. Hearing loss has been shown to be independently associated with unemployment and underemployment (Emmett & Francis, 2015), increased odds of lower occupation class (He et al., 2018), and increased odds of disability pension (Anne-Sofie Helvik et al., 2013). Current literature uses diverse methodologies and demonstrates varying results. Therefore, we sought to examine the potential association between hearing loss and income among

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individuals with adult-onset hearing loss to determine if there was a consensus among the literature.

DESIGN

This systematic review follows reporting guidelines suggested by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Two informationists constructed and performed the search strategy in consultation with the research team. A pilot search through a total of eight databases (PubMed (NCBI), Embase (Elsevier), The Cochrane Library (Wiley), AB/INFORM Collection (EBSCO), Business Source Ultimate (EBSCO), Web of Science (Clarivate), Scopus (Elsevier), and PsycINFO (EBSCO)) was run utilizing controlled vocabulary, such as MeSH and Emtree, where appropriate, in combination with the keyword terms related to the concepts of income and hearing loss. The searches were limited to the English language only. No date range limit was applied to the results. The original literature search was conducted on October 1st, 2018 and an updated search was run on February 8th, 2021. A complete search strategy is available in Supplemental Table 1.

The literature search yielded 5,334 references, and 3 additional sources were added through reference review. Using Covidence (EMK Capital; London, United Kingdom) 2,982 duplicates were removed, 2,355 publications underwent title and abstract screening, resulting in 161 articles eligible for full text-review, including 3 records obtained from reference review. During the screening process, two independent reviewers screened the title and abstract of each article according to the inclusion and exclusion criteria. Inclusion criteria aimed to include papers, 1) that examined the association between adult-onset hearing loss in relation to income or socioeconomic position, 2) focused on an adult population (defined as 18 years of age or older), 3) written in English, and 4) with full-text available. Exclusion criteria included 1) written in a non-English language 2) a predominantly pediatric population focus (<18 years old), 3) a focus on congenital hearing loss, and 4) unavailable full texts. Each record was assigned a “Yes”, “No”, or “Maybe” response by both reviewers. Any conflicts between responses were resolved by a third team member. All “Yes” and “Maybe” articles (n=161) underwent full-text review, and all records assigned “No” responses were excluded.

The full-text review was conducted by the same two reviewers using the same inclusion and exclusion criteria as the title and abstract screening process. The remaining records were subject to a rigorous full-text review to assess the record for eligibility. Records were assigned a status of ineligible and excluded due to reasons including 1) wrong outcomes, 2) wrong comparator, 3) not a full-text article (i.e., conference posters or abstracts), 4) wrong study design, and 5) focus on a pediatric population. Wrong outcomes were defined as outcomes that did not evaluate income. Wrong comparators were defined as studies that did not compare adults with adult-onset hearing loss to those without hearing loss. Wrong study design was defined as studies that were descriptive and did not include a comparison of income between adults with adult-onset hearing loss and those without hearing loss. The remaining records were included in this systematic review on adult-onset hearing loss and income, and extraction was performed by the two independent reviewers. During extraction,

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the two reviewers rated the study quality using the Newcastle-Ottawa Quality Assessment Scale adapted for cross-sectional studies (PA Modesti et al, 2016). Points were assigned according to the checklist. A third reviewer resolved discrepancies until consensus was obtained. Due to heterogeneity among study designs, a meta-analysis was not performed.

RESULTS

After full-text review, 46 total articles met the inclusion criteria (Figure 1). Of the included articles, 42 measured the association between income and hearing loss as their primary focus, while for four other papers the association between hearing loss and income was a secondary outcome.

The way in which hearing loss and income were measured and defined varied across studies. Hearing loss was measured through either audiometric testing of pure-tone averages (n=24) or via subjective measures, including self-report (n=22). Among studies that included audiometric data, the definition of hearing loss varied between studies. Income was measured via self-reported measures across all studies but was defined in a variety of ways. Some studies presented income as a categorical variable and others presented income as a continuous variable.

