



## Prospective study of alcohol consumption and self-reported hearing loss in women



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### ABSTRACT

Chronic excess alcohol intake has been associated with irreversible hearing loss and acute alcohol intake may temporarily impair auditory function; however, some evidence suggests that long-term moderate alcohol intake may be related to lower risk of hearing loss. This study prospectively examined the association between total alcohol and individual alcoholic beverage consumption and risk of hearing loss in women. Data were prospectively collected from 65,424 participants in the Nurses' Health Study II (NHS II), aged 27–44 years at baseline (follow-up 1991–2009). Alcohol consumption was assessed using a validated questionnaire every 4 years. An incident case was defined as a self-reported hearing problem that began after 1991. Cox proportional hazards multivariate regression was used to adjust for potential confounders. During 1,024,555 person-years of follow-up, 12,384 cases of hearing loss occurred. After multivariate adjustment, there was no significant association between total alcohol consumption and risk of hearing loss. In exploratory analyses, beer consumption was associated with increased risk and wine consumption was associated with reduced risk. No significant association was observed for consumption of liquor. Total alcohol consumption is not associated with risk of hearing loss in women. The modest associations observed for beer (direct) and wine (inverse) may be due to chance or residual confounding but merit further study.

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### Introduction

Hearing loss is a highly prevalent and disabling chronic condition that can impair communication, quality of life, and health (Agrawal, Platz, & Niparko, 2008). Although it is often perceived as an inevitable companion of aging, recent evidence suggests modifiable factors can potentially aid in prevention or slow progression of hearing loss (Curhan, Shargorodsky, Eavey, & Curhan, 2012; Durga, Verhoeve, Anteunis, Schouten, & Kok, 2007; Fransen et al., 2008).

Alcohol consumption may influence several mechanisms that have been proposed to underlie age-related hearing decline. Compromise of the cochlear blood supply, with resultant hypoxia and ischemic damage, oxidative stress and associated mitochondrial dysfunction and loss of neurosensory cochlear cells, and neurodegeneration of central auditory pathways, may all contribute

to hearing loss during aging (Fitzpatrick & Eviatar, 1980; Gates & Mills, 2005; Han & Someya, 2013; Meerton, Andrews, Upile, Drenovak, & Graham, 2005; Someya & Prolla, 2010). Alcohol intake may protect cochlear blood flow (Seidman, Quirk, & Shirwany, 1999), promote cytoprotective and anti-inflammatory mechanisms that strengthen cellular survival pathways, and directly enhance neuroprotective mechanisms that preserve hearing (Collins et al., 2009). However, alcohol intake may also adversely alter central processing of auditory information (Fitzpatrick & Eviatar, 1980; Meerton et al., 2005; Upile et al., 2007).

Although chronic excess alcohol intake has been associated with irreversible hearing loss (Rosenhall, Sixt, Sundh, & Svanborg, 1993) and acute alcohol intake may temporarily impair auditory processing and worsen auditory thresholds (Fitzpatrick & Eviatar, 1980; Hienz, Brady, Bowers, & Ator, 1989; Kähkönen, Marttinen Rossi, & Yamashita, 2005; Liu, Hsu, Hwang, Tseng, & Chen, 2004; Pearson, Dawe, & Timney, 1999; Robinette & Brey, 1978; Upile et al., 2007), some evidence suggests that long-term moderate alcohol intake may protect against hearing loss (Gopinath et al., 2010; Popelka

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et al., 2000). Reversible auditory changes that have been demonstrated following acute alcohol ingestion include temporary worsening of auditory thresholds, poorer speech discrimination, elevation of the acoustic reflex threshold, and impaired processing of tones, frequency change, and novel sounds (Fitzpatrick & Eviatar, 1980; Kähkönen et al., 2005; Pearson et al., 1999; Robinette & Brey, 1978; Upile et al., 2007). In guinea pigs, acute intraperitoneal alcohol injection was associated with temporary worsening of hearing thresholds; however, no significant change in hearing thresholds was observed following 60 days of alcohol intake administered via drinking water (Liu et al., 2004). In humans, some cross-sectional studies reported an inverse association between alcohol consumption and hearing loss (Gopinath et al., 2010; Popelka et al., 2000), although others did not (Brant et al., 1996; Sousa, Castro Júnior, Larsson, & Ching, 2009). In a recent large population-based cross-sectional study of 164,770 adults in the UK aged 40–69 years who completed a speech-in-noise hearing test (the Digit Triplet Test), those who were current consumers of alcohol were approximately 40% less likely to have a hearing loss than lifetime teetotalers, and the inverse association was similar across 3 levels of alcohol intake: from 1 to 118.4 g/week, 118.4–196.8 g/week, and 196.8 g/week or more (Dawes et al., 2014).

