



Biopsychosocial Classification of Hearing Health Seeking in Adults Aged Over 50 Years in England

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Ear and Hearing

Biopsychosocial classification of hearing health-seeking in adults aged over 50 in England --Manuscript Draft--

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Abstract:	<p>Objectives. Only 14% of the United Kingdom population aged 55-74 years with a hearing impairment use a hearing aid. Rates are similarly low in other countries. The present study aims were to identify barriers to obtaining a hearing aid and inform interventions by examining the biopsychosocial characteristics of older adults according to seven categories: i) Do not report hearing difficulties, ii) Report hearing difficulties, iii) Told a healthcare professional about experiencing hearing difficulties, iv) Referred for a hearing assessment, v) Offered a hearing aid, vi) Accepted a hearing aid, and vii) Report using a hearing aid regularly. Design. Logistic regression of cross-sectional data from 2,845 participants aged 50-89 years of age living in England (the English Longitudinal Study of Aging wave 7, 2015) with a hearing impairment determined by an objective hearing screening (indicating a hearing threshold of >35 dB HL at 3 kHz in the better ear). Classification of hearing health-seeking category was recorded from participant self-report. Participants in each category were compared to people in all subsequent categories in order to examine the associations between each category and biopsychosocial correlates (gender, age, ethnicity, educational level, wealth, audiometric hearing level, self-reported health status, cognitive performance, attitudes to aging, living alone, and engagement in social activities) using multiple regression. Results. The proportions of individuals in categories i to vii was 40% (1139/2845), 14.0% (396/2845), 4.5% (129/2845), 4.0% (114/2845), 1.2% (34/2845), 7.7% (220/2845) and 28.6% (813/2845), respectively. Severity of hearing impairment was the only factor correlated with all of the categories of hearing health-seeking. Other correlates associated with at least one category of hearing health-seeking included gender, age, self-reported health, participation in social activities, and cognitive function. Discussion. 40% of those with audiometrically identified hearing impairment did not report hearing difficulties. Targeting people in this category via</p>

	hearing screening and linking the screening to referral may lead to an increase in hearing aid uptake and use. Each category of hearing health-seeking was associated with different variables, therefore each category has different drivers and interventions will vary depending on the category of hearing health-seeking.
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Dear Sir or Madam,

Please find attached a manuscript entitled, “Biopsychosocial classification of hearing health-seeking in adults aged over 50 in England” which we would like to submit for consideration in Ear and Hearing.

I can confirm that:

- This manuscript consists of original, unpublished material and is not under consideration for publication anywhere else
- Participants were treated in accordance with the ethical standards of the British Society of Audiology.
- The authors of the manuscript are: Chelsea S. Sawyer (University of Manchester), Christopher J. Armitage (University of Manchester), Kevin J. Munro (University of Manchester; Central Manchester University Hospitals NHS Foundation Trust), Gurjit Singh (Phoank; University of Toronto), and Piers D. Dawes (University of Manchester), all of whom consent to their names appearing on the manuscript
- The corresponding author of the manuscript is Chelsea S. Sawyer (Chelsea.sawyer@manchester.ac.uk, Telephone: +44 (0)161 275 8568)

Please do not hesitate to contact me, should you require any further information.

Yours faithfully

Chelsea Sawyer

**Biopsychosocial classification of hearing health-seeking in adults aged over 50 in
England**

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1 **Biopsychosocial classification of hearing health-seeking in adults aged over** 2 **50 in England**

3 **Abstract**

4 **Objectives.** Only 14% of the United Kingdom population aged 55-74 years with a hearing
5 impairment use a hearing aid. Rates are similarly low in other countries. The present study
6 aims to identify barriers to obtaining a hearing aid and inform interventions by examining the
7 biopsychosocial characteristics of older adults according to seven categories: i) Do not report
8 hearing difficulties, ii) Report hearing difficulties, iii) Told a healthcare professional about
9 experiencing hearing difficulties, iv) Referred for a hearing assessment, v) Offered a hearing
10 aid, vi) Accepted a hearing aid, and vii) Report using a hearing aid regularly. **Design.**
11 Logistic regression of cross-sectional data from 2,845 participants aged 50-89 years of age
12 living in England (the English Longitudinal Study of Aging wave 7, 2015) with a hearing
13 impairment determined by an objective hearing screening (indicating a hearing threshold of
14 >35 dB HL at 3 kHz in the better ear). Classification of hearing health-seeking category was
15 recorded from participant self-report. Participants in each category were compared to people
16 in all subsequent categories in order to examine the associations between each category and
17 biopsychosocial correlates (gender, age, ethnicity, educational level, wealth, audiometric
18 hearing level, self-reported health status, cognitive performance, attitudes to aging, living
19 alone, and engagement in social activities) using multiple regression. **Results.** The
20 proportions of individuals in categories i to vii was 40% (1139/2845), 14.0% (396/2845),
21 4.5% (129/2845), 4.0% (114/2845), 1.2% (34/2845), 7.7% (220/2845) and 28.6% (813/2845),
22 respectively. Severity of hearing impairment was the only factor correlated with all of the
23 categories of hearing health-seeking. Other correlates associated with at least one category of
24 hearing health-seeking included gender, age, self-reported health, participation in social

25 activities, and cognitive function. **Discussion.** 40% of those with audiometrically identified
26 hearing impairment did not report hearing difficulties. Targeting people in this category via
27 hearing screening and linking the screening to referral may lead to an increase in hearing aid
28 uptake and use. Each category of hearing health-seeking was associated with different
29 variables, therefore each category has different drivers and interventions will vary depending
30 on the category of hearing health-seeking.

31 **Key words:** Hearing impairment; help-seeking; referral; uptake; hearing aid; use; utilisation

32 **Introduction**

33 Hearing impairment is a growing problem due to an aging population (Action on Hearing
34 Loss 2011). Hearing impairment is associated with negative health outcomes, including
35 communication difficulties (RNID 2006), poorer quality of life (Chia et al. 2007; RNID
36 2006), lower self-rated health (Mulrow et al. 1990), depression and anxiety (Gopinath et al.
37 2009), cognitive decline (Maharani et al. 2018), social isolation (Gopinath et al. 2012;
38 Gopinath et al. 2009), and adverse impact on friends and family members (Stark & Hickson
39 2004).