We examined the setting of the included studies, where 31 countries were represented across the 46 manuscripts, some of which can be found in Supplemental Table 2. A total of 36 studies were performed in high-income countries as determined by *The World Bank* (World Bank Country and Lending Groups. 2021), 7 studies were located in countries classified as upper-middle income countries and 2 studies were performed in lower middle-income countries. Specifically, in North America, the majority of studies were based in the United States (n=19) and Canada (n=2). The remainder of articles included 8 located in Europe (with England/UK [n=4], Sweden [n=1], Netherlands [n=1], Germany [n=1], and multi-country European locations [n=1]). Another 2 articles came from the Oceania region, with Australia being the sole location. In Asia, 1 study was performed in the Philippines, another in Bangladesh, 1 in Japan, another in Malaysia, 4 in South Korea, and 4 in China. In Central and South America, a total of 3 studies were performed in Guatemala (n=1), Brazil (n=1), and Chile (n=1).

Data regarding ethnicity varied greatly across all studies with only nine studies reporting data on the self-identified ethnicity of participants. Of the nine studies that reported data on ethnicity, 8 of these studies were based in the United States and inclusion of participants who self-identify as racial or ethnic minorities was limited. Regarding sex, study cohorts ranged from 30% to 63% of participants who self-identified as female.

All studies were cross-sectional in design, and all analyzed large population-based data sets (n>1000) with the exception of single study by Spreckley et al (Spreckley et al., 2020) (n=441). Of the included studies, 41 found an association between income and hearing loss, and 5 found there was no association between hearing loss and income.

The Newcastle-Ottawa Scale Assessment was used to assess the quality of the included studies, where possible scores ranged 0 – 9. The scores for the included studies ranged

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from the lowest score of 5 to the highest score of 9. For the purposes of this review, a score of 5 or less was classified as low quality, 6–7 as medium quality, and 8 or higher as high quality (Smithson & Mitchell, 2018). Four studies were determined to be low quality, with a score of 5. Twenty-six studies were determined to be of medium quality with scores of 6 or 7. Sixteen studies were determined to be of high quality with eleven of these receiving a quality score of 8 and five studies receiving a score of 9. The highest quality studies are highlighted in Supplemental Table 2. All studies adjusted for age which is a known non-modifiable risk factor for hearing loss (Daniel, 2007). Nearly half of the included studies (twenty out of forty-six, 43.5%) adjusted for education, which is a known confounding variable for income (Michael Grossman, 1972). Out of the studies that adjusted for education, only seven were nationally representative with the primary focus being on hearing loss and income (Table 1). Six out of the seven of these studies found an association between income and hearing loss. Among the highest quality studies (Newcastle-Ottawa Scale Assessment ≥8), eleven studies included audiometric testing and nine of the eleven found an association between lower income and audiometric hearing loss (Table 2).

Of the 41 studies that found an association between income and adult-onset hearing loss, nine of those studies examined differences in the association of adult-onset hearing loss and income by sex or gender (Table 3). Of the nine studies analyzing sex or gender differences, six found significant differences. Of these nine, four studies found the association between income and hearing loss was greater for men or males (Fukui et al., 2018; Lee et al., 2015; Scholes et al., 2018; Tsimpida et al., 2019). In contrast, in Hasson et al, the authors looked at gender differences and found that among non-working respondents, the association between socioeconomic position (including income in their measure) and hearing difficulty is significant only among women after adjusting for age (Hasson et al., 2010). Barnartt and Altman examined gender differences and found that both men and women with hearing loss had higher wages than did men in the general population (Barnartt & Altman, 1997). However, between men and women, women with hearing loss earned less than men with hearing loss (Barnartt & Altman, 1997). The remaining two studies examined gender differences in the association between income and hearing loss but found no significant difference.

