

**The leaky pipeline of hearing care: primary to secondary care evidence from the English Longitudinal Study of Ageing (ELSA)**

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**ABSTRACT**

**Objective**

Proportions of older adults' transitions through acknowledging their hearing loss to getting access to treatment are unknown. This was examined using data from a nationally representative cohort in England.

**Design**

Patient and healthcare factors associated with referrals were examined cross-sectionally, through primary to secondary care. Non-report predictors identified using multiple logistic regression models.

**Study Sample**

1 8,529 adults with hearing data in the English Longitudinal Study of Ageing Wave 7.

2 **Results**

3 Nearly 40% of those with acknowledged hearing loss did not tell a doctor or nurse  
4 (n=857/2,249). Women (OR 2.68, 95%CI 2.14-2.98), retirees (OR 1.30, 95%CI 1.17-1.44),  
5 those with foreign education (OR 2.74, 95%CI 2.47-3.04), lower education (OR 2.86, 95%CI  
6 2.58-3.18), smokers (OR 4.39, 95%CI 3.95-4.87), and heavy drinkers (OR 1.67, 95%CI 1.58-  
7 1.85) were more likely to not report hearing loss. Of those who acknowledged and reported  
8 hearing difficulties, willingness to try hearing aid(s) was high (78.9%).

9 **Conclusions**

10 Unacknowledged, or acknowledged but not reported hearing loss by individuals, and non-  
11 referrals by primary healthcare professionals, are barriers to accessing hearing healthcare.  
12 Future research should report hearing aid use as the proportion of individuals who  
13 acknowledge their hearing loss, to avoid an overestimation of the non-use of hearing aids  
14 within study samples.

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## 1 INTRODUCTION

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3 Hearing loss is a significant public health issue, estimated to affect a large proportion  
4 of the population (McDaid et al, 2021). In England alone, hearing loss affects more than 40%  
5 of adults over 70 years of age, a percentage with marked regional variability between the  
6 northern and southern parts of the country (Tsimpida et al, 2022). Hearing loss in later life  
7 has a significant social and psychological impact on an individual's life, posing a substantial  
8 risk to the functional abilities that enable healthy ageing (Young, 2014; Tsimpida et al,  
9 2021b).

10 Although there are associations between age and hearing loss, a recent study in  
11 England provided evidence that age is a less critical factor in the aetiology of hearing loss  
12 than previously believed (Tsimpida et al, 2020b). Reframing the discussion around hearing  
13 loss in later life to reflect that it is not an inevitable accompaniment of ageing, could  
14 encourage secondary preventative strategies around early identification of hearing  
15 problems. In addition, there is scientific evidence that the use of hearing aids to manage  
16 hearing loss improves the hearing-related and health-related quality of life for those with  
17 mild to moderate hearing loss (Ferguson et al, 2017), which is vital given the substantial  
18 burden of this long-term condition (Wilson et al, 2017).

19 Current evidence shows a wide variation in rates of hearing aid uptake that has been  
20 reported depending on the sample and the country assessed (Bisgaard & Ruf, 2017;  
21 Bisgaard et al, 2022). Heterogeneity in the use of hearing aids may reflect differences  
22 between health systems and hearing aid provision between different countries, for  
23 example, availability and cost (Sawyer et al, 2020). However, hearing aid use is also low in

1 countries where hearing aid provision for most people is covered by public health insurance,  
2 for example, in England, where the cost should not be a major barrier to hearing aid uptake,  
3 as hearing aids are provided in a universal healthcare setting and are free at the point of  
4 delivery (Barton et al, 2001). Today, hearing loss remains significantly underdiagnosed and  
5 untreated (Benova et al, 2015; Sawyer et al, 2019; Dillon et al, 2020). Currently there is no  
6 national screening programme for early identification of hearing loss in adults through a  
7 routine free health check in primary care (Tsimpida et al, 2020a). The early identification of  
8 hearing loss and subsequent uptake of hearing aids is often delayed unnecessarily for many  
9 years (Hill et al, 2015).

10 Health system users in England may experience several barriers in their hearing  
11 pathway from primary to secondary care. Benova et al. (2015), analysed data from Wave 2  
12 of the English Longitudinal Study of Ageing (ELSA) (Zaninotto & Steptoe, 2019), and broke  
13 down the hearing data questions in the ELSA into six distinct stages corresponding to the  
14 help-seeking process: self-diagnosis (Stage 1), the individual's initiation of contact with a  
15 health provider in primary care (Stage 2), referral to an ear specialist (Stage 3), hearing aid  
16 recommendation (Stage 4), compliance with the recommendation to obtain a hearing aid  
17 (Stage 5) and adherence with the recommendation to use a hearing aid (Stage 6).

18 However, a previous study (Tsimpida et al, 2020a) revealed that participants may be  
19 misclassified as being in Stage 1, without being aware of having hearing loss. For example,  
20 an ELSA participant may report having great difficulty following a conversation if there is  
21 background noise (such as television, radio, or children playing), and consequently  
22 categorised as having self-reported difficulties; however, in a subsequent question, the

1 participant may answer that their hearing is excellent, showing that they were not aware of  
2 having hearing loss when they completed the questionnaire.

3 To address the above discrepancy, a different approach was taken to identify those  
4 who are recorded as having hearing loss, based on the design of the questionnaire, and, in  
5 parallel, are aware of their hearing loss, as denoted by Tsimpida et al. (Tsimpida et al,  
6 2020a). This issue had not been addressed in the study published by Benova et al. (2015),  
7 as the validation of self-reported hearing data with pure-tone screening audiometry data  
8 was not possible in their study. Distinguishing between those who are and those who are  
9 not aware of their hearing loss is important when exploring the proportions of hearing aid  
10 uptake. Including those who are unaware of their hearing loss in calculations of hearing aid  
11 uptake, prevents accurate examination of the willingness to try hearing aids amongst those  
12 who are aware of their hearing loss. Participants without awareness of their hearing loss  
13 would have no reason to seek help for hearing difficulties. Additionally, both must be  
14 tackled by distinct strategies; in the case of low awareness, supporting early identification  
15 is required, whereas low uptake of hearing aids by individuals who are aware of their  
16 hearing loss, strategies to improve access to and uptake of hearing aids is needed.

