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Socioeconomic differences in hearing among middle-aged and older adults: cross-sectional analyses using the Health Survey for England

Shaun Scholes,[1] Jane Biddulph,[1] Adrian Davis,[2] Jennifer S. Mindell[1]

ABSTRACT

Background Hearing loss impacts on cognitive, social and physical functioning. Both hearing loss and hearing aid use vary across population subgroups. We examined whether hearing loss, and reported current hearing aid use among persons with hearing loss, were associated with different markers of socioeconomic status (SES) in a nationally representative sample of community-dwelling middle-aged and older adults.

Methods Hearing was measured using an audiometric screening device in the Health Survey for England 2014 (3292 participants aged 45 years and over). Hearing loss was defined as >35 dB HL at 3.0 kHz in the better-hearing ear. Using sex-specific logistic regression modelling, we evaluated the associations between SES and hearing after adjustment for potential confounders.

Results 26% of men and 20% of women aged 45 years and over had hearing loss. Hearing loss was higher among men in the lowest SES groups. For example, the multivariable-adjusted odds of hearing loss were almost two times as high for those in the lowest versus the highest income tertile (OR 1.77, 95% CI 1.15 to 2.74). Among those with hearing loss, 30% of men and 27% of women were currently using a hearing aid. Compared with men in the highest income tertile, the multivariable-adjusted odds of using a hearing aid nowadays were lower for men in the middle (OR 0.50, 95% CI 0.25 to 0.99) and the lowest (OR 0.47, 95% CI 0.23 to 0.97) income tertiles. Associations between SES and hearing were weaker or null among women.

Conclusions While the burden of hearing loss fell highest among men in the lowest SES groups, current hearing aid use was demonstrably lower. Initiatives to detect hearing loss early and increase the uptake and the use of hearing aids may provide substantial public health benefits and reduce socioeconomic inequalities in health.

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[1]Department of Epidemiology and Public Health, University College London (UCL), London, UK
[2]UCL Ear Institute, University College London (UCL), London, UK

Correspondence to
Dr Shaun Scholes;
s.scholes@ucl.ac.uk

Strengths and limitations of this study

► Estimates of the burden of hearing loss, the use of hearing aids among persons with hearing loss and their associations with socioeconomic status are rarely available from nationally representative health examination surveys.

► We used data from a screening audiometry device to estimate the prevalence of hearing loss. The prevalence of current hearing aid use was estimated among persons with hearing loss.

► The associations between different markers of socioeconomic status and hearing were examined after adjustment for a wide range of confounders such as age, exposure to work-related noise and risk factors for cardiovascular disease.

► Exclusion of persons from the study due to difficulties in interviewer–participant communication through conditions such as deafness means that our estimates are likely to underestimate the true prevalence of hearing loss among community-dwelling middle-aged and older adults.

INTRODUCTION

Hearing loss is well known to impact on cognitive, social and physical functioning.[1–3] It can be congenital, but most is acquired and is sensorineural and irreversible in nature.[4] Preventing hearing loss requires understanding its aetiology and risk factors.[5] Epidemiological studies have shown that hearing loss increases with age[6–8] and increases with the duration of exposure to work-related noise.[8] It is higher among men,[6–8] higher among persons with cardiovascular disease (CVD) risk factors[6 8–11] and is inversely associated with socioeconomic status (SES).[6–8 12] Early detection and hearing aid use may be effective at ameliorating the impact of hearing loss.[13] However, levels of hearing aid use among persons most likely to benefit are low,[14–17] especially among persons with hearing loss in the lowest SES groups.[14 18–20]

Based on the UK National Study of Hearing conducted in four cities in the early 1980s, 16% of adults aged 17–80 years had a bilateral, and 25% had a unilateral or bilateral, hearing loss.[21] Uptake and use of hearing aids was low, with uptake being 10%–30% among persons with hearing loss, and up to 25% of hearing aid owners never using them.[22] To provide up-to-date estimates of the burden

of hearing loss, the Health Survey for England (HSE) 2014 included, for the first time in a nationally representative sample of the population, valid screening audiometry data. The aim of this study was to estimate the prevalence of (1) hearing loss and (2) current hearing aid use (among persons with hearing loss), in this sample of community-dwelling middle-aged and older adults across population subgroups defined by demographics, work-related noise exposure and by the presence of CVD risk factors. We also examined the associations between SES and hearing.

METHODS
Study population
The present study used data from the HSE. The HSE is an annual, nationally representative cross-sectional survey of the non-institutionalised general population of all ages. A maximum of two children per household contributed to the 2014 survey. In households with more than two children, two were randomly selected using the Kish grid method.[23] Multistage stratified probability sampling is used with postcode sectors as the primary sampling unit and the Postcode Address File as the sampling frame for households. Details about the HSE are described elsewhere.[23] Interview and nurse-visit response rates were 55% and 37%, respectively. Participants gave verbal consent to be interviewed, visited by a nurse, participate in a hearing test and have blood pressure and anthropometric measurements taken, and gave written consent for blood sampling.