40 Hearing aids are the primary treatment for hearing loss (Action on Hearing Loss 2011) and
41 there are two pathways to obtaining a hearing aid in the United Kingdom. One pathway is
42 through consultation with a private hearing aid dispenser and purchase of a hearing aid at an
43 average cost of around £2,500 per pair (Action on Hearing Loss 2017). The other pathway is
44 to obtain socially subsidised hearing aids via the National Health Service (NHS), which
45 provides over 80% of hearing aids in the United Kingdom (The Ear Foundation 2011). In the
46 NHS hearing care pathway, the individual must inform their general medical practitioner of
47 their hearing difficulties and be referred for a hearing assessment at an NHS audiology clinic
48 (Action on Hearing Loss 2017). After attending an NHS audiology clinic, being assessed and

49 recommended a hearing aid, hearing aids are provided, fitted, and maintained at no direct cost
50 to the recipient.

51 Despite free access to hearing aids and the clear benefit of hearing aids in improving
52 communication (Ferguson et al. 2017), individuals may delay seven to ten years from the
53 point that they first notice hearing difficulties to first seeking professional help (Davis et al.
54 2007), perhaps due to stigma around hearing loss (David & Werner 2016). The rate of
55 hearing aid use among those with a hearing impairment in the United Kingdom is low, with
56 only 14% of those with a hearing impairment aged 55-74 years old using a hearing aid (Davis
57 et al. 2007; Smeeth et al. 2002). The low rate of hearing aid use among those with a hearing
58 impairment may be attributable to multiple factors. People may not recognise that they have a
59 hearing impairment because hearing loss is slow and gradual (National Institute on Aging
60 2017), or people may not be aware the hearing services available or how to access them.
61 General medical practitioners may perceive hearing loss as a normal part of aging or may
62 prioritise other health issues (Wallhagen & Pettengill 2008; Yueh et al. 2003), and so may not
63 refer people who report hearing difficulties to audiology services (Davis et al. 2007;
64 Schneider et al. 2010). If people do access audiological services and are offered hearing aids,
65 they may refuse them (e.g., Abdellaoui & Huy, 2013) and even after having obtained hearing
66 aids, people may not use them (e.g., Solheim et al. 2018). In the present study, the primary
67 aim was to provide a cross-sectional snapshot of the proportion of people 50-89 years of age
68 with a hearing impairment who reported being at various categories of hearing health-seeking
69 in order to identify barriers to hearing aid ownership and use.

70 Benova et al. (2014) proposed six categories of hearing health-seeking based on the UK NHS
71 hearing health care pathway to help understand socioeconomic inequalities in hearing health-
72 seeking in England. Benova et al. analysed data from wave two of the English Longitudinal
73 Study of Aging (n=8,780 adults aged 50-89 years old). Benova et al.'s six categories are:

74 'Self-reported hearing difficulties', 'Told a healthcare professional', 'Referred to ear
75 specialist', 'Hearing aid recommended', 'Obtained a hearing aid', and 'Using a hearing aid'.
76 Benova et al. found that disadvantaged social economic position was associated with higher
77 likelihood of self-reported hearing difficulties, however social economic position was not
78 associated with telling a healthcare professional about hearing difficulties. Benova et al.
79 found that those from a more privileged social economic position who reported experiencing
80 hearing difficulties were less likely to have a hearing aid recommended. One potential
81 limitation of Benova et al.'s study was their focus solely on social economic position, gender,
82 and age as correlates of hearing health-seeking. The present study thus extends Benova et
83 al.'s work by considering biopsychosocial correlates of hearing health-seeking in addition to
84 social correlates.

85 A second limitation of Benova et al.'s study that is addressed in the present research was their
86 reliance on self-reported hearing loss to classify the study sample. In the absence of an
87 audiometrically-identified hearing impairment Benova et al. were unable to consider a
88 potentially vital category, namely, people with a hearing impairment who did not report any
89 hearing difficulties. In the present study, availability of an objective measure of hearing
90 impairment means we were able to consider a seventh category of hearing health-seeking,
91 categorising individuals with a hearing impairment who report no hearing difficulties,
92 (category i 'Do not report hearing difficulties) in addition to the six hearing health-seeking
93 categories proposed by Benova et al.

94 The present study expands on Benova et al.'s analysis of the categories of hearing health-
95 seeking by i) using objective measures of hearing to identify those who have a hearing
96 impairment irrespective of self-report and ii) modelling a wider selection of potential
97 correlates of hearing health-seeking including: audiometric hearing level (Fisher et al. 2015;
98 Gatehouse 1994; Gopinath et al. 2011; Hartley et al. 2010; Hosford-Dunn & Halpern 2001;

99 Moon et al. 2015; Nash et al. 2013; Popelka et al. 1998), living situation (Hickson et al. 1986;
100 Hickson et al. 1999), participation in social activities (Fisher et al. 2015; Fuentes-López et al.
101 2017), and cognitive function (Fisher et al. 2015) in addition to social economic position,
102 gender and age (Benova et al. 2014). The primary aim was to report the number of people at
103 each of the categories and the secondary aim was to identify correlates of each category to
104 identify 'high risk' groups.

105 **Method**

106 **Participants**

107 This research was conducted using the English Longitudinal Study of Ageing (ELSA). The
108 ELSA database contains information about wellbeing, health, social, lifestyle and the
109 economic situation of people aged 50 and over living in England (Rogers et al. 2015).
110 Invitation letters were sent randomly to households that had previously participated in the
111 Health Survey for England in any or all of the following years: 1998, 1999 and 2001 (Rogers
112 et al. 2015). Ethical approval was granted for all ELSA waves from the National Research
113 and Ethics Committee (Natcen Social Research 2012). The present study focused on a subset
114 of 2,845 respondents aged 50-89 years old who participated in wave seven of ELSA data
115 collection who had a hearing impairment, as identified by the HearCheck Screener (Siemens,
116 Munich, Germany).