17 Currently, there is a lack of evidence around awareness and reporting of hearing loss  
18 or the barriers they may encounter in the help-seeking process. The lack of studies that  
19 explore the proportion of people seeking help for hearing-related problems and the  
20 subsequent proportions that are referred, diagnosed and treated or remained undiagnosed  
21 has been acknowledged by the UK National Screening Committee (NSC). In addition, the UK  
22 NSC has recognised the need for more high-quality evidence regarding the proportion of  
23 UK adults with hearing loss accessing treatment amongst the detected population in the UK

1 (Solutions for Public Health, 2021). Identifying potential individual and system-level barriers  
2 to treatment for hearing loss is essential to inform interventions and health policy strategies  
3 for hearing screening in England.

4 Therefore, this study aims: a) to investigate the characteristics of the patient pathway  
5 for adults with acknowledged hearing loss in England, and b) to examine patient and  
6 system-level factors associated with non-referrals from primary care to ear specialists for  
7 audiological examinations, based on a nationally representative cohort of older adults.

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## 9 **MATERIALS AND METHODS**

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### 11 **Study Population**

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13 We used data from the ELSA, a large population-based prospective cohort study that  
14 provides a nationally representative sample of adults in England aged 50 and older (Stephoe  
15 et al, 2013).

16 The full analytic cohort was composed of individuals who participated in the seventh  
17 wave of the ELSA (n = 9,666), which collected information between June 2014 and May  
18 2015. For our study, we analysed a sample of n = 8,529 adults that had a hearing assessment  
19 using the HearCheck Screener, which tests for audibility of pure tone stimuli at 1.0 kHz and  
20 3.0 kHz (Siemens Audiologische Technik GmbH, 2007), and did not have an ear infection or  
21 a cochlear implant (Zaninotto & Steptoe, 2019). All participants gave written, informed  
22 consent at the recruitment wave to participate in the ELSA and in each subsequent wave.

1 Ethical approval was granted for the ELSA by the National Research and Ethics Committee  
2 (Zaninotto & Steptoe, 2019; Natcen Social Research, 2018).

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#### 4 **Outcomes**

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##### 6 *Self-reported hearing loss*

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8 Self-reported hearing loss is defined in the ELSA as (a) having declared fair or poor  
9 hearing on a five-point Likert scale (excellent, very good, good, fair or poor), or (b) whether  
10 they had moderate or great difficulty in following a conversation if there is background  
11 noise (such as television, radio, or children playing) (Zaninotto & Steptoe, 2019).

12 The concordance of the ELSA self-reported hearing loss with pure-tone screening  
13 audiometry has been examined in a previous study (Tsimpida et al, 2020a). The sensitivity  
14 of the self-reported measure in the ELSA Wave 7 was 69.8% (95%CI 67.9–71.7), which refers  
15 to the ability of the self-reported measure to correctly identify seven in ten people with  
16 psychoacoustically measured hearing loss greater than 35 dB HL at 3 kHz in the better-  
17 hearing ear (true-positive results). This is the level of hearing loss at which intervention has  
18 shown to be beneficial (Davis et al, 2007). The specificity of the self-reported hearing loss  
19 was 69.3% (95% CI 68.1–70.4).

20 We further categorised those 2,249 with acknowledged self-reported hearing loss  
21 into those with moderate self-reported hearing loss (if they reported that their hearing was  
22 fair or had moderate difficulty following a conversation with background noise) and those  
23 with moderately severe or severe self-reported hearing loss (if they reported that their

1 hearing was poor or had great difficulty following a conversation with background noise).  
2 That categorisation was based on the concordance of the ELSA self-reported hearing loss  
3 with pure-tone screening audiometry (Tsimpida et al, 2020b).

4

#### 5 *Current hearing aid use*

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7 As part of the ELSA data collection, participants who self-reported hearing loss were  
8 asked whether they ever wore a hearing aid, with the following possible answers: (a) Yes,  
9 most of the time, (b) Yes, some of the time, and (c) No. In this study, we defined hearing aid  
10 use in this study as responses (a) or (b) and hearing aid non-use as responses (c) (Zaninotto  
11 & Steptoe, 2019).

12

#### 13 **Covariates**

14

15 We used indicators of socioeconomic position (SEP) as covariates within our analyses.  
16 These were the highest educational attainment [no qualifications; foreign/other; O levels  
17 (refers to ordinary level, the final certification of secondary education and is usually taken  
18 between 14 and 16 years of age; A levels (stands for advanced level, the advanced level  
19 qualification for students aged 16 years and above; degree/higher education), tertiles of  
20 the self-reported occupation according to the National Statistics socioeconomic  
21 classification (NS-SEC) (routine and manual occupations; intermediate; managerial and  
22 professional) and the quintiles of the net household income and the total non-pension  
23 wealth (first quintile lowest; fifth quintile highest).



1 We also examined the demographic covariates of respondents (age and sex) as well  
2 as several lifestyle factors as covariates (physical activity and tobacco and alcohol  
3 consumption), because previous evidence has shown that these are key risk factors for  
4 hearing loss in older adults (Tsimpida et al, 2018; Tsimpida et al, 2021a). Levels of physical  
5 activity were described by a variable that examined the frequency at which the respondents  
6 do moderate sports or activities, with the possible answers being: (1) more than once a  
7 week, (2) once a week, (3) one to three times a month and (4) hardly ever or never. Tobacco  
8 consumption through any type of nicotine product was in three categories: current  
9 smokers, former smokers, and those that have never smoked. We constructed a continuous  
10 variable to represent the sum of units of alcohol that the participants consumed in the last  
11 seven days according to the Chief Medical Officer’s Drinking Guidelines (Department of  
12 Health, 2016), which count each measure of spirits as one unit, and each glass of wine or  
13 pint of beer as two units. The constructed variable of units of alcohol during the last seven  
14 days was further dichotomised into those that did or did not consume more than 14 units  
15 of alcohol during the previous seven days (Department of Health, 2016).