Overall, 8077 participants aged ≥16 years were interviewed, including questions on the use of hearing aids (see section on current hearing aid use). All participants aged ≥16 years who had a nurse-visit were eligible for the hearing test, excluding those with a cochlear implant or with a current ear infection (figure 1). Participants aged 16–44 years were excluded due to hearing loss being comparatively rare (n=46). In addition, a number of persons would have been excluded if interviewer–participant communication difficulties through conditions such as deafness were sufficient to prevent inclusion in the study. The final analytical sample was 3292 participants.

Hearing test
Hearing was measured using an audiometric screening device (HearCheck screener, Siemens, Erlangen, Germany) in participants' own homes. Two evaluation studies comparing the results of the screener to pure tone audiometry showed good sensitivity (range: 78%–92%) and acceptable to good specificity (62%–95%).[24 25] This handheld device produced a series of three sounds of decreasing volume at 1.0 kHz (55 dB HL, 35 dB HL and 20 dB HL) and then at 3.0 kHz (75 dB HL, 55 dB HL and
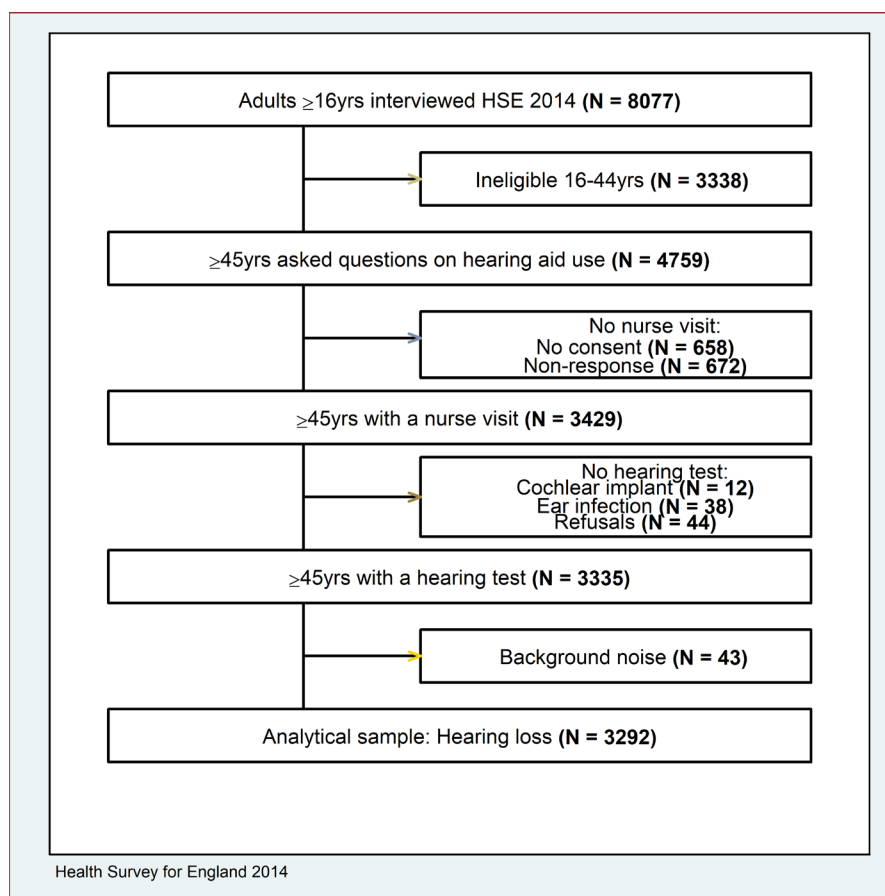

Figure 1 Selection of study participants, Health Survey for England (HSE) 2014.

35 dB HL). Both ears were tested, starting with the left. Participants were instructed to indicate when they heard a noise by raising their finger. If an irregular pattern was found (a combination of responses indicating that quieter sounds were heard but louder ones were not), the test was repeated at least 60 s later for that ear. Participants with an irregular pattern at the first test, but a regular pattern at the second test, were included in the analyses. Further details of the testing procedures are available elsewhere.[17]

Outcomes

Hearing loss

Hearing loss was defined as >35 dB HL at 3.0 kHz in the better-hearing ear, the level at which intervention has been shown to be definitely beneficial.[26] More specifically, a comparison of different screen programmes conducted as part of the NHS Health Technology Assessment Programme showed that hearing loss of >35 dB HL at 3.0 kHz was the best predictor (in terms of the d-prime statistic: a combination of good sensitivity and low false alarm rate) for the ability of persons to gain the greatest benefit from hearing aids.[26] Hearing loss of >35 dB HL at 3.0 kHz had 88% sensitivity and 10% false alarm rate.[26] Hearing loss was subdivided into two mutually exclusive categories: (1) 'moderate loss': >35 dB HL to 54 dB HL (tone not heard at 35 dB HL, but heard at 55 dB HL and at 75 dB HL) and (2) 'moderately severe or severe loss': >55 dB HL (tone not heard at 35 dB HL and at 55 dB HL, but the tone may, or may not, have been heard at 75 dB HL). Prevalence estimates were multiplied by the 2014 household population to estimate the number of people with hearing loss.[27]

Current hearing aid use

As part of the main interview, all participants were asked if they ever wore a hearing aid nowadays: those who answered negatively were asked whether they had ever tried one. Current hearing aid use, for the purposes of the present study, consisted of those participants who answered positively to the question about use of a hearing aid nowadays. Participants classed as not currently using a hearing aid consisted of those who had tried hearing aids in the past but did not use a hearing aid nowadays, and those who had never tried a hearing aid.