117 **Measurements**

118 Participants were interviewed at home, and information was collected about participants'
119 demographic characteristics, lifestyle, environmental factors, and medical information.
120 Correlates of hearing health-seeking were selected for analysis in the present study based on
121 previous research of the correlates of hearing health-seeking behaviour (Vestergaard Knudsen

122 et al. 2010; Meyer & Hickson 2012; Ng & Loke 2015). The potential correlates of hearing
123 health-seeking included gender, age, ethnicity, educational level, wealth, audiometric hearing
124 level (total tones heard for the better ear based on HearCheck performance – see below), self-
125 reported health status, cognitive performance, attitudes to aging, living alone, and
126 engagement in social activities.

127 *Categories of hearing health-seeking*

128 The categories of hearing health-seeking behaviour were based on those identified by Benova
129 et al. (2014). The current study added an extra initial category ‘Do not report hearing
130 difficulties’, which was based upon participants’ identified as having a hearing impairment
131 and who responded “no” to “Do you ever have any difficulties with your hearing?” The
132 second category ‘Report hearing difficulties’, refers to whether an individual reported having
133 hearing difficulties based on responding “yes” to the question; “Do you ever have any
134 difficulties with your hearing?” and “no” to “Have you told a doctor or nurse about your
135 hearing problems?” The third category ‘Told a healthcare professional about hearing
136 difficulties’ was identified based on responding “yes” to the question, “Have you told a
137 doctor or nurse about your hearing problems?” and “no” to the question; “When you told the
138 doctor or nurse about your hearing problems, did he or she refer you to an ear specialist to
139 check your hearing?” The fourth category being ‘referred for a hearing assessment’, was
140 based on responding “yes” to the question; “When you told the doctor or nurse about your
141 hearing problems, did he or she refer you to an ear specialist to check your hearing?” and
142 “no” to the question; “Has any doctor or nurse or ear specialist recommended a hearing aid?”
143 Interviewers clarified the term ‘ear specialist’ by telling participants “by ear specialist we
144 mean an ENT doctor, an Ear Nose and Throat doctor, an otolaryngologist, or an audiologist”.
145 The fifth category was ‘Offered a hearing aid’, based on responding “yes” to the question;
146 “Has any doctor or nurse or ear specialist recommended a hearing aid?” and “no” to the

147 question; “Have you ever tried one?” The sixth category was ‘Accepted a hearing aid’, based
148 on responding “yes” to the question; “Have you ever tried one?” and the response “no” to the
149 question; “Nowadays, do you ever wear a hearing aid?” ‘Report using a hearing aid
150 regularly’ was the seventh and final category, identified based on the response “Yes, most of
151 the time” or “Yes, some of the time” to a single question, “Do you wear your hearing aid(s)
152 some of the time or most of the time?”

153 *Audiometric hearing level*

154 The HearCheck Screener (Siemens, Munich, Germany) was used to index audiometric
155 hearing level by the interviewers and they measured potential audiometric hearing level at the
156 participant’s home. Otoscopy was not conducted prior to the HearCheck Screener. The
157 HearCheck Screener involves presenting tones at two frequencies and three intensities at each
158 frequency (1 kHz; 20 dB HL, 35 dB HL and 55 dB HL and 3 kHz; 35 dB HL, 55 dB HL and
159 75 dB HL). Participants are asked to indicate when they hear a tone by raising their finger.
160 The sensitivity and specificity of the HearCheck Screener was 90.9% and 95.4%,
161 respectively, with reference to hearing impairment at 40 dB HL (Fellizar-Lopez et al. 2011).
162 Hearing impairment is defined as hearing fewer than six tones in the better hearing ear,
163 indicating a hearing threshold of >35 dB HL at 3 kHz. Each ear was tested separately for
164 approximately 30 seconds per ear. Hearing aid users completed the test without their hearing
165 aids. The HearCheck Screener is described in greater detail by Davies et al. (2017).

166 *Socioeconomic status, age and gender*

167 Socioeconomic status was measured using two variables, wealth and education. Educational
168 levels were categorised according to the individual’s highest level of study. Participants who
169 reported “degree or equivalent” were categorised ‘University or higher’. Participants who
170 reported “NVQ (National Vocational Qualifications)” or “HND or “HNC (Higher National

171 Certificate)” or “A levels/AS levels or equivalent”, or “O levels/ GCSEs (General Certificate
172 of Secondary Education) or equivalent”, or “CSEs (Certificate of Secondary Education) or
173 equivalent”, were categorised as ‘high school or lower’. Participants who reported “no
174 qualification” were categorised as ‘no qualification’. Wealth was coded into quartiles using
175 participant’s total net financial wealth. Age and gender were coded for each participant.
176 Ethnicity was recoded into white or non-white categories.

177 ***Self-reported health***

178 Self-reported health was measured by the response to a single item “Would you say your
179 health is...?” Participants were categorised based on their response “Excellent”, “Very good”,
180 “Good”, “Fair”, or “Poor”.

181 ***Cognitive function and attitudes towards ageing***

182 An index of cognitive function was constructed from the sum of all the memory tests used in
183 ELSA wave seven, including word list recall, animal naming, backwards counting from 20,
184 serial sevens, naming objects and people, and word list recall repeat (detailed information
185 may be found at - [https://www.elsa-](https://www.elsa-project.ac.uk/uploads/elsa/docs_w7/1_W7MS_Project%20Instructions_v1.pdf)
186 [project.ac.uk/uploads/elsa/docs_w7/1_W7MS_Project%20Instructions_v1.pdf](https://www.elsa-project.ac.uk/uploads/elsa/docs_w7/1_W7MS_Project%20Instructions_v1.pdf)) consistent
187 with previous studies which have constructed an index of cognitive function (Colom et al.
188 2006; Dawes et al. 2015).

189 Attitudes towards aging were indexed in two ways. First, a summed score was obtained from
190 the attitude to aging questionnaire (Demakakos et al. 2006), which consists of 12 items
191 scored on a 5 point Likert scale (*strongly agree* to *strongly disagree*). Negatively phrased
192 items measuring attitude to aging were transformed to a positive score. For example, “We can
193 learn a lot from old people” and “Old age is a time of ill-health”. The full list of items can be

194 found at <http://www.elsa-project.ac.uk/uploads/elsa/report06/ch11.pdf>. Participants were also
195 asked “How old do you feel you are?” a response was given in years. The age participants felt
196 was then subtracted from the chronological age of participants to produce a score for
197 perceived age relative to actual age.