16 We dichotomised marital status into; currently married (married, first and only  
17 marriage; in a registered civil partnership; and remarried, in a second or later marriage) and  
18 not married (single, that is never married and never registered in a marriage; separated, but  
19 still legally married; divorced; and widowed). Retirement status was also dichotomised as  
20 currently being or not being retired.

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## 22 **Statistical Analysis**

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1 Descriptive statistical measures are provided for hearing loss, hearing in noise, and  
2 hearing-aid recommendations within the ELSA Wave 7 (n = 8,529). Participants' self-  
3 reported hearing loss (moderate, moderately severe or severe) were reported as absolute  
4 (n) and relative (%) frequencies.

5 We fitted multiple logistic regression models to identify predictors of non-reporting  
6 of acknowledged hearing loss within the sample of a) those who self-reported hearing loss  
7 (n = 2,249), b) those who self-reported moderate hearing loss (n = 1,565), and c) those who  
8 self-reported moderately severe or severe hearing loss (n = 684). Age was categorised into  
9 three groups (50–64; 65–74; and 75–89) to allow for a comparison with Tsimpida et al.  
10 (Tsimpida et al, 2020a). There were a number of missing data for covariates (shown in **Table**  
11 **1 in the Additional File**). We performed analyses which showed that there was no pattern  
12 in the missing data regarding age, sex, education, occupation, income and wealth. Due to  
13 the low proportion of missingness, we excluded records with missing data from our  
14 analyses, concluding that this would be unlikely to affect the validity of our findings (Little  
15 & Rubin, 2019; Mittag, 2013).

16 For all models, odds ratios and 95% confidence intervals are presented. We used the  
17 Hosmer -Lemeshow test as a post-estimation tool, which demonstrates the goodness-of-fit  
18 of logistic regression models. The two-tailed significance level was set at  $\leq 0.05$ . All data  
19 were analysed using Stata/SE 16.1.

20

## 21 **RESULTS**

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23 *Self-reported hearing loss*

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2 To obtain a clean sample of those with self-reported and actively recognised hearing  
3 loss, we used the categories from a previously published study (Tsimpida et al, 2020a), to  
4 exclude those who had responded that they had difficulty in following a conversation if  
5 there is background noise but reported at the same time that their hearing is very good,  
6 good, very good or excellent. That study revealed that of the 3,425 participants recorded as  
7 having self-reported hearing loss (Stage 1 in Benova’s stages for help-seeking) (Benova et  
8 al, 2015), 65.7% (n = 2,249) acknowledged hearing loss (Tsimpida et al, 2020a).

9 Figure 1 shows the characteristics of the sample for hearing loss, hearing in noise,  
10 and hearing aid recommendation in the ELSA Wave 7 (n = 8,529: males = 3,728 and females  
11 = 4,801). The 38.2% of those with acknowledged hearing loss (n = 857/2,249) did not tell a  
12 doctor or nurse in primary care about their hearing loss, missing the opportunity to be  
13 referred to an ear specialist to assess their hearing. Two participants of the 2,249 responded  
14 ‘I do not know’ and were excluded from the analysis.

15 Out of the 1,390 participants who told a doctor or nurse about their hearing problems,  
16 82.4% were referred to secondary care for an audiological examination (n = 1,145/1,390).  
17 In addition, nearly a third of those individuals (30.2%, n=420/1,390) who told a doctor or  
18 nurse about their hearing loss, were not recommended a hearing aid by healthcare  
19 providers.

20

21

*Figure 1*

22

1 Table 1 shows a summary of multiple logistic regression for variables predicting the  
2 non-report to a doctor or nurse in primary care of acknowledged hearing difficulty in the  
3 ELSA Wave 7. We also present the corrected odds ratios for sensitivity and specificity  
4 (Antunes, 2019). The corrected odds ratio in the multiple logistic regression models showed  
5 that demographic, socioeconomic and lifestyle factors were associated with the non-  
6 reporting of acknowledged hearing loss to a doctor or nurse in primary care. Significant  
7 predictors for non-reporting, by those who had moderate or worse hearing loss (Model I),  
8 were females (OR 2.68, 95%CI 2.14-2.98), retirees (OR 1.30, 95%CI 1.17-1.44), having a  
9 foreign education (OR 2.74, 95%CI 2.47-3.04), having a lower education, defined as O  
10 level/CSE grade (OR 2.86, 95%CI 2.58-3.18), and having a current smoking habit (OR 4.39,  
11 95%CI 3.95-4.87). In addition, those consuming alcohol above the low-risk-level guidelines,  
12 defined as 14 units of alcohol per week (Department of Health, 2016), had a greater  
13 likelihood of non-reporting of a recognised hearing problem than those who consumed  
14 alcohol below the low-risk level guidelines (OR 1.67, 95%CI 1.58-1.85).

15

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*Table 1*

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18 *Current hearing aid use*

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20 Figure 2 shows the responses to hearing aid uptake and use questions in the ELSA  
21 Wave 7 by those with self-reported hearing loss. Seven hundred and eighty-two participants  
22 reported that they currently wear a hearing aid [most of the time (62%, n = 485/782) or

1 some of the time nowadays (38%, n = 297/782)]. The majority of hearing aid users got their  
2 hearing aids for free through the NHS (82%, n = 642/782).

3

4

*Figure 2*

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6 Figure 3 shows additional analyses on those who acknowledged their hearing loss,  
7 told a doctor or nurse in primary care about their hearing loss and were referred to an ear  
8 specialist to check their hearing. Out of a total of n = 1,145 participants that had been  
9 referred for an ear examination, 62% (n = 444 + 267 = 711) (as shown in Figure 2), reported  
10 they used hearing aids, and adhered to treatment most of the time (n = 444), or some of  
11 the time, (n = 267). In addition, 16.8% (n = 192/1,145) of those who had been referred for  
12 an ear examination had tried hearing aids, although they do not currently wear one.  
13 Therefore, the majority (78.9%) of individuals who acknowledged their hearing loss, told a  
14 doctor or nurse and were referred for an ear examination used or tried a hearing aid.

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*Figure 3*

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18 Figure 4 summarises the above findings, which are presented as 6 Stages in the  
19 hearing pathway and depicts the percentage of those who leave the pathway before  
20 successfully completing each stage.