Markers of socioeconomic status

Tertiles of equivalised household income, quintiles of the area-based Index of Multiple Deprivation (IMD 2010: Q1 least deprived; Q5 most deprived),[28] and the highest formal educational attainment (degree or higher, below degree, no qualifications) were chosen as related, but different, markers of SES. Broader categories of SES were used for the analysis of current hearing aid use among persons with hearing loss due to smaller sample sizes. The IMD 2010 quintiles were recoded into three categories: Q1 and Q2 (least deprived), Q3, and Q4 and Q5 (most deprived). Educational status was recoded into two categories: O level and above, and no qualifications.

Covariates

Covariates were grouped into: (1) demographic characteristics (age, region), (2) exposure to work-related noise and (3) risk factors for CVD (cigarette smoking, body mass index (BMI), diabetes, hypertension, dyslipidaemia and physical inactivity). Modifiable risk factors for CVD are well-known to be independently associated with hearing impairment,[11 29] and potentially confound the associations between SES and hearing loss. Age-at-interview was categorised into four groups (45–54, 55–64, 65–74 and ≥75 years). Government Office Region was grouped into North, Midlands, London and South. Duration of exposure to work-related noise was established by asking participants whether they had ever worked in a place that was so noisy that you had to shout to be heard (response categories: 'no', 'yes, for <1 year', 'yes, for at least 1 year but <5 years', and 'yes, for 5 years or longer'). Cigarette smoking status categories were current, ex-regular and never. Single measurements of height and weight were taken by trained interviewers using standard protocols. BMI was computed as weight in kg divided by height in metres squared (m^2): participants were classified as normal-weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) or obese (≥30.0 kg/m^2). We used two indicators of hyperglycaemia: self-reported physician diagnosis of diabetes, and raised glycated haemoglobin (HbA1c ≥6.5%) irrespective of diagnosis. Hypertension was defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg and/or current use of medication taken for the purposes of lowering blood pressure. Total cholesterol was measured in non-fasting blood samples. Dyslipidaemia was defined as total cholesterol ≥5.0 mmol/L and/or current use of lipid-lowering medication. Based on the Short-Form International Physical Activity Questionnaire, participants spending <30 min per week in moderate-to-vigorous physical activity were classed as physically inactive.[30] Broader categories of these covariates were used in some cases for the analysis of current hearing aid use due to smaller sample sizes. Age-at-interview was recoded into three categories: 45–64, 65–74 and ≥75 years. Duration of exposure to work-related noise was dichotomised into none and at least some exposure to loud noise.

Statistical analysis

All analyses were sex-specific. Hearing loss prevalence (overall and by severity) was estimated among the overall population and as stratified by demographic characteristics, exposure to work-related noise, CVD risk factors, and SES. Prevalence estimates were directly age-standardised within sex to the English household population using the four age groups described above. Differences in the prevalence of hearing loss across groups were evaluated using the χ^2 test. This analysis was repeated to estimate the prevalence of current hearing aid use among those participants with hearing loss.

Logistic regression modelling was used to evaluate the association between SES and hearing loss after adjustment

for demographics, exposure to work-related noise and CVD risk factors. Associations were summarised using ORs with 95% CIs. We decided a priori to run separate models for the three indicators of SES rather than estimate a single model to avoid multicollinearity. Two sequential models were fitted. SES and hearing loss associations were age-adjusted (model A), and then further adjusted for region, exposure to work-related noise, and CVD risk factors (model B). To maximise power age was entered in the models as a continuous variable. SES was entered in the models as a categorical variable, with the highest status group as the reference category. We repeated the analyses to evaluate the association between SES and current hearing aid use, with an additional adjustment for the severity of hearing loss. All analyses accounted for the complex survey design, incorporating the nurse-visit weight which accounted for individual non-participation and preserved the national representativeness of the sample. Data set preparation was performed in SPSS V.20.0 (IBM). Statistical analysis was conducted using Stata V.13.1. The HSE 2014 dataset is available via the UK Data Service (http://www.ukdataservice.ac.uk).

RESULTS

Compared with participants with data collected from the nurse-visit stage, participants interviewed in the survey but without data from the nurse-visit were more likely to be in the lowest income tertile (P=0.002), to have no formal educational qualifications (P<0.001), to reside in the most deprived IMD quintile (P<0.001), and to be current cigarette smokers (P=0.011) (online supplementary table 1).