DISCUSSION

To our knowledge, this is the first systematic review to characterize the association between income and adult-onset hearing loss. The available literature is limited in study design with all included studies cross-sectional in nature. The literature, however, varied in demographics, definitions, and statistical methodology as reflected by the adapted Newcastle-Ottawa Scores. Of the included studies, almost all studies (41/46) supported an association between income and hearing loss. Of the sixteen most rigorous studies (Newcastle-Ottawa score ≥8), fourteen out of sixteen demonstrated an association between lower income and hearing loss. Among the highest quality studies that included audiometric testing, nine of eleven studies found an association between lower income and hearing loss. There was a total of seven studies that were nationally representative, controlled for education and had a primary focus on hearing loss and income. Six out of the seven of these highest-quality studies found an association between lower income and hearing loss. The

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observed relationship remained significant after adjusting for a variety of sociodemographic variables, including age and sex, which were adjusted for across all seven studies. All studies included a large sample size of >1000 participants.

In this systematic review, we found a preponderance of studies with results demonstrating that lower income is associated with hearing loss. We are unable to infer causality due to the cross-sectional nature of the available studies, and the directionality of the association between income and hearing loss is unknown. There are several possible mechanisms underlying the association between hearing loss and income. One potential mechanism is those of lower income are more likely to live and work in areas with greater noise exposure (Cruickshanks et al., 2010). Previous study findings show that workers of low socioeconomic position are more likely to be employed in dangerous jobs and less likely to have access to safety equipment and other industrial protection (Verma et al., 2011). Alternatively, those with low incomes may be at increased risk of exposure to environmental factors contributing to hearing loss, such as greater recreational noise exposure (Feder et al., 2017; John H. Mills & Jacquelyn A. Going, 1982), ototoxic drugs (John H. Mills & Jacquelyn A. Going, 1982), and/or viral and bacterial infections (John H. Mills & Jacquelyn A. Going, 1982) resulting in increased rates of hearing loss. Another potential mechanism of the relationship between income and hearing loss, in this direction, is a potential lack and/or delay in hearing care among individuals of lower socioeconomic position due to cost barriers (Mcmaughan et al., 2020).

Alternatively, it is possible the relationship between income and hearing loss is related primarily to hearing loss. Individuals with hearing loss may have greater difficulty and/or do not receive proper accommodations in the workplace resulting in lost wages (Kramer et al., 2006). Individuals with hearing loss report significantly less “control” in the workplace, higher effort required during listening, and more frequent sick leave due to distress than colleagues without hearing loss (Kramer et al., 2006). More research in this area is critical to understanding the mechanisms by which income is related to hearing loss.

Importantly, while there were a wide variety of countries represented in this review, there was notable absence of sufficient data on ethnicity. Only nine of the included 46 studies reported the ethnicity of participants. A previous systematic review that examined racial and ethnic representation in clinical trials related to hearing loss management in adults found a similar paucity (Pittman et al., 2021). The lack of data on ethnicity in the included studies highlights the ongoing need for hearing-related research that represents the diversity of populations.

Gender and/or sex may also play a role in the association between income and hearing loss. Nine studies examined these differences with eight focusing on what the authors labeled either gender or sex differences. Five studies found an association between lower income and hearing loss among men but not among women or that the association was greater for men rather than women. As a potential mechanism, men may take more “gendered jobs”, such as factory, military, or construction jobs, which continue to be primarily male-dominated occupations in addition to being some of the loudest (2019 Demographics: Profile of the Military Community.2019; Labor Force Statistics from the Current Population