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*Figure 4*

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## 1 **DISCUSSION**

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### 3 **Summary of the main findings**

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5       This study examined individual and healthcare system factors associated with primary  
6 to secondary care referrals in a nationally representative study of older adults in England.  
7 We found that 38.1% of those with an acknowledged hearing loss did not tell a doctor or  
8 nurse about their hearing problems, missing the opportunity to be referred to an ear  
9 specialist to assess their hearing. Several demographic, socioeconomic and lifestyle factors  
10 were associated with the non-reporting of hearing loss to a doctor or nurse in primary care.  
11 Almost one out of five patients who told a primary care healthcare provider about their  
12 hearing loss did not receive an onward referral to secondary care for a further hearing  
13 assessment, as per recommendation No. 12 in NICE Guideline NG98 (NICE, 2018). A large  
14 proportion (78.9%) of those who acknowledged, and reported hearing loss and being  
15 referred to secondary care, were willing to try and use hearing aids.

16

### 17 **Comparison with previous literature**

18

19       Our study adds to previous studies that found that GPs refer only a small percentage of  
20 those mentioning any hearing loss in primary care to secondary care (Yueh et al, 2003; Davis  
21 et al, 2007; Schneider et al, 2010; Wallhagen & Pettengill, 2008). However, we found that  
22 nearly one in five (17.5%) who told a doctor or nurse about their hearing problems were  
23 not referred to secondary care; this is a much lower percentage than the 50% reported in a

1 previous study by Davis et al., (2007) who examined patients from six GP practices in  
2 Nottingham, (not a nationally representative sample). A more recent study by Sawyer et al.  
3 (2020) also explored data from the ELSA, but did not find that onward referral from GPs  
4 were a barrier at all; they found that only 4.5% of those reporting hearing loss reported not  
5 being referred for a hearing assessment.

6 To our knowledge, our study is the first to examine socioeconomic, and lifestyle  
7 predictors of unreported but acknowledged hearing loss in primary care, based on a  
8 representative sample of older adults in England. Sawyer et al. (2020) examined the  
9 biopsychosocial classification of seeking hearing health in the ELSA and found that  
10 socioeconomic position was not associated with any stage in the help-seeking process.  
11 However, their study examined different stages in the hearing pathway to the present  
12 research and followed an alternative methodology to the published ELSA Wave 7 protocol  
13 (publicly available at <https://www.elsa-project.ac.uk/study-documentation>).

14

## 15 **Strengths and limitations**

16

17 Our study presents the first evaluation from a representative sample of older adults in  
18 England of help-seeking for hearing problems, hearing aid recommendation, uptake and  
19 use by older adults who acknowledge and report difficulties in their hearing. These findings  
20 provide novel insights, as previously published studies in England do not differentiate  
21 between those with acknowledged and unacknowledged hearing loss to attribute  
22 proportion-based estimates of hearing aid uptake and use (Benova et al, 2015; Scholes et

1 al, 2018). This may contribute to the wide variation in rates of hearing aid uptake that has  
2 been reported (Bisgaard & Ruf, 2017; Bisgaard et al, 2022).

3 In our study, it is clear that a large proportion of people would be unlikely to access  
4 hearing healthcare because they had unacknowledged hearing loss. We found that, for  
5 those individuals who had the opportunity to access hearing healthcare, the percentage of  
6 individuals reporting the use of hearing aids was encouragingly large. If this population were  
7 considered together with those who had unacknowledged hearing loss, the proportion of  
8 hearing aid use would appear much smaller. To obtain a more accurate proportion of  
9 hearing aid uptake amongst adults who acknowledge and report hearing loss, participants  
10 in studies should be asked 'if they have ever told a doctor or nurse about their hearing loss'.  
11 For example, Scholes (2018a) reports that among those with hearing loss, 30% of men and  
12 27% of women were currently using hearing aids. However, it is unclear what proportion of  
13 participants were unaware of their hearing loss prior to participation in the study, and  
14 therefore highly unlikely to have sought help for hearing loss. Considering the proportions  
15 of adults with acknowledged and unacknowledged hearing loss separately is likely to be  
16 much more useful for future work in this area; the proportion of those with acknowledged  
17 hearing loss may be more helpful in understanding barriers and facilitators to accessing  
18 hearing healthcare. On the other hand, considering the proportions of those with  
19 unacknowledged hearing loss is also important for health policy changes towards the early  
20 identification of hearing loss cases, and the development of public health interventions for  
21 increasing awareness around hearing health. As suggested by the UK National Screening  
22 Committee (Solutions for Public Health, 2021), the accurate evidence on the proportion of



1 uptake of treatment in populations might provide a better estimate for the acceptability of  
2 hearing aids and our study provides a more robust way for this proportion to be calculated.

3       However, our study has several limitations. First, the cross-sectional analyses did not  
4 allow for causal or temporal relationships among the factors associated with the non-  
5 reporting of hearing loss to a health professional and the potential effect of existing  
6 comorbid health conditions that may downgrade hearing loss as a health priority.

7       In addition, it was not possible to analyse hearing aid uptake among those who did not  
8 report hearing difficulty (but could have experienced hearing loss), as they did not have the  
9 opportunity to respond to these questions. As shown in our study, a number of older adults  
10 may experience hearing loss without reporting it to a doctor or nurse in primary care. The  
11 recently launched technical guidelines by the World Health Organization recommend  
12 screening in primary care for older adults who do not report hearing loss so as to address  
13 such cases of unacknowledged hearing loss (WHO, 2021).

14       The assessment of hearing acuity via a hearing screening device in the ELSA Wave 7 was  
15 performed only on those who did not have an ear infection or a cochlear implant. Of the  
16 9,666 participants in the ELSA Wave 7,  $n = 208$  had an ear infection, and  $n = 50$  had a  
17 cochlear implant, and we were not able to obtain any data on them. In addition, the  
18 validation of self-reported hearing loss was constrained by the HearCheck Screener's  
19 technical characteristics, as it generates high-frequency sounds at 3 kHz at 75 dB HL, 55 dB  
20 HL, and 35 dB HL. Therefore, no information for mild hearing loss has been obtained, and  
21 further evidence in future studies regarding the transitions of people with mild hearing loss  
22 is needed.