198 *Living alone and participation in social activities.*

199 Living alone was categorised from the response to a question about the number of people
200 living in the household. Participants who reported two or more people in the household were
201 categorised as ‘living with others’ and those who reported only one were categorised as
202 ‘living alone’. Participation in social activities was indexed based on the number of responses
203 to "Are you a member of any of these organisations, clubs or societies?" (political party, trade
204 union or environmental groups/tenants groups, resident groups, neighbourhood watch/church
205 or other religious groups/charitable associations/education, arts or music groups or evening
206 classes(s)/sports clubs, gyms, exercise classes/any other organisations, clubs or societies).

207 **Data analysis**

208 Analyses were performed using IBM SPSS version 22. The number of participants at each
209 health-seeking category was calculated. Descriptive statistics (mean, standard deviations and
210 frequencies) on baseline participant’s biopsychosocial characteristics for each category were
211 calculated. Mann Whitney U test and Chi-square tests were conducted to explore differences
212 between demographic and psychosocial factors of individuals at each category, with
213 individuals who were at each category compared to the individuals in all the subsequent
214 categories combined. Spearman correlation coefficients were conducted to examine
215 correlations between biopsychosocial factors, and the categories of hearing health-seeking.

216 Multivariate logistic regressions were used to simultaneously model biopsychosocial
217 correlates of each category of hearing health-seeking. Participants who reported being at all
218 subsequent categories were compared to those at the target category (for example,
219 participants in category ii were compared with participants in categories iii-vii), in order to
220 those in the target category with all those who had progressed from the target category. The
221 biopsychosocial correlates included gender, age, wealth, education, audiometric hearing
222 level, self-reported health status, living alone, participation in social activities, attitude
223 towards aging, age participant felt and cognitive function. The total variance in category
224 membership accounted for by the biopsychosocial correlates in the multivariable model was
225 estimated with the Nagelkerke r^2 statistic

226 **Results**

227 **Proportion of adults in each category of hearing health-seeking**

228 2,845 participants were identified as having a hearing impairment (determined by the
229 HearCheck Screener). Figure 1 presents the numbers and proportions of participants who
230 reported being at each category of hearing health-seeking behaviour. The largest proportion
231 of participants was in the initial category, with 40% of those identified with a hearing
232 impairment 'Do not report hearing difficulties'. Only 14.0% of the sample reported hearing
233 difficulties but had not yet told a healthcare professional (category ii 'Report hearing
234 difficulties'). 4.5% of participants had reported telling a healthcare professional about their
235 hearing difficulties but were not referred to an ear specialist (category iii 'Told a healthcare
236 professional about hearing difficulties'). 4.0% of participants reported they were referred to
237 an ear specialist but were not recommended a hearing aid (category iv 'Referred for a hearing
238 assessment'). 1.2% of participants reported they had been recommended a hearing aid but
239 declined one (category v 'Offered a hearing aid'). 7.7% of those identified with a hearing
240 impairment reported they had accepted a hearing aid but did not regularly use it (category vi

241 ‘Accepted a hearing aid’). The remaining 28.6% of participants reported regularly using their
242 hearing aid. Of those who obtained a hearing aid 22.4% reported no longer using their
243 hearing aids.

244 *Insert Figure 1 here.* Number of adults aged 50-89 with an audiometrically identified hearing
245 impairment who report being at various categories of hearing health-seeking.

246 **Correlates of the categories of hearing health-seeking**

247 **Category i (have a hearing impairment but) ‘Do not report hearing difficulties’**

248 Individuals who were in category i were younger, more likely to be female, have a minority
249 ethnicity, better hearing, better self-reported health, participated in less social activities, felt
250 older, and had poorer cognitive function compared to all the other participants in the study
251 sample (Table 1). When all factors were entered into regression model and compared only to
252 those in later categories of health-seeking, only age, gender, hearing level, self-reported
253 health status, and cognitive function were correlated with ‘Do not report hearing difficulties’
254 (Table 2.) The Nagelkerke r^2 for the model was 0.19. Compared to individuals in later
255 categories of health-seeking, individuals in category i (‘Do not report hearing difficulties’)
256 were younger (OR .98 [CI .97, .99]), tended to be female (OR .68 [CI .55, .84]), had better
257 hearing (OR .46 [CI .40, .52]), report very good health (OR 1.69 [CI .1.08, 2.64]), and lower
258 cognitive function (OR .98 [CI .97, .99]).

259 *Insert Table 1 here. Characteristics of the seven hearing health-seeking categories.*

260 *Insert Table 2 here. The odds ratios from the multivariate logistic models for five of the*
261 *categories of the hearing health-seeking behaviour*

262 **Category ii ‘Report hearing difficulties’**

263 Individuals in category ii were older, had better hearing, had better self-reported health,
264 tended to live with others, and had a more positive attitude to aging than all the other

265 participants in the study sample (Table 1). When all factors were entered into regression
266 model and compared only to those in later categories of health-seeking, only age, hearing
267 level, self-reported health status, and participation in leisure activities were correlated with
268 the category 'Report hearing difficulties' (Table 2.) The Nagelkerke r^2 for the model was
269 0.19. Compared to individuals in later categories of health-seeking, individuals in category ii
270 ('Report hearing difficulties') were younger (OR .97 [CI .95, .99]), had better hearing (OR
271 .50 [CI .42, .59]) and reported excellent or very good health (OR 4.08 [CI 1.78, 9.37] & OR
272 2.80 [CI 1.37, 5.72], respectively), and participated in a fewer number of social activities (OR
273 .86 [OR .76, .98]).

274 **Category iii 'Told a healthcare professional about hearing difficulties'**

275 Individuals who were in category iii were younger, had poorer hearing, had poorer self-
276 reported health, participated in more social activities, and had a more negative attitude to
277 aging compared to all other participants in the study sample (Table 1). When all variables
278 were modelled and compared only to those in later categories of health-seeking (see Table 2),
279 only hearing level and self-reported health status were correlated with having 'Told a
280 healthcare professional about hearing difficulties'. The Nagelkerke r^2 for the model was 0.14.
281 Compared to individuals in later categories of health-seeking, individuals in category iii
282 ('Told a healthcare professional about hearing difficulties') had better hearing (OR .55 [CI
283 .43, .70]) and participated in a fewer number of social activities (OR .78 [OR .63, .97]).