Hearing loss

Table 1 shows the age-standardised estimates of the prevalence of hearing loss. For simplicity, we present only estimates by age, duration of exposure to work-related noise and each indicator of SES in the main text, with the estimates for region and for each CVD risk factor available as online supplementary data. Overall, 26% of men and 20% of women aged ≥45 years had hearing loss defined as >35 dB HL at 3.0 kHz in the better-hearing ear (n=769/3292), equivalent to 5.2 million persons. The prevalence of 'moderate' loss (15% men, 12% women) exceeded that of 'moderately severe or severe' loss (11% men, 7% women). Hearing loss increased monotonically with age, reaching 67% of men and 58% of women aged ≥75 years. Only among men in the oldest age group did the prevalence of 'moderately severe or severe' loss (39%) exceed that of 'moderate' loss (29%). Among men, hearing loss was higher among those exposed to work-related noise for ≥5 years (P<0.001), in the lowest income tertile (P=0.005), residing in areas of higher deprivation (P=0.011), and with no formal educational qualifications (P<0.001). Patterns among women were similar but the differences in the prevalence of hearing loss across the SES groups did not reach statistical significance

(P=0.077 and P=0.070 for IMD and for educational status, respectively). Of the risk factors for CVD, hearing loss was higher among men and women with doctor-diagnosed diabetes (P<0.001 men; P=0.005 women), with elevated Hb1Ac irrespective of diagnosis (P<0.001 men; P=0.025 women) and among women classed as physically inactive (P=0.028) (online supplementary table 2).

Figure 2 shows the associations between SES and hearing loss (expressed as ORs) after age (model A) and additional adjustment for region, duration of exposure to work-related noise and CVD risk factors (model B). Among men, the multivariable-adjusted associations were partly attenuated: nevertheless, the multivariable-adjusted odds of hearing loss showed a strong socioeconomic gradient. 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) and were over two times as high for men with no formal educational qualifications versus those with at least a degree (OR 2.35, 95% CI 1.54 to 3.59). For women, the association between SES and hearing loss did not reach statistical significance. For example, the odds of hearing loss were 1.4 times higher for women with no formal educational qualifications versus those with at least a degree (OR 1.43, 95% CI 0.83 to 2.48).

Current hearing aid use

Among participants with hearing loss, 30% of men and 27% of women wore hearing aids nowadays (n=264/769; table 2). Lower proportions had tried hearing aids in the past but did not use a hearing aid nowadays (7% men, 10% women): higher proportions had never tried a hearing aid (63% men, 64% women) (data not shown). Current use of a hearing aid for persons with 'moderately severe or severe' loss (53% men, 47% women) exceeded that for persons with 'moderate' loss (18% men, 19% women) (P<0.001 men; P=0.004 women). Current hearing aid use increased monotonically with age but was confined to the minority, reaching close to 40% for participants aged ≥75 years.

Differences in current hearing aid use by population subgroups were typically minor (P>0.05), with the exception of lower use of a hearing aid nowadays among women classed as physically inactive (P=0.003) (online supplementary table 3). Lower use among participants reporting doctor-diagnosed diabetes (n=143/768) did not reach statistical significance (P=0.101 men; P=0.077 women). Figure 3 shows the associations between SES and current hearing aid use after age-adjustment (model A) and full-adjustment (model B). Compared with men in the highest income tertile, the multivariable-adjusted odds of using a hearing aid nowadays were lower for men in the middle (OR 0.50, 95% CI 0.25 to 0.99) and the lowest (OR 0.47, 95% CI 0.23 to 0.97) income tertiles. Among men, area deprivation (as measured by IMD) and highest educational attainment were associated with current hearing aid use in the same direction (ie, lower levels of use in the lower SES groups) but the ORs did

Table 1 Age-standardised prevalence (%) and SE of hearing loss, persons aged 45 years and over, HSE 2014