1 We need to take into consideration that the data in a survey may not directly reflect  
2 individual choices and decisions, as communication partners can influence decision-making  
3 surrounding hearing loss treatment both positively and negatively, for instance, regarding  
4 the decision whether or not to obtain a hearing aid (Schulz et al, 2016). Furthermore, the  
5 steps in the help-seeking behaviour process were informed by the available variables in the  
6 ELSA dataset and not by the author's interpretations or other theoretical models that have  
7 previously discussed the processes that individuals have to navigate to acknowledge their  
8 hearing loss (Barnett et al, 2017; Laplante-Lévesque et al, 2015).

9 The majority of the participants in our study (82.1%, n = 642/782) reported that they  
10 got their hearing aids for free through the NHS. Participants who paid privately amounted  
11 to 14.6% (n = 114/782), while 3.3% (n = 26/782) got their hearing aids both through the NHS  
12 and privately (see Figure 2). However, the current data did not allow us to explore  
13 additional barriers that may be faced when paying privately to get a hearing aid, or the  
14 reasons to choose the private option since a hearing aid can be obtained through the NHS  
15 for free.

16 We did not analyse the characteristics of those who reported hearing difficulty but  
17 were not referred to secondary care by a primary care professional. Identifying potential  
18 reasons for health professionals' behaviour is an area for future investigation through  
19 qualitative and geographical research, as this may occur due to other factors, such as limited  
20 healthcare resources in some regions of England where the prevalence of hearing loss is  
21 high (Tsimpida et al, 2022). Likewise, the reasons behind the non-reporting of hearing loss  
22 revealed in our study may reflect a stigma to admitting hearing problems, potential barriers  
23 in health communication with providers or low health literacy skills among specific

1 population groups. A previous study showed that women, those with low education,  
2 smokers and heavy drinkers were at a higher risk of not recognising their hearing had  
3 deteriorated and were thus less likely to seek help (Tsimpida et al, 2020a). Therefore, these  
4 population groups not only are not only at a higher risk of not recognising the symptoms of  
5 hearing loss but are also more likely to not report them once they are aware of their hearing  
6 loss. Further information about the experiences of these population subgroups in England,  
7 along with any personal predictors on hearing aid uptake, use, and benefits (Ferguson et al,  
8 2016; Nixon et al, 2021; Van Leeuwen et al, 2021) should be further explored, as it was not  
9 possible to obtain this information through this dataset.

10 Lastly, the ELSA provides data for individuals living in private households, and data for  
11 individuals living in residential and nursing homes are not included (Marmot et al., 2003).  
12 Furthermore, the study does not offer any information on participants from ethnic  
13 minorities, as there is no ethnicity variable in the ELSA.

14  
15

## 16 **Research and policy implications**

17

18 In 2021, the UK NSC (Solutions for Public Health, 2021) acknowledged that the limitation  
19 of the review on screening for hearing loss in adults was the insufficiency of good quality  
20 evidence to clearly judge an outcome or effect relating to the key questions about screening  
21 adults for hearing loss. For example, no studies were identified that explored the proportion  
22 of people seeking help for hearing-related problems and the subsequent proportions that  
23 were referred, diagnosed and treated or remained undiagnosed. A larger volume of high-

1 quality evidence is needed on the proportion of uptake of treatment in the detected  
2 population in the UK.

3 Therefore, our study provides novel evidence that may have important health policy  
4 implications and underscores the need for evidence-based hearing screening programmes  
5 in England. The early detection of hearing loss by primary care professionals in routine  
6 assessments may not only promote better diagnosis of hearing loss and better hearing  
7 health but also prevent or delay the onset of conditions known to relate to untreated  
8 hearing loss, such as social isolation and depression (Tsimpida et al, 2021b). Our findings  
9 highlight opportunities for targeted interventions in England to raise awareness of primary  
10 prevention and initial symptoms of hearing loss, aiming to improve the reporting of hearing  
11 loss to primary care health professionals, which can lead to further hearing assessment for  
12 individuals. Public health campaigns may help improve public awareness of the importance  
13 of addressing hearing loss early (David et al, 2018; Tsimpida et al, 2020a). Adults aged 50-  
14 75 years have been identified in a recent study as a key target group for a potential hearing  
15 awareness campaign (Alperstein & Beach, 2022). Future studies exploring the reasons for  
16 the underutilisation of hearing aids, including cultural or language barriers (Ismail et al,  
17 2019), and studies targeting specific socioeconomic groups that are particularly unlikely to  
18 access hearing services and use hearing aids (Scholes et al, 2018), are of particular  
19 importance.

20 Our findings also support the need for effective interventions to improve primary care  
21 providers' hearing loss awareness in England (Maru et al, 2021). In a recent study, only 40%  
22 of primary care providers believed hearing loss is treatable, and only 17% believed it is  
23 preventable (Sydlowski et al, 2022), which shows that primary healthcare professionals'

1 current awareness and literacy surrounding hearing loss are poor. Knowledge regarding the  
2 types of message framing in clinical communication between people with hearing loss and  
3 primary care providers is limited and needs further exploration. Training modules for  
4 hearing loss awareness from the early stages of medical education and throughout their  
5 medical career (i.e., continuous professional development seminars) would be beneficial  
6 (Maru et al, 2021).

7 Recent developments in the Royal College of General Practitioners (RCGP) Core  
8 Curriculum now stress the importance of early intervention, effective communication, and  
9 improved access for people who are deaf or have hearing loss, aligned with NICE Guidance  
10 (Ftounh et al, 2018), which states that audiological assessments should be arranged for adults  
11 presenting with hearing loss for the first time (or in whom hearing loss is suspected). To  
12 help ensure this can be achieved, future work should assess in detail health provider and  
13 system factors to better understand why one in five people in our study were not referred  
14 by professionals for an ear examination. The feasibility of multilevel interventions (at the  
15 patient, provider, and system level) to improve access and continuity of care for people with  
16 hearing loss is an area for future investigations.