284 **Category iv 'Referred for a hearing assessment'**

285 Individuals who reported having been 'Referred for a hearing assessment' were more likely
286 to be male, were younger, had poorer hearing, and had poorer self-reported health, compared
287 to the rest of the study sample (Table 1). When all factors were entered into the multivariate
288 model (Table 2) and compared only to those in later categories of health-seeking, only age,
289 hearing level and self-reported health were associated with being 'Referred for a hearing

290 assessment'. The Nagelkerke r^2 for the model was 0.23. Compared to individuals in later
291 categories of health-seeking, individuals in category iv 'Referred for a hearing assessment'
292 were younger (OR .91 [CI .87, .95]) and had better hearing (OR .44 [CI .32, .60]).

293 **Category v 'Offered a hearing aid'**

294 Individuals who reported being 'Offered a hearing aid' but did not obtain one were less
295 affluent compared to other participants in the study sample (see Table 1). Due to the small
296 numbers of those in category v 'Offered a hearing aid' and the requirement of a minimum of
297 10 cases per predictor to support multiple regression analysis (Concato et al. 1995; Peduzzi et
298 al. 1996) it was not possible to undertake multivariate modelling of 'Offered a hearing aid'.

299 **Category vi 'Accepted a hearing aid'**

300 Individuals who reported they have 'Accepted a hearing aid' had better hearing compared to
301 the rest of the study sample (See Table 1). The Nagelkerke r^2 for the model was 0.09. When
302 all factors were entered into the multivariate model simultaneously and compared to those in
303 the final category, (Table 2) only hearing level was associated with category vi 'Accepted a
304 hearing aid'. Compared to individuals who reported regular use of their hearing aid(s),
305 categories individuals in category vi 'Accepted a hearing aid' had better hearing (OR .63 [CI
306 .52, .76]).

307 **Category vii 'Report using a hearing aid regularly'**

308 Individuals who 'Report using a hearing aid regularly' tended to be male, older, from a white
309 ethnic background, wealthier, had better hearing, had poorer self-reported health and were
310 more socially active, compared to the rest of the study sample (Table 1). Multivariate
311 modelling of the final category 'Report using a hearing aid regularly' was not undertaken as
312 this was the final category of hearing health-seeking with no later categories for comparison.

313 **Discussion**

314 The principal findings were, first, that among UK adults with a hearing impairment, the
315 largest category of hearing health-seeking was people who had a hearing impairment but did
316 not report hearing difficulties. The large proportion of people with an audiometrically
317 identified hearing impairment but did not report hearing problems suggested that recognition
318 of hearing difficulties may be problematic. Second, severity of hearing impairment was the
319 only factor correlated with all of the categories of hearing health-seeking that were modelled,
320 with those with poorer hearing being more likely to be in the later categories of hearing
321 health-seeking. Other correlates associated with at least one category of hearing health-
322 seeking included gender, age, self-reported health, participation in social activities, and
323 cognitive function. The following discussion focuses on the implications of the findings.

324

325 **Proportion of adults within various categories of hearing health-seeking**

326 Only 28.6% of individuals with an audiometric hearing impairment reported using their
327 hearing aid regularly. In order to obtain hearing aid(s) individuals must go through several
328 categories of hearing health-seeking. Among those with a hearing impairment, 40.0% ‘Do not
329 report any hearing difficulties’ (category i), and 14.0% ‘Report hearing difficulties’ but have
330 not acted on them (category ii). Fewer participants reported being in the remaining categories
331 of hearing health-seeking; only 17.4% of individuals reported being in one of the remaining
332 four categories of hearing health-seeking (category iii ‘Told a healthcare professional about
333 hearing difficulties’, category iv ‘Referred for a hearing assessment’, category v ‘Offered a
334 hearing aid’, category vi ‘Accepted a hearing aid’). Similar rates were reported by Benova et
335 al. for the category ‘Accepted a hearing aid’. The proportion of adults in category ii, iii and iv
336 in the present study (13.9%, 4.5%, and 4.0%, respectively) was lower than the rates in
337 Benova et al.’s study (which were 54.2%, 12.4%, and 7.8%, respectively). The present study
338 reported higher rates of hearing aid use among people with a hearing impairment (28.6%)

339 than Benova et al.'s study (16.7%). This difference may be due to Benova et al.'s use of an
340 index of self-reported hearing difficulties that may have been over-inclusive. In Benova et
341 al.'s study self-reported hearing difficulty was identified on the basis of either self-reported i)
342 difficulty following a conversation in background noise or ii) poor or fair hearing. Hearing in
343 background noise is difficult even for those with normal hearing (Pinkerton 2017) and
344 Tremblay et al. (2015) found that 12% of those with normal hearing report experiencing
345 hearing difficulties in background noise.

346

347 The largest proportion of adults were in stage i and a recent report from the UK
348 Department of Health (2015) identified awareness of hearing loss and earlier recognition of
349 hearing loss as key targets for reducing the cost of untreated hearing loss. The Department of
350 Health report also identified that those aged 65 years or older wanted more opportunities for
351 hearing screening at both primary and secondary care. Hearing screening may increase
352 hearing aid uptake and individuals may also benefit from earlier identification and treatment
353 of hearing problems (Davis et al. 2007; Morris et al. 2012; Yueh et al. 2010). However, The
354 UK National Screening Committee (2016) advised against adult hearing screening, due to the
355 lack of controlled trials of the effectiveness of hearing screening to promote hearing aid
356 uptake.

357 Rawool and Keihl (2008) previously reported that individuals often fail to recognise
358 hearing loss or are in denial about hearing loss and suggested outreach programs to promote
359 earlier recognition and acceptance of hearing loss. Other studies reported that individuals
360 may perceive hearing loss as being a natural part of aging and is therefore something that
361 should be accepted and lived with rather than being addressed (Ng & Loke 2015; Oberg et al.
362 2012; Van den Brink et al. 1996). Interventions to promote recognition and help-seeking for
363 hearing difficulties could use Michie et al.'s (2011) behaviour change wheel, which is a

364 framework for designing evidence based interventions. The behaviour change wheel
365 incorporates a model that posits that the key drivers of behaviour are capability, opportunity,
366 and motivation (“COM”). That a large proportion of people with hearing impairment do not
367 report hearing problems indicates that interventions to promote hearing help-seeking may
368 need to focus on increasing capability (e.g. knowledge of the signs of hearing loss, physical
369 ability to report hearing problems), opportunity (e.g. somewhere to report hearing problems,
370 support from family) or motivation (e.g. knowledge of the consequences of untreated hearing
371 loss).