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Survey. 2021; Laughlin & Christnacht, 2017). Furthermore, there is an overrepresentation of women in professions that are at the lower end of the pay scale, of the 15 million low-wage workers more than two-thirds are women even though women are less than half of the overall workforce(Morrison & Gallagher Robbins, 2015). Alternatively, it may be the case that sex-based differences may be attributable to the protective nature of estrogens (Caruso et al., 2003; Sohrabji et al., 1995). One major effect of estrogens on the central nervous system is to protect against cell death by itself or by interacting with neutrophils or neurotransmitters (Sohrabji et al., 1995). It has also been demonstrated that estradiol plays a role in regulating hearing sensitivity and perception in females, specifically changes in auditory perception and auditory latencies are susceptible to the menstrual cycle (Caruso et al., 2003). Sex-based differences may aid in understanding the directionality of the association between hearing loss and income. Importantly, however, there was inconsistency in the language employed regarding what the authors meant to encompass with their terminology surrounding sex or gender differences. Four studies found no gender differences. Hasson et al. found among non-working respondents, the association between socioeconomic position and hearing problems is significant only in women when adjusting for age. With mixed results on gender and sex differences, further investigation is needed. Importantly, sex and gender were often used interchangeably among included studies. Due to this, many of these papers lacked clarity in whether they were actually measuring sex or gender differences and highlight the need for greater precision in examining sex and/or gender-based differences.

Limitations

Within the available literature, hearing loss was not uniformly defined across all studies, being a mixture of utilizing the World Health Organization (WHO) criteria of pure tone average of > 25 dB or using self-reported measures. Self-report for hearing data can be influenced by recall, social desirability biases, or differing interpretation of questions due to current disability status and experience with disability as well as by demographic factors (Coyle et al., 2017; El-Gasim et al., 2012; Schwartz et al., 2007). Several studies show that self-report may not be a direct measure of health status (Coyle et al., 2017; El-Gasim et al., 2012; Schwartz et al., 2007), because of this it may be beneficial for future studies to preferentially consider audiometric testing. Furthermore, there was variability in how income was defined. While income was self-reported across all studies, some used categorical definitions of low, middle, and high income, some used classifications of socioeconomic position that included income, and others used poverty-to-income ratios. Based on self-reported data, there is the risk of recall or reporting bias (Althubaiti, 2016). Future studies may benefit from combining administrative data with survey data to measure income, particularly among nationally representative studies. For example, income could be measured using statistical records derived from tax returns at the Statistics of Income (SOI) Division of the Internal Revenue Service in conjunction with survey responses for income classification (Bricker et al., 2015).

Notably, though there were high, upper middle, and lower middle-income countries represented, the included studies lacked data from countries considered to be low income. The lack of studies in low-income countries may be due to our review limiting itself

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to income, rather than socioeconomic position more broadly, and leaving out literature that may originate in settings where measures of wealth depend on other aspects, such as assets, social exchanges, and other livelihood activities (Braithwaite & Mont, 2009). Future research may be more inclusive by examining the association between socioeconomic position and hearing loss and incorporating broader measures that consider additional aspects beyond income, such as housing or access to running water. Regardless, more research is needed in low-income country settings to examine the relationship between income and hearing loss across the spectrum of countries. Additionally, since all the studies examined used cross-sectional data, we are unable to draw conclusions related to causality or underlying mechanisms. More longitudinal studies are necessary to examine directionality and better characterize the relationship between income and hearing status.

Additional research is also needed to determine ways to reduce or eliminate the potential socioeconomic effects of hearing loss, whether through policy interventions, clinical approaches, or behavior-modifying interventions. It is paramount that income, as a social determinant to hearing health which is also in turn associated with many other negative health outcomes (Genther et al., 2013; Genther et al., 2015; Li et al., 2014; Lin et al., 2013; Uhlmann et al., 1989), be addressed. The recent COVID-19 pandemic has not only exposed health inequities but exacerbated them (Jensen et al., 2021). Reducing or eliminating the socioeconomic effects of hearing loss would only help in working toward greater health equity. With the expected rise in hearing loss due to the growing and aging world population (World report on hearing. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.), it is especially urgent.