17 The hearing measures in the ELSA are directly comparable to seven other national  
18 surveys with harmonised physical and anthropometric measurements that are publicly  
19 available in the 'Gateway to Global Ageing' [<https://g2aging.org/>]. Our study, the first to  
20 address the research aims of this manuscript in a nationally representative dataset, offers  
21 a unique opportunity for researchers to examine the same research questions in other  
22 countries and undertake cross-national comparisons with significant health policy  
23 implications.

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**Conclusions**

Several barriers in the pipeline of hearing care exist at the patient, provider, and system levels. Our study revealed that the majority (78.9%) of individuals who acknowledge and report hearing loss are happy to use or try a hearing aid. Our findings indicate that the percentage of hearing aid users should be calculated as a proportion of those who actively acknowledge and report having hearing loss, otherwise this may lead to an underestimation of those who could potentially use a hearing aid, putting the blame on individuals while the actual reason for the underutilisation may lie with health system failures and wider determinants of health. Development of interventions to improve both the acknowledgement and reporting of hearing loss by both individuals and primary healthcare providers is encouraged by our findings, as a promising avenue for addressing preventable barriers to accessing hearing healthcare.

1 Declarations and ethics statements

2 **Ethics approval** Ethical approval for all the ELSA waves was granted by the National  
3 Research and Ethics Committee (MREC/01/2/91).

4 **Informed consent from participants** Written informed consent was obtained from all  
5 individual participants included in ELSA (not relating specifically to this study). Details of the  
6 ELSA study design, sample and data collection are publicly available at the ELSA's project  
7 website [<https://www.elsa-project.ac.uk/>].

8 **Data availability statement** The English Longitudinal Study of Ageing dataset is publicly  
9 available via the UK Data Service (<http://www.ukdataservice.ac.uk>). Statistical code is  
10 available from the corresponding author upon request at [d.tsimpida@liverpool.ac.uk](mailto:d.tsimpida@liverpool.ac.uk).

11 **Consent to publish statement** Not applicable.

12 **Competing interests** DT is owner of a 'Design Patent' for hearing aid (International Design  
13 Classification Version: 13-2021, Registered Design No: 6196408). All other authors declare  
14 that they have no competing interests.

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16 commercial, or not-for-profit sectors. The independent input of HH was funded by the  
17 National Institute for Health and Care Research (NIHR), award references BRC-1215-  
18 200003, CDF-2018-11-ST2-016 and PB-PG-0816-20044.

19 **Author contributions** DT and SR developed the idea, and all authors designed the study. DT  
20 was responsible for conducting the analyses, interpreting the results, and drafting the  
21 manuscript. DT, SR, MP and HH critically revised the manuscript. All authors have read and  
22 approved the final manuscript and agree to be accountable for all aspects of the work in

1 ensuring that questions related to the accuracy or integrity of any part of the work are  
2 appropriately investigated and resolved.

3 **Disclaimer** The views expressed in this article are those of the authors and not necessarily  
4 those of the NHS, the NIHR, or the Department of Health and Social Care.

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1 **Figure 1** The questions on hearing loss, hearing in noise, and hearing aid recommendation  
2 in the English Longitudinal Study of Ageing (ELSA) Wave 7 (n=8,529)

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4 <sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4,  
5 fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such  
6 as television, radio, or children playing).

7 <sup>b</sup> Two participants responded 'I do not know' and were excluded from the analysis  
8

9 **Figure 2** The questions on hearing aid uptake and use in the English Longitudinal Study of Ageing  
10 (ELSA) Wave 7 among those with self-reported hearing loss <sup>a</sup> (n=2,249)

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12 <sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4,  
13 fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such  
14 as television, radio, or children playing).

15 <sup>b</sup> One participant responded 'I do not know' and was excluded from the analysis  
16

17 **Figure 3** Behaviour on hearing aids use among 1,145 participants who acknowledged hearing loss,  
18 disclosed it to a doctor or nurse in primary care, and were referred to an ear specialist to check their  
19 hearing (data from the English Longitudinal Study of Ageing (ELSA) Wave 7, a nationally  
20 representative cohort of 8,529 older adults aged 50 years old and above in England).

21  
22 **Figure 4** Proportions of participants in the English Longitudinal Study of Ageing (ELSA) Wave 7 with  
23 self-reported hearing loss <sup>a</sup> who leave the hearing pathway before the successful completion of the  
24 corresponding stage.

25 <sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4,  
26 fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such  
27 as television, radio, or children playing).

28  
29 **Table 1.** Summary of multiple logistic regression for variables predicting the non-report of  
30 an acknowledged hearing difficulty to a doctor or nurse in primary care in the English  
31 Longitudinal Study of Ageing (ELSA) Wave 7.

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36 **Additional File**

37 File name: Additional File

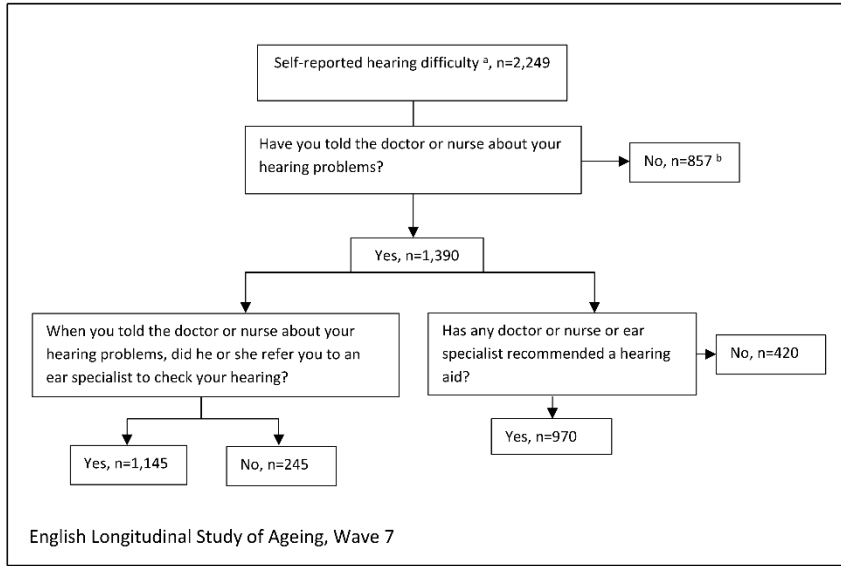
38 File Format: .pdf

39 Title of data: Table 1

40 Description of data:

41 **Table 1.** Sociodemographic characteristics of participants with self-reported hearing loss in  
42 the English Longitudinal Study of Ageing (ELSA) Wave 7 (n=2,249, aged 50-89).