372 Few participants reported being offered a hearing aid but not having obtained one
373 (category vi ‘Accepted a hearing aid’). The very high uptake of hearing aids may be because
374 individuals sufficiently motivated to attend a hearing assessment may be more likely to be
375 motivated to follow the advice of a hearing health care professional to obtain a hearing aid
376 following a hearing assessment (Armitage et al. 2017). A high level of motivation to use
377 hearing aids in individuals attending audiological clinics has been demonstrated in previous
378 studies (Sawyer et al. in press; Armitage et al. 2017; Meister et al. 2008; Meister et al. 2014).

379 22.4% of participants in this study who had obtained a hearing aid reported not using
380 their hearing aids. This rate of non-use is consistent with other studies conducted in Europe,
381 Australia and United States which reported non-use ranging from 23-30% in adults from
382 varying age ranges (49 years and older [Chia et al. 2007], 48-92 years old [Popelka et al.
383 1998], 49 – 99 years old [Hartley et al. 2010], 75 years and older [Lupsakko et al. 2005], and
384 85 years and older [Gussekklo et al. 2003]). A scoping review identified limited benefit from
385 the hearing aid, difficulties with hearing aid care and maintenance and perception of
386 insufficient need for a hearing aid as the main reasons why people do not use their hearing
387 aids (McCormack & Fortnum 2013).

388 **Correlates of the categories of hearing health-seeking**

389 Each category had different correlates associated with it, suggesting that each category may
390 have different drivers. Therefore the content and focus of interventions to promote hearing
391 health-seeking would need to vary according to the category of health-seeking that was
392 targeted. Hearing level was the only correlate associated with all categories of health-seeking,
393 with those with poorer hearing were more likely to be in the later categories. Individuals with
394 poorer hearing may perceive greater need for help and therefore more likely to address their
395 hearing difficulties. Several review papers have also reported that hearing level is associated
396 with hearing help-seeking (Vestergaard Knudsen et al. 2010), hearing aid uptake
397 (Vestergaard-Knudsen et al. 2010; Jenstad & Moon 2011; Meyer & Hickson 2012; Ng &
398 Loke 2015) and use (Ng & Loke 2015). Michie et al.'s (2011) behaviour change wheel could
399 be used to design interventions to promote recognition of hearing difficulties.

400 'Do not report hearing difficulties' was the only category that was independently
401 associated with gender, with males less likely to be in the category 'Do not report hearing
402 difficulties' of the hearing health-seeking pathway compared to later categories. Perhaps the
403 association between gender and 'Do not reporting hearing difficulties' is due to females
404 having better coping strategies for dealing with hearing loss, and are thus less likely to report
405 experiencing hearing difficulties than men. Previous research by Hallberg et al. (2008) found
406 females were more likely to use non-verbal communication strategies, e.g., lip-reading and
407 sitting close to the speaker, compared with males. An alternative explanation for the negative
408 association between 'Do not report hearing difficulties' and male gender may be due to
409 residual confounding with audiometric hearing level; males tend to have poorer hearing than
410 females (Davis et al. 2007), so tend to be in later categories of hearing health-seeking
411 compared to females. Benova et al. (2014) reported that women were less likely to report
412 hearing difficulties (category ii 'Report hearing difficulties') and tell a healthcare
413 professional (category iii 'Told a healthcare professional about hearing difficulties') whereas

414 in the present study gender was not associated with category ii and iii. The difference in
415 findings may be explained as males generally tend to have poorer hearing (Davis et al. 2007)
416 and may be due to residual confounding with audiometric hearing level.

417 Cognitive function was associated with reporting hearing difficulties, with those
418 with better cognitive function being more likely to be in later categories (i.e. had reported
419 hearing difficulties and acted on them). Individuals with better cognitive function may have
420 better insight into hearing difficulties, be more likely to initiate help-seeking and be able to
421 negotiate their way through hearing health care pathways.

422 Individuals with better self-reported health were more likely to be in the two initial
423 categories ('Do not report hearing difficulties' and 'Report hearing difficulties') compared to
424 later categories. Individuals who have poorer self-reported health may also be more likely to
425 report other health concerns including hearing difficulties and therefore more likely to be in
426 the later categories of the hearing health-seeking pathway. Alternatively, poorer self-reported
427 health may be associated with reported hearing difficulties due to residual confounding with
428 audiometric hearing level, as individuals with poorer health may have more severe hearing
429 impairment (Hogan et al. 2009; Tafforeau & Demarest 2001).

430 Age was associated with three (category i, ii, and iv) of the five categories modelled.
431 Individuals who are older generally have poorer hearing and therefore this may be why they
432 were less likely to be in the category i 'Do not report hearing difficulties' and ii 'Report
433 hearing difficulties' compared to the later categories. Alternatively younger individuals may
434 perceive hearing loss as a sign of getting old (Dawes et al. 2014) and therefore may be
435 reluctant to report experiencing hearing difficulties or accept/use a hearing aid. Previous
436 studies have reported stigma influences acceptance of hearing loss and hearing aid use
437 (Vestergaard Knudsen et al. 2010; Wallhagen 2009). The benefit of hearing aids to

438 individual's quality of life and social participation may need to be highlighted to younger
439 individuals with a hearing impairment (Wallhagen & Strawbridge 2017).

440 Participation in leisure activities was associated with the second and third categories of the
441 hearing health-seeking behaviour. Socially active people were less likely to be in these
442 categories compared to the later categories (i.e. more socially active people in later
443 categories). Socially active people may be more likely to perceive a need for help with their
444 hearing and therefore motivated to address hearing difficulties and maintain good
445 communication.