Few studies have examined this relation prospectively. In a prospective study of 870 men and women age 49 and older, no association was observed between alcohol consumption and the 5-year incidence of measured hearing loss. However, there was insufficient power to be conclusive (Gopinath et al., 2010). In a prospective study of 26,809 older men, we found no association between total alcohol consumption and the risk of self-reported hearing loss (Curhan, Eavey, Shargorodsky, & Curhan, 2011). To our knowledge, this relation has not been studied prospectively in younger women. Thus, the influence of long-term alcohol consumption on hearing remains unclear. Therefore, we prospectively examined the relation of alcohol consumption and risk of hearing loss in 65,424 women in the Nurses' Health Study II (NHS II). In addition, as the relationships between alcohol consumption and other health outcomes have varied by type of beverage consumed (Choi, Atkinson, Karlson, Willett, & Curhan, 2004; Wannamethee, Camargo, Manson, Willett, & Rimm, 2003), we explored the relationships between beer, white wine, red wine, and liquor consumption and risk of hearing loss.

## Methods

### Study participants

The Nurses' Health Study II is an ongoing cohort study of 116,430 female nurses who were aged 25–42 years and living in 14 US states at cohort inception in 1989. Participants have been followed by biennial mailed questionnaires that elicit information on dietary and lifestyle factors and various health outcomes; the follow-up rate over 22 years exceeds 90% of eligible person-time. Detailed information on diet, including alcohol consumption, has been obtained every 4 years (Questionnaires can be viewed online at [www.channing.harvard.edu/nhs/?page\\_id=70](http://www.channing.harvard.edu/nhs/?page_id=70)). The 2009 long-form questionnaire asked women whether they have a hearing problem and at what age a change in hearing was first noticed. Those who reported a hearing problem that began before the study baseline or a history of cancer other than non-melanoma skin cancer (due to possible exposure to ototoxic chemotherapeutic agents) were excluded from the analysis. The number of women included in the analysis was 65,424. The final study population was arrived at as follows: 90,488 participants answered the 2009 long-form questionnaire, the version that included the hearing question; 12,156 participants were excluded from the analysis because they

had not answered the 1991 baseline FFQ; 2584 were excluded because they reported hearing loss prior to 1991 biennial questionnaire (study baseline); 9191 were excluded because they did not answer the hearing loss questions; 173 reported mild, moderate, or severe hearing loss but were excluded because they did not report the age of onset; 859 reported cancer (other than non-melanoma skin cancer) and were excluded due to the possibility of exposure to ototoxic chemotherapy; and 101 participants were pregnant at baseline and again prior to onset of hearing loss during follow-up, thus were excluded.

Although some participants were lost to follow-up since the inception of this cohort and/or did not answer the 2009 questionnaire, the baseline characteristics of participants who did and did not answer the 2009 questionnaire did not differ appreciably (data not shown). The study protocol was approved by the Institutional Review Board of the Partners Health Care System.

### Assessment of alcohol consumption

In 1991, and every 4 years thereafter, participants were asked to complete a food-frequency questionnaire (FFQ) on their intake of specific foods and beverages, each with a specified portion size, during the previous 12 months. Separate questions asked about the consumption of regular beer (1 glass, bottle, can), light beer (1 glass, bottle, can), red wine (4 oz. [120 mL] glass), white wine (4 oz. [120 mL] glass), and liquor (e.g., whiskey, gin) (1 drink or shot). The response categories were “never or < once/month”, “1–3/month”, “1/week”, “2–4/week”, “5–6/week”, “1/day”, “2–3/day”, “4–5/day”, and “6+/day”. Regular beer was considered to contain 13 g of alcohol per serving, light beer 11 g, wine 11 g per 4 oz. serving, and spirits 14 g per serving. Total grams per day of alcohol were calculated by summing the frequency of consumption multiplied by the alcohol content of the reported beverages. Information on alcohol consumption obtained in this way was validated in a similar cohort of women by comparison of the information collected on 2 FFQs with four 1-week diet records collected 3 months apart; the correlation for alcohol consumption between questionnaires and dietary records was  $r = 0.90$ . Reported alcohol intake was significantly correlated with serum high-density lipoprotein levels ( $r = 0.40$ ;  $p < 0.001$ ) (Giovannucci et al., 1991).

### Ascertainment of hearing loss

Self-reported hearing loss, the primary outcome, was ascertained based on responses to the 2009 questionnaire. Participants responded to the questions: “Do you have a hearing problem?” (“no”, “mild”, “moderate”, “severe”) and, “If so, at what age did you first notice a change in your hearing?”

We defined a case as a hearing problem first noticed after 1991. Although hearing loss is often insidious in onset, incident cases were defined as hearing loss at the age it was first noticed by the participant. We did not have information on severity of hearing loss at the time of onset, thus we were not able to perform prospective analyses that considered severity of hearing loss as the outcome. Pure-tone audiometry is considered the gold standard for hearing loss evaluation; however, cost and logistic limitations precluded such assessment in this large population. Previous evaluations of the reliability of using a single question to assess self-reported hearing loss have reported this method to be a reasonably reliable measure (Gomez, Hwang, Sobotova, Stark, & May, 2001; Schow & Gatehouse, 1990; Sindhusake et al., 2003). A validity study in a population of individuals aged 30–65 years evaluated the performance of a single question compared with the results of pure-tone audiometry and found the sensitivity and specificity were 79.6% and 77.4%, respectively (Ferrite, Santana, & Marshall, 2011).

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