Conclusions and Implications

Overall, current literature on the association between adult-onset hearing loss and income consistently supports an association. Due to its prevalence and association with negative health outcomes, hearing loss is increasingly recognized as a public health priority. Income influences health (Angus S. Deaton & Christina H. Paxson, 1998) and the existing literature suggests another example of income acting as a social determinant with another aspect of health - hearing. With a growing and aging population, the urgency in addressing this is high. Ultimately, more research is needed in 1) gathering longitudinal data, including studies based within low-income countries in order to better understand the mechanisms underlying this relationship and 2) in determining ways to reduce or eliminate the potential socioeconomic effects of hearing loss.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CONFLICTS OF INTEREST:

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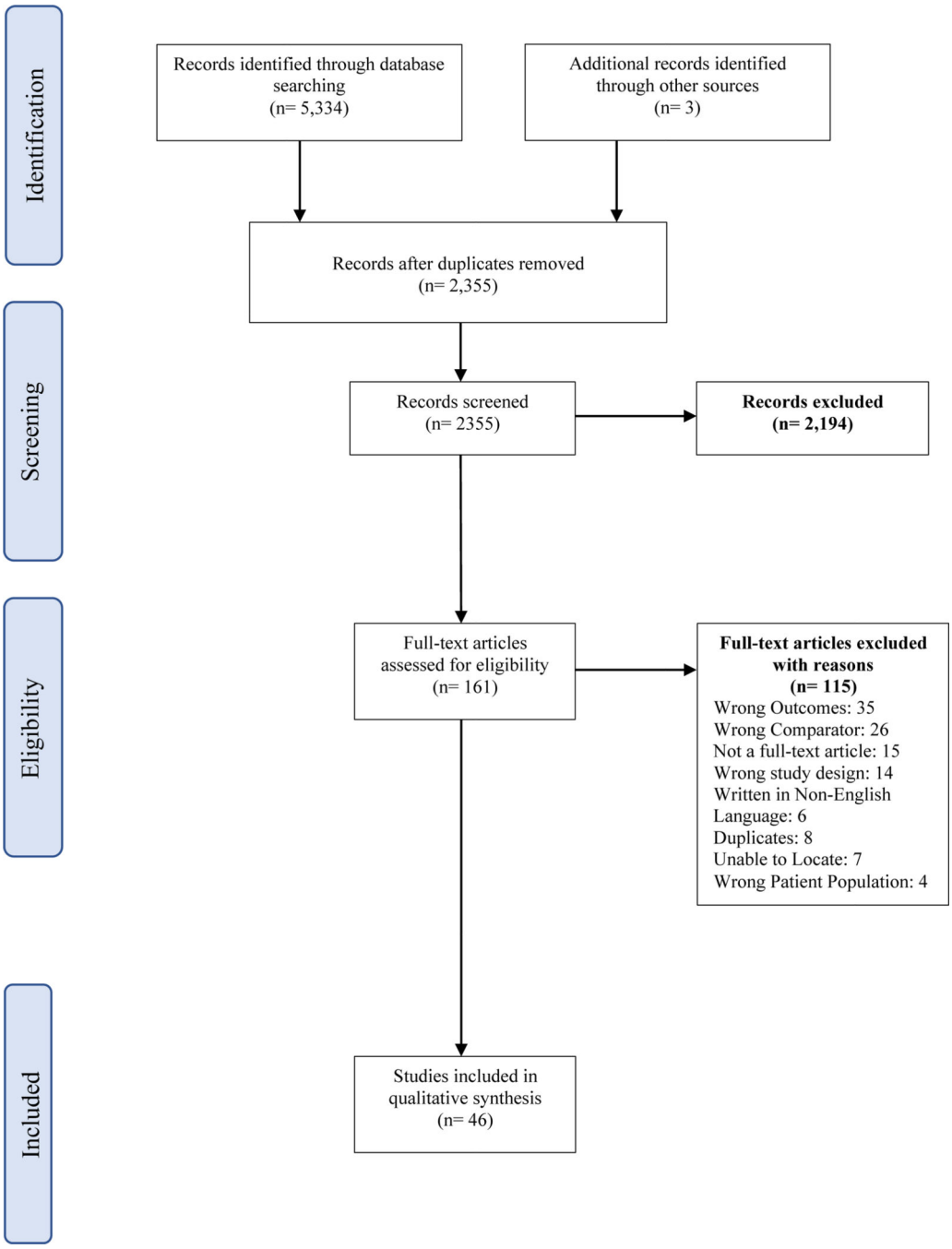

Figure 1:
PRISMA Flow Diagram

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Table 1:

Nationally representative studies that controlled for education, with a primary focus on hearing loss and income

Studies are arranged in alphabetical order per the first author.