446 The present study did not find that socioeconomic status was associated with any of the
447 categories of hearing health-seeking, whereas Benova et al. (2014) reported that those from
448 lower socioeconomic backgrounds were more likely to report hearing difficulties (stage ii)
449 and that those from higher socioeconomic backgrounds were *less* likely to be recommended
450 hearing aids by a hearing specialist (stage v). Benova et al.'s finding that those from lower
451 socioeconomic backgrounds were more likely to report hearing difficulties is consistent with
452 literature that linked low socioeconomic status to hearing loss (Dawes et al. 2014; Scholes et
453 al. 2018). The present study only included those with audiometrically identified hearing
454 impairment, and did not examine socioeconomic or any other correlates of hearing
455 impairment. Benova et al.'s report of those from higher socioeconomic status being less
456 likely to be recommended hearing aids may be explained by a lack of control for audiometric
457 levels of hearing impairment; those from higher socioeconomic backgrounds may not have
458 been recommended a hearing aid because they likely had milder levels of hearing impairment
459 than those from lower socioeconomic backgrounds.

460 **Limitations**

461 The study provided a cross-sectional snap-shot of the proportion of English adults over age
462 50 with hearing impairment who reported being at various categories of hearing health-
463 seeking. Due to the cross-sectional study design, the study cannot determine cause and
464 effect. Ideally progression through the categories of hearing health-seeking would need to be
465 tested longitudinally. No data relating to progression through each category were obtained,
466 and it was not possible to examine the timing of progression through categories of hearing
467 health-seeking. However the study provides an insight into relative proportions of adults who
468 are at various categories of hearing health-seeking and particular characteristics of those at
469 each category that may warrant further research attention.

470 Due to the small numbers of people who did not obtain a hearing aid, no multivariate
471 regression could be performed for 'Offered a hearing aid'. Although there were differences in
472 age, audiometric hearing level and wealth between those who choose to obtain hearing aids
473 versus those who declined to use hearing aids, it was not possible to determine the
474 independent association of any characteristic with this category of hearing health-seeking.
475 However, because nearly 100% of people who reported being recommended a hearing aid
476 also reported having obtained one, the correlates of this category seem relatively unimportant.

477 Hearing health-seeking may be lower in ethnic minority versus majority groups in the
478 UK (Sawyer et al. 2017). Unfortunately, the ELSA data set did not have sufficient numbers
479 of people to support analysis of hearing health-seeking by ethnic background. There were no
480 data on adults' intentions or attitudes towards hearing aids. Previous studies have shown
481 attitudes, such as self-efficacy, have been implicated with hearing aid use (Kricos 2000).
482 Future studies may need to examine how attitudes and beliefs influence progression through
483 categories of hearing health-seeking.

484 No adjustments were made for multiple statistical comparisons in the present study. We
485 chose not to adjust for the multiple comparisons because all of the potential correlates of help
486 seeking were identified a priori based on previous research and because Bonferroni
487 corrections have been criticised for being too conservative (Forstmeier & Schielzeth 2011)
488 and increasing the likelihood of false negatives (Perneger 1998). Some of the associations
489 reported here may be false positives, although most of the correlates of hearing health-
490 seeking reported in the present study are consistent with those reported in previous research,
491 which gives confidence in the reliability of results.

492 The HearCheck Screener only tests hearing at 1000 Hz and 3000 Hz and classifies a
493 hearing impairment as better ear threshold > 35 d HL at 3000 Hz. The HearCheck does not
494 test lower frequencies tested in pure-tone audiometry (250 Hz, 500 Hz, and 2000 Hz). It is
495 unknown if, based on pure-tone audiometry, individuals were eligible for a hearing aid. It is
496 therefore possible that individuals are not in the later category as they did not fit audiometric
497 criteria for a hearing aid based on pure-tone audiometry. However Davis et al. (2007)
498 reported that the best marker for classifying individuals with a hearing impairment who were
499 likely to benefit from hearing aids were thresholds > 35 dB HL; which is the threshold of
500 impairment indicated by HearCheck.

501 Individuals in the early category 'Do not report hearing difficulties' arguably do not need a
502 hearing aid as they do not perceive their hearing loss as an issue. However age-related
503 hearing loss is gradual and individuals might not be aware of their difficulties (Rabinowitz
504 2000) or perceive their difficulties as caused by external factors (Action on hearing Loss,
505 n.d.). Davis et al. (2009) reported that individuals with a hearing loss who were identified and
506 fitted earlier had greater benefit through the additional years of use and were better able to
507 adapt to using a hearing aid compared to those of the same age fitted with a hearing aid later.

508 **Conclusion**

509 In a population snapshot of hearing health-seeking among people with a hearing impairment,
510 the largest category of people was those who did not report hearing difficulties. Earlier
511 recognition of hearing difficulties might be facilitated by hearing screening to prompt people
512 to take action or via interventions informed by the behaviour change wheel. Interventions to
513 promote hearing health-seeking need to be category specific, due to the different correlates of
514 each category of hearing health-seeking.