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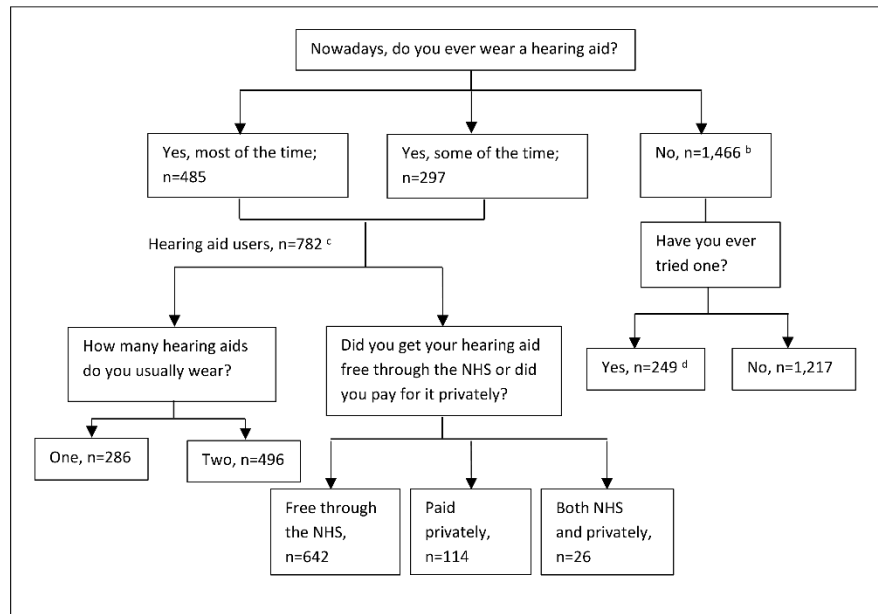


**Figure 1** The questions on hearing loss, hearing in noise, and hearing aid recommendation in the English Longitudinal Study of Ageing (ELSA) Wave 7 (n=8,529)

<sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4, fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such as television, radio, or children playing).

<sup>b</sup> Two participants responded 'I do not know' and were excluded from the analysis

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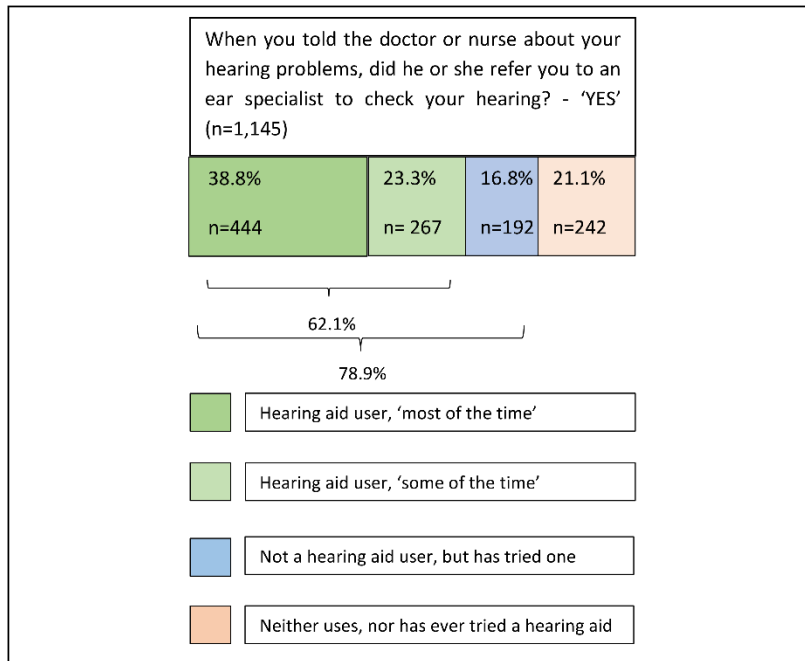


**Figure 2** The questions on hearing aid uptake and use in the English Longitudinal Study of Ageing (ELSA) Wave 7 among those with self-reported hearing loss <sup>a</sup> (n=2,249)

<sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4, fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such as television, radio, or children playing).

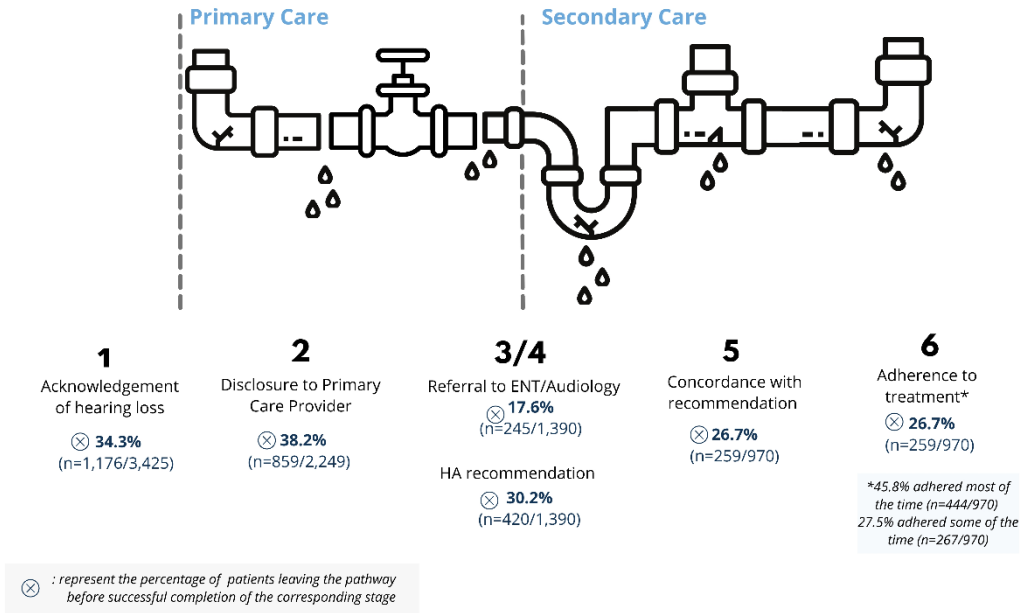
<sup>b</sup> One participant responded 'I do not know' and was excluded from the analysis

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**Figure 3** Behaviour on hearing aids use among 1,145 participants who acknowledged hearing loss, disclosed it to a doctor or nurse in primary care, and were referred to an ear specialist to check their hearing (data from the English Longitudinal Study of Ageing (ELSA) Wave 7, a nationally representative cohort of 8,529 older adults aged 50 years old and above in England).