Characteristics	Men					Women				
	N	Hearing loss % (SE)*	Moderate (SE)†	Moderate to severe % (SE)‡	P value§	N	Hearing loss % (SE)*	Moderate % (SE)†	Moderate to severe % (SE)‡	P value§
N	1485	425	244	181		1807	344	217	127	
All	1485	26.2 (1.2)	15.2 (1.0)	11.0 (0.9)	–	1807	19.6 (1.0)	12.2 (0.8)	7.4 (0.7)	<0.001
Age group										
45–54	420	8.0 (1.5)	7.0 (1.4)	1.0 (0.5)	<0.001	560	3.1 (0.9)	2.3 (0.7)	0.7 (0.4)	<0.001
55–64	401	17.0 (2.0)	10.9 (1.7)	6.1 (1.2)		446	10.6 (1.6)	8.6 (1.4)	2.0 (0.7)	
65–74	402	37.0 (2.5)	23.8 (2.2)	13.3 (2.0)		476	20.4 (1.8)	14.5 (1.6)	5.9 (1.1)	
≥75	262	67.3 (3.2)	28.6 (2.8)	38.7 (3.1)		325	57.9 (2.9)	30.6 (2.5)	27.3 (2.6)	
Duration of work-related noise exposure										
None	819	22.2 (1.6)	13.4 (1.3)	8.9 (1.2)	<0.001	1468	18.6 (1.1)	12.1 (0.9)	6.5 (0.7)	0.091
<5 years	226	24.6 (2.9)	11.1 (2.3)	13.5 (2.4)		128	18.8 (3.8)	10.8 (3.0)	7.9 (2.7)	
≥5 years	434	35.1 (2.5)	21.5 (2.1)	13.6 (1.7)		210	25.4 (3.0)	13.6 (2.4)	11.8 (2.2)	
Income tertiles										
Highest	491	21.3 (2.5)	13.1 (2.0)	8.2 (1.7)	0.005	484	16.5 (2.3)	11.0 (1.9)	5.5 (1.4)	0.413
Middle	458	28.6 (2.2)	16.7 (1.9)	12.0 (1.5)		562	19.3 (1.8)	11.9 (1.4)	7.4 (1.2)	
Lowest	305	32.9 (2.8)	19.8 (2.2)	13.1 (2.0)		417	20.1 (1.9)	13.1 (1.6)	7.0 (1.2)	
Index of Multiple Deprivation quintiles										
Least deprived	369	21.4 (2.2)	11.0 (1.8)	10.3 (1.7)	0.011	448	18.6 (2.1)	11.4 (1.5)	7.2 (1.4)	0.077
2	340	23.0 (2.4)	13.2 (1.8)	9.8 (1.7)		407	17.6 (1.7)	11.5 (1.5)	6.1 (1.2)	
3	311	27.2 (2.7)	17.1 (2.3)	10.1 (1.8)		392	17.5 (2.1)	10.9 (1.7)	6.6 (1.5)	
4	255	32.6 (2.9)	18.2 (2.5)	14.4 (2.2)		312	19.8 (2.6)	10.6 (2.1)	9.2 (1.7)	
Most deprived	210	30.2 (3.3)	18.0 (2.6)	12.2 (2.6)		248	26.3 (2.7)	18.4 (2.4)	7.9 (1.7)	
Education status										
Degree or higher	344	20.1 (2.6)	12.3 (2.1)	7.8 (1.7)	<0.001	309	14.5 (3.5)	7.8 (2.2)	6.7 (2.5)	0.070
Below degree	733	23.2 (1.8)	12.8 (1.3)	10.4 (1.4)		941	18.4 (1.6)	12.1 (1.2)	6.4 (1.1)	
No qualifications	407	40.1 (3.0)	26.5 (2.9)	13.7 (1.7)		555	23.6 (2.1)	14.7 (1.8)	8.9 (1.1)	

*Hearing loss: >35dB HL at 3.0kHz (tone not heard at 35 dB HL).
†Moderate loss: >35 to 54 dB HL (tone not heard at 35 dB HL, but heard at 55 and at 75 dB HL).
‡Moderately severe or severe loss: >55dB HL (tone not heard at 35 and at 55 dB HL, but may or may not have heard the tone at 75 dB HL).
§Prevalence of hearing loss (>35dB HL at 3.0kHz in the better hearing ear) across the categories of each variable (age group, duration of work-related noise exposure, income tertiles, Index of Multiple Deprivation quintiles and highest educational attainment) were compared using the χ^2 tests. No adjustment to the P values for multiple comparisons was made.
dB, decibel; HL, hearing level; HSE, health survey for England.
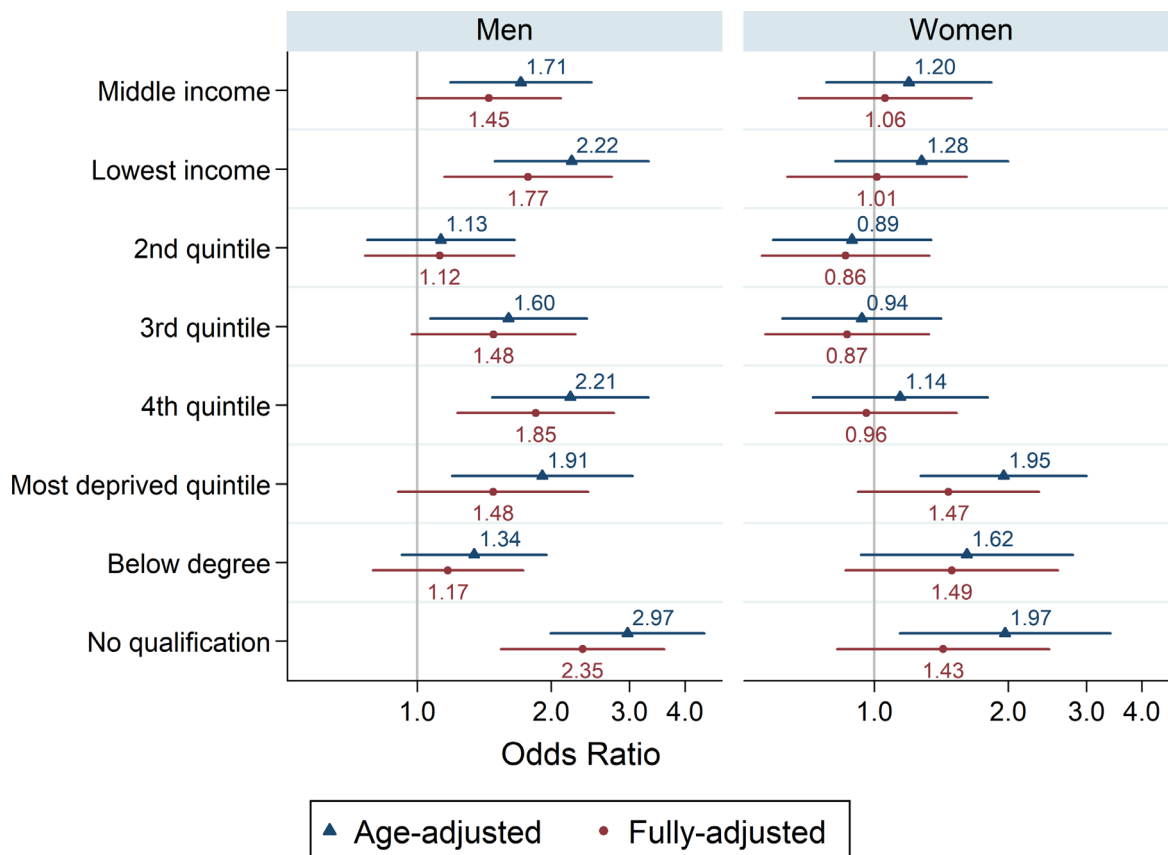
Figure 2 Association between socioeconomic status (SES) and hearing loss in middle-aged and older adults. Indicators of SES were equivalised household income tertiles (highest tertile as reference), Index of Multiple Deprivation quintiles (least deprived) and highest educational attainment (degree or higher). Lines represent OR (outcome=hearing loss) and its 95% CI. Model A (triangles): adjusted for age. Model B (circles): adjusted for age, exposure to work-related noise, region and cardiovascular disease risk factors (smoking, body mass index, diabetes, hypertension, dyslipidaemia and physical inactivity).