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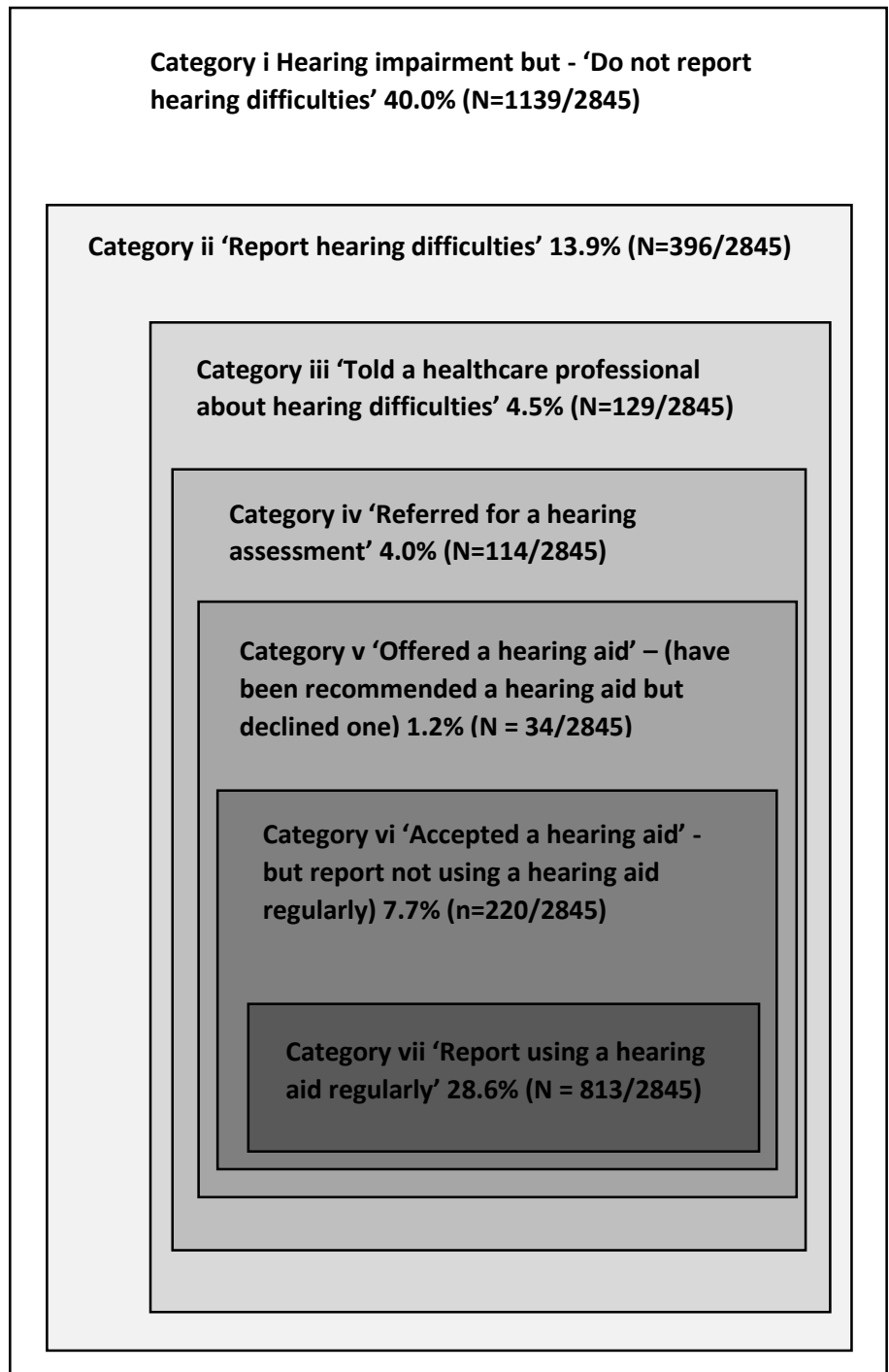


Figure 1. Venn diagram for the proportion of adults aged 50-89 with an audiometrically identified hearing impairment (n=2845) who reported being at various categories of hearing health-seeking

Table 1. Characteristics of the seven hearing health-seeking categories

	Total Participants (N = 2,845)	Category i 'Do not report hearing difficulties'			Category ii 'Report hearing difficulties'			Category iii 'Told a healthcare professional about hearing difficulties'			Category iv 'Referred for a hearing assessment'			Category v 'Offered a hearing aid'			Category vi 'Accepted a hearing aid'			Category vii 'Report using a hearing aid regularly'		
		Yes	No	<i>p</i>	Yes	No	<i>p</i>	Yes	No	<i>p</i>	Yes	No	<i>p</i>	Yes	No	<i>p</i>	Yes	No	<i>P</i>	Yes	No	<i>p</i>
		40.0% (N=1139/2845)	(N = 1,706/2,845)		(13.9% N = 396/2,845)	(N = 2,449/2,845)		(4.5% N = 129/2,845)	(N=2,716/2,845)		(4.0% N = 114/2,845)	(N = 2,731/2,845)		(1.2% N = 34/2845)	(N = 2811/2845)		(7.7% N = 220/2,845)	(N = 2,625/2,845)		(28.6% N = 813/2,845)	(N = 2032/2,845)	
Gender (Male)	49.6%	44.2%	53.2%	<.01	50.8%	49.4%	.63	46.5%	49.8%	.47	61.4%	49.1%	.01	50.0%	49.6%	.97	54.1%	49.3%	.17	54.2%	47.8%	<.01
Age	72.12 (SD 9.13)	71.03 (SD 9.26)	72.85 (SD 8.98)	<.01	74.52 (SD 8.25)	70.09 (SD 8.86)	<.01	70.05 (SD 9.17)	71.46 (SD 8.90)	.001	66.90 (SD 8.09)	71.59 (SD 8.90)	<.01	70.55 (SD 11.01)	71.41 (SD 8.89)	.08	72.73 (SD 8.11)	71.30 (SD 8.97)	.08	74.52 (SD 8.25)	70.09 (SD 8.86)	<.01
Ethnicity (White British)	96.5%	94.6%	97.8%	<.01	97.2%	96.4%	.41	96.1%	96.5%	.80	94.7%	96.6%	.29	97.1%	96.5%	.86	97.7%	96.4%	.31	98.9%	95.6%	<.01
Wealth				.35			.68			.13			.21			<.01			.59			<.01
First Quartile (Lowest income)	26.3%	28.0%	25.1%		23.8%	26.7%		33.6%	25.9%		34.5%	25.9%		38.2%	26.1%		29.0%	26.0%		21.6%	28.2%	
Second Quartile	27.2%	26.3%	27.8%		27.4%	27.2%		19.5%	27.6%		22.7%	27.4%		44.1%	27.0%		27.6%	27.2%		29.4%	26.3%	
Third Quartile	24.7%	24.8%	24.7%		24.6%	25.9%		25.8%	24.7%		24.7%	24.5%		24.9%	11.8%		21.2%	25.0%		25.4%	24.5%	
Fourth Quartile (Highest income)	21.8%	20.9%	22.4%		22.8%	21.6%		21.1%	21.8%		21.1%	21.8%		5.9%	22.0%		22.1%	21.8%		23.7%	21.0%	
Education				.42			.08			.30			.76			.23			.55			.37

University or higher qualification post primary	14.8%	13.7%	15.6%		16.6%	14.6%		14.0%	14.9%		12.9%	14.9%		12.5%	14.9%		14.4%	14.9%		16.3%	14.3%	
No qualification post primary school	35.6%	36.3%	35.2%		30.1%	36.5%		42.1%	35.3%		38.6%	35.5%		35.4%	50.0%		39.2%	35.3%		36.2%	34.1%	
Audiometric