**ELSA Wave 7 - adults with self-reported hearing difficulties**  
**The patient pathway for adults with acquired hearing loss**  
 - the leaky pipeline of hearing healthcare



**Figure 4** Proportions of participants in the English Longitudinal Study of Ageing (ELSA) Wave 7 with self-reported hearing loss <sup>a</sup> who leave the hearing pathway before the successful completion of the corresponding stage.

<sup>a</sup> The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4, fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such as television, radio, or children playing).

1 **Table 1. Summary of multiple logistic regression for variables predicting the non-report of an acknowledged hearing difficulty to a doctor or nurse in**  
 2 **primary care in the English Longitudinal Study of Ageing (ELSA) Wave 7.**  
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<b>Predictor</b>	<b>Model I <sup>a</sup></b>		<b>Model II <sup>b</sup></b>		<b>Model III <sup>c</sup></b>	
	<i>Did not report hearing loss to a doctor or a nurse in primary care while they had moderate or worse hearing loss</i>	<i>Corrected odds ratio<sup>d</sup></i>	<i>Did not report hearing loss to a doctor or a nurse in primary care while they had moderate hearing loss</i>	<i>Corrected odds ratio</i>	<i>Did not report hearing loss to a doctor or a nurse in primary care while they had moderately severe or severe hearing loss</i>	<i>Corrected odds ratio</i>
<b>Gender</b> (female)	<b>1.45 (1.14-1.86) *</b>	<b>2.68 (2.14-2.98)</b>	<b>1.39 (1.04-1.86)</b>	<b>2.36 (2.13-2.62)</b>	1.05 (0.58-1.90)	1.10 (0.99-1.22)
<b>Age</b> (65-74)	0.78 (0.57-1.07)	0.51 (0.46-0.57)	0.74 (0.51-1.06)	0.43 (0.39-0.48)	0.97 (0.42-2.21)	0.90 (0.81-1.0)
<b>Age</b> (75-89)	0.56 (0.40 -0.79)	0.15 (0.14-0.17)	0.58 (0.39-0.86)	0.18 (0.16-0.20)	0.72 (0.31-1.70)	0.40 (0.36-0.44)
<b>Retirement status</b> (not retired)	1.12 (0.87 -1.56)	<b>1.30 (1.17-1.44)</b>	1.13 (0.81-1.59)	<b>1.33 (1.20-1.48)</b>	1.32 (0.66 -2.63)	<b>2.03 (1.83-2.25)</b>
<b>Education</b> (Foreign/Other)	<b>1.46 (1.01-2.10)</b>	<b>2.74 (2.47-3.04)</b>	1.53 (0.99-2.38)	<b>3.19 (2.87-3.54)</b>	1.27 (0.57-2.83)	<b>1.82 (1.64-2.02)</b>
<b>Education</b> (O level/ CSE grade)	<b>1.48 (1.08-2.02)</b>	<b>2.86 (2.58-3.18)</b>	<b>1.52 (1.06-2.21)</b>	<b>3.12 (2.81-3.46)</b>	0.76 (0.35-1.67)	0.47 (0.42-0.52)
<b>Occupation</b> (routine/manual)	1.05 (0.78-1.40)	1.10 (0.99-1.22)	1.21 (0.87-1.70)	<b>1.60 (1.44-1.78)</b>	0.83 (0.41-1.66)	0.60 (0.54-0.67)
<b>Income</b> (lowest)	1.00 (0.91-1.10)	0.97 (0.87-1.08)	0.96 (0.86-1.07)	0.88 (0.79-0.98)	1.13 (0.89-1.44)	<b>1.33 (1.20-1.48)</b>
<b>Smoking habit</b> (current)	<b>1.67 (1.11-2.53)</b>	<b>4.39 (3.95-4.87)</b>	1.28 (0.79-2.01)	<b>1.86 (1.68-2.06)</b>	<b>3.34 (1.42-7.89)</b>	<b>6.46 (5.82-7.17)</b>

<b>Excessive alcohol consumption</b> (>14 units/week)	1.23 (0.99-1.54)	<b>1.67 (1.50-1.85)</b>	1.16 (0.90-1.49)	<b>1.43 (1.29-1.59)</b>	1.34 (0.78-2.31)	<b>2.12 (1.91-2.35)</b>
<b>Physical Activity</b> (moderate sports or activities hardly ever, or never)	0.96 (0.86-1.06)	<b>0.88 (0.79-0.98)</b>	1.00 (0.88-1.13)	0.97 (0.87-1.08)	0.87 (0.69-1.10)	<b>0.68 (0.61-0.75)</b>

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<sup>a</sup> MODEL I: The sum of those who rated their hearing as fair or poor on a 5-point Likert scale (with 1 indicating excellent; 2, very good; 3, good; 4, fair; and 5, poor) or responded that they have moderate or great difficulty in following a conversation if there is background noise (such as television, radio, or children playing).  
<sup>b</sup> MODEL II: Moderate self-reported hearing difficulty: if their hearing was fair OR had moderate difficulty following a conversation in background noise.  
<sup>c</sup> MODEL III: Moderately severe or severe self-reported hearing difficulty: if their hearing was poor OR had great difficulty following a conversation in background noise.  
<sup>d</sup> Odds ratio corrected based on sensitivity 69.8% (95%CI 67.9-71.7), and specificity 69.3% (95% CI 68.1-70.4) after comparison with data from HearCheck Screener.  
 \*Data in brackets refer to 95% CI, and statistically significant results are presented in bold.

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