not reach statistical significance. For women, SES was not associated with current hearing aid use.

DISCUSSION

In this nationally representative sample of community-dwelling persons aged 45 years and over, >1 in four persons had a level of hearing loss that would benefit from hearing aid use. However, <1 in three persons with hearing loss reported using a hearing aid nowadays, suggesting a significant level of unmet need. The burden of hearing loss fell highest among persons in the lowest SES groups, especially among men, suggesting hearing loss as a source of socioeconomic inequalities in health. Even after adjustment for the severity of hearing loss, hearing aid use was evidently lower for men in the middle-income and low-income groups compared with their high-income counterparts.

Comparisons with previous studies are difficult due to differences in the age range of participants.[6] Considerable heterogeneity also exists in the definition and the measurement of hearing loss.[31] WHO defines adult disabling hearing impairment as a permanent unaided hearing threshold for the better-hearing ear of ≥41 dB HL (averaged over 0.5, 1.0, 2.0 and 4.0 kHz).[32] Using this

definition, disabling hearing loss was estimated to affect 360 million people worldwide in 2012 (>5% of the global population).[33] The Global Burden of Disease Hearing Loss Expert Group uses a threshold of >35 dB HL for all age groups, and equates 'unilateral hearing impairment' with 'bilateral mild hearing impairment'.[7] The estimated global prevalence of hearing loss using this alternative definition was 12% for men and 10% for women aged ≥15 in 2008.[7] Analysis of HSE 2014 data by the same authors of the present study found that 13% of adults (14% men, 12% women) had loss of >35 dB HL at 3.0 kHz in the better-hearing ear.[17] Our findings of differences in the burden of hearing loss agree with other population-based studies in which the prevalence of hearing loss was higher for men than women,[6–8 34–37] increased monotonically with age,[6–9 21 34–36 38] increased with longer exposure to occupational noise,[8] co-existed with CVD risk factors such as diabetes,[6 8–11] and was higher in the lowest SES groups,[6 9 35 36 38 39] especially for men.[12] In contrast to other studies,[6 8–10] hearing loss did not vary in the present study by current smoking status.

Other studies have shown similar or lower levels of hearing aid use among persons with hearing loss. Using the Digit Triplet Test, 21.5% of UK Biobank participants

Table 2 Age-standardised prevalence (%) and SE of current hearing aid use among persons with hearing loss, persons aged 45 years and over, HSE 2014