Authors (Year)	Country	How Hearing Loss was Defined	How Income was Defined	Other Factors Controlled	Results
Cruickshanks et al (2016)	United States	Speech-frequency PTA >25 dB in either ear	Self-reported, categorized variable	Age, sex, study center, and Hispanic/ Latino background	Those with the highest income level were significantly less likely to have hearing impairment than people with the lowest income (OR=0.56, 95% CI = 0.29, 0.73 for $75k vs. <$10k).
He et al (2018)	China	PTA >25 dB in the better-hearing ear	Self-reported, categorized variable	Adjusted for occupation, sex, marital status, and age group	In urban and rural areas for working age adults, income was NOT significantly associated with hearing loss after adjustments (OR: 1.1 (09, 1.4)).
Jung, D. and Bhattacharyya, N. (2012)	United States	Record linkage encompassing 34 medical condition codes corresponding/relating to hearing loss	Self-reported, continuous variable	Adjusted for age, sex, race, ethnicity, insurance, region, marital status, and Charlson comorbidity index	With respect to wage income, adults with hearing loss mean wage was less than the mean wage of the those without hearing loss (net difference of $7,791; p<0.001).
Kim et al (2018)	United Kingdom	Self-reported	Self-reported, continuous variable	Adjusted for sex, ethnicity, marital status, number of dependent children, age, and household size.	Individuals with hearing impairment are significantly more likely to have lower household income than those without hearing impairment (£ 814 vs. £ 606, p<0.001).
Lee et al (2015)	South Korea	Looked at low-frequency/ high-frequency average thresholds	Self-reported, categorized variable	Adjusted for sex, age, and other health related factors	Participants with low monthly income (≤ US$2000) had a higher threshold for low-frequency sounds (95% CI: 1.396, 2.545, P<0.001) and high-frequency sounds (95% CI: 0.782, 2.441, p<0.001) compared to those with a high monthly income (≥US$4000).
Park et al (2017)	South Korea	Unilateral or bilateral air-conduction >25 dB in speech-frequency in worse ear	Self-reported, categorized variable	Adjusted for age, sex, noise-exposure, and other health related factor.	The prevalence of hearing loss was lower among participants in the upper quadrant (p=0.0128; OR=0.74, 95% CI: 0.44–0.77),
Seto et al (2018)	United States	Self-reported	Self-reported, continuous variable	Adjusted for age, sex, race, and other socioeconomic factors (mean income for a person's PUMA, and income inequality for a person's PUMA.	High personal income is associated with lower rates of hearing disability (OR=0.68, 95% CI: 0.6,0.78).

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Table 2:

Highest Quality Studies (Quality Scores of ≥ 8*) that Included Audiometric Testing

Studies are arranged in alphabetical order per the first author.