Characteristics	Men			Women		
	N	Hearing aid use % (SE)	P value*	N	Hearing aid use % (SE)	P value*
N	425	29.7 (3.1)		344	26.9 (3.3)	
Severity of loss						
Moderate†	244	17.8 (3.2)	<0.001	217	19.1 (3.5)	0.002
Moderate to severe‡	181	52.9 (6.3)		127	47.1 (8.7)	
Age group						
45–64	101	25.4 (4.6)	0.056	63	21.2 (5.1)	0.035
65–74	147	34.3 (4.3)		94	31.4 (4.9)	
≥75	177	40.2 (3.7)		187	39.1 (3.7)	
Duration of work-related noise exposure						
None	250	26.1 (3.9)	0.234	287	25.3 (3.6)	0.296
Some	173	33.5 (4.9)		56	35.5 (9.4)	
Income tertiles						
Highest	84	36.0 (6.5)	0.548	54	24.7 (6.5)	0.900
Middle	149	31.2 (5.5)		105	28.6 (5.8)	
Lowest	118	26.0 (6.1)		90	26.0 (7.0)	
Index of Multiple Deprivation quintiles						
Least deprived 1 and 2	179	29.8 (5.3)	0.812	158	29.1 (5.2)	0.615
Quintile 3	101	33.5 (8.0)		66	29.3 (6.6)	
Most deprived 4 and 5	145	27.9 (4.6)		120	22.6 (5.6)	
Education status						
O level or above	227	32.3 (4.2)	0.354	151	28.0 (4.3)	0.654
No qualifications	198	26.3 (4.6)		192	24.7 (5.6)	

*Prevalence of current hearing aid use across the categories of each variable (age group, duration of work-related noise exposure, income tertiles, Index of Multiple Deprivation quintiles and highest educational attainment) were compared using the χ^2 test. No adjustment to the P values for multiple comparisons was made.
†Moderate loss: >35 to 54 dB HL (tone not heard at 35 dB HL, but tone heard at 55 and 75 dB HL).
‡Moderately severe or severe loss: >55 dB HL (tone not heard at 35 and 55 dB HL, but may or may not have heard the tone at 75 dB HL).
dB, decibel; HL, hearing level; HSE, health survey for England.

aged 40–69 years with 'poor' speech recognition in noise testing reported using a hearing aid.[38] Based on the 1999–2006 US National Health and Nutrition Examination Survey, hearing aid use among participants aged 50 years and older with hearing loss was 14.2%.[15] Our findings of subgroup differences in levels of hearing aid use are consistent with other studies which showed that use increases with age[15 40] and with the severity of hearing loss.[15 19] Our finding of lower utilisation among men in the lowest SES groups, independent of the severity of hearing loss, is also consistent with other studies.[18 19 38 40 41]

Associations between SES and hearing loss likely involve multiple simultaneous pathways[35] including other concomitant factors of lower SES such as educational and employment factors (including exposure to work-related noise), and modifiable lifestyle factors.[8] While occupational noise is now limited and generally well-controlled in the UK,[42] past exposure may have had serious long-term consequences for hearing in middle-age and older-age.

It remains unclear the extent to which hearing loss is a driver of low SES or whether low SES is a driver of hearing loss.[35] First, analysis in Finland showed that hearing loss early in life—with its detrimental impact on educational attainment in adolescence—can be a driver of low SES in young adulthood through fewer opportunities for entering into higher education and through more frequent spells of unemployment.[43] Second, longitudinal studies have suggested low SES to be a key driver of hearing loss in middle-to-older age through factors such as working in jobs with a greater potential for exposure to damaging levels of noise. For example, analysis of the Beaver Dam Eye Study showed that the development of incident hearing loss was more likely among participants with lower levels of educational attainment and among those participants who worked in industrial occupations versus management and professional positions.[37 44]

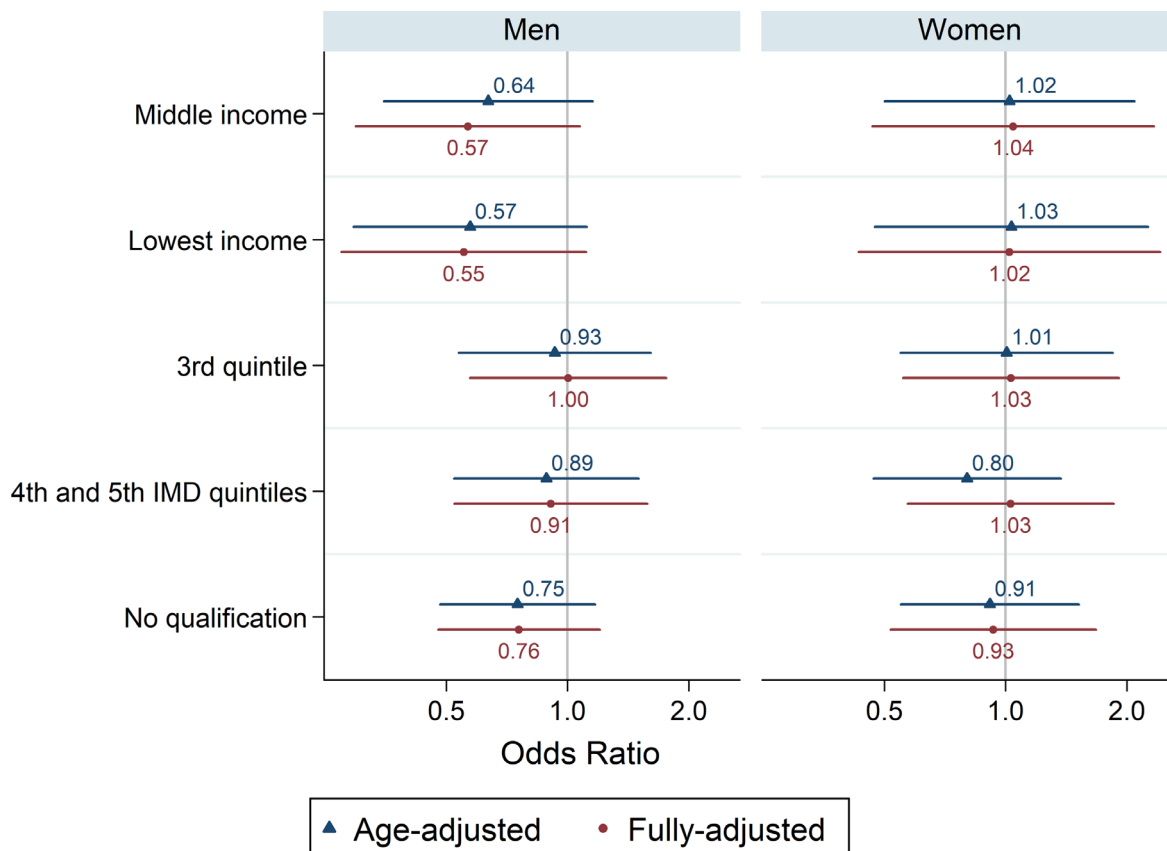The diabetes–hearing loss associations found in our study are in agreement with a recent meta-analysis.[45]

Figure 3 Association between socioeconomic status (SES) and current hearing aid use in middle-aged and older adults with hearing loss. Indicators of SES were equivalised household income tertiles (highest tertile as reference), Index of Multiple Deprivation (IMD) quintiles (least deprived Q1 and Q2) and highest educational attainment (O level and above). Lines represent OR (outcome=hearing aid use) and its 95% CI. Model A (triangles): adjusted for age. Model B (circles): adjusted for: age, severity of hearing loss, exposure to work-related noise, region and cardiovascular disease risk factors (smoking, body mass index, diabetes, hypertension, dyslipidaemia and physical inactivity).

Explanations for the association between diabetes and hearing loss include the microvascular and neuropathic complications that affect diabetics in multiple organ systems which may also affect the inner ear.[46 47] This study confirms the low level of current hearing aid use, especially among men in the lowest SES groups. Previous studies have demonstrated non-financial barriers to uptake and use, with self-recognition of hearing problems being the strongest factor.[48] Low take up and use are typically attributed to a perception of hearing loss being an expected consequence of ageing. Non-audiological drivers for older adults with hearing impairment consulting a health professional and/or to use hearing aids included a positive attitude to hearing aids (their own and from significant others) and self-efficacy about hearing aids (eg, placement and battery removal).[49] Although treatment and hearing aid provision is financially supported in the UK through the National Health Service, persons in the lower SES groups use specialist health services less frequently than those in higher SES groups.[50]

The main strength of this study was the use of valid screening audiometry data within a nationally representative health examination survey. Data from a hearing test overcomes the underestimation of socioeconomic inequalities in health that are typically associated with self-reports.[51] Other analyses of HSE 2014 showed that socioeconomic inequalities in hearing were most apparent using the data from the audiometric screening device but not from the self-report data,[17] partly reflecting differences in levels of expectations and differences in levels of awareness of adverse health conditions.[52] This study also has a number of limitations. Differences in the propensity to respond at the nurse-visit may have weakened the sample's representativeness and reduced the generalisability of our findings, but the use of statistical weights to account for the biases in individual participation would have mitigated this to a considerable extent. The estimates of hearing loss prevalence are conservative due to the exclusion of: (1) the institutionalised population, (2) individuals with a cochlear implant or with a current ear infection and (3) the exclusion of an unknown number of individuals with conditions such as deafness that were judged to impede interviewer–participant communication. The relatively small number of participants with hearing loss may have resulted in our analyses of current hearing aid use to be underpowered to detect differences among

subgroups. For the same reason, we were unable to examine differences in usage among subgroups stratified by the severity of hearing loss. Insufficient numbers meant that we were unable to provide separate reliable estimates for minority ethnic groups. Our findings could have been influenced by unmeasured confounders such as the duration of exposure to non-occupational noise. Lastly, since we used cross-sectional data, we were unable to assess the temporal relationship between SES and hearing, and so could not establish causality.

In conclusion, hearing loss is highly prevalent, affecting more than one in four men and affecting one in five women. However, less than one in three persons with hearing loss reported using a hearing aid nowadays, suggesting a significant level of unmet need. While the burden of hearing loss falls highest among persons, but especially men, in the lowest SES groups, use of hearing aids is demonstrably lower. Initiatives to detect hearing loss early, and the increased uptake of hearing aids, may provide substantial public health benefits and reduce socioeconomic inequalities in health.

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