Author (Year)	Country	Hearing loss and income are associated?	Results	Quality Score
Beria et al (2007)	Brazil	X	Those at higher risk for hearing loss are those in the lower income bracket (OR=1.56; 95% CI = 1.06–2.27)	8
Emmett, Susan D. and Francis, Howard W (2016)	United States	X	Individuals with hearing loss demonstrated 1.5 times higher odds of reporting low income (1.58, 95% CI: 1.16–2.15) than individuals with normal hearing	8
Glenister, KM & Simmons, D (2019)	Australia	X	People earning less than $1000 per week were significantly more likely to have difficulty hearing [OR 1.39 (95% CI 1.03–1.88)]	9
He et al (2018)	China		In urban and rural areas for working age adults, income was NOT significantly associated with hearing loss after adjustments (OR: 1.1 (09, 1.4))	9
Lee et al (2015)	South Korea	X	Participants with low monthly income (≤ US$2000) had a higher threshold for low-frequency sounds (95% CI: 1.396, 2.545, P<0.001) and high-frequency sounds (95% CI: 0.782, 2.441, p<0.001) compared to those with a high monthly income (≥US$4000).	9
Luo et al (2020)	China	X	Persons with low individual SES had a higher prevalence of hearing impairment (1.9%, 95% CI:1.9%, 2%) than those with moderate and high individual SES (0.6%, 95% CI:0.6%,0.6% and 0.4%, 95% CI: 0.4%,0.4%, respectively)	8
Park et al (2017)	South Korea	X	The prevalence of hearing loss was lower among participants in the upper quadrant (p=0.0128; OR=0.74, 95% CI: 0.44–0.77).	8
Scholes et al (2018)	United Kingdom	X	The odds of hearing loss were almost two times as high for men in the lowest versus the highest income tertile (OR 1.77, 95% CI 1.15 to 2.74). For women the association between SES and hearing loss did not reach statistical significance.	8
Tsimpida et al (2019)	United Kingdom	X	The adjusted odds of hearing loss were higher for those in the lowest versus the highest household income quintile (men: OR 1.62, 95% CI 1.08 to 2.44, women: OR 1.36, 95% CI 0.85 to 2.16)	8
Von Gablenz, P. & Holube, I. (2017)	Germany	X	The proportion of hearing-impaired decreases steadily and significantly from age-adjusted low to high status groups (prevalence difference amounts to maximally 16%)	8
Yang et al (2020)	China		No significant correlation was found between income and hearing impairment	8

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Table 3:

Studies that examined sex/gender differences in the association between hearing loss and income

Studies are arranged in alphabetical order per the first author.

Author (Year)	Country	Percentage of men or males/percentage of women or females (sample size)	Was there a significant difference?	Findings	Quality Score
Barnartt, SN & Altman BM (1997)	United States	67.8% men and 32.2% women	X	Men w/ hearing impairments average wage incomes more than $1000 greater than men in gen pop. for women it was $800 than women in gen pop. Women mean income was 55% of their male counterparts.	7
Benito et al (2016)	United States	56.1% men and 43.9% women		There were no significant gender differences – predicted earnings for deaf or hard of hearing men and women with average characteristics are lower than men and women with normal hearing (6.1% lower for men, 6.5% lower for women).	8
Fukui et al (2019)	Japan	49.5% men and 51.5% women	X	Medium household income (3 to 5 million yen) was independently inversely associated with the prevalence of hearing impairment in men, but no association was found among women	6
Hasson et al (2009)	Sweden	45% men and 55% women	X	Among non-working respondents, the association between SES and hearing problems is significant only in women when adjusting for age (OR=0.8, $p<0.05$).	7
Lee et al (2016)	South Korea	46% males and 54% females	X	Prevalence of people whose income level is in the lowest quartile was significantly higher in males with hearing impairment than those without ($p<0.0001$). In the case of females, the difference was insignificant ($p=0.6692$).	6
Lohr et al (1986)	United States	“Just over half were women”		There were no differences between sexes - For both “men and women” low income was significantly related to the presence of hearing impairment ($p<0.05$ for both)	7
Scholes et al (2018)	England/UK	45.1% men and 54.9% women	X	The odds of hearing loss were almost two times as high for men in the lowest versus the highest income tertile (OR 1.77, 95% CI 1.15 to 2.74). For women the association between SES and hearing loss did not reach statistical significance.	8
Tsimpida et al (2019)	England/UK	45.6% men and 54.4% women	X	The adjusted odds of hearing loss were higher for those in the lowest versus the highest household income quintile. Odds were greater for men. (men: OR 1.62, 95% CI 1.08 to 2.44, women: OR 1.36, 95% CI 0.85 to 2.16).	8
Von Gablenz, P. & Holube, I. (2017)	Germany	46.5% men and 53.5% women		No differences between genders - The proportion of hearing impaired decreases steadily and significantly from age-adjusted low to high status groups for both males and females regardless of gender stratification.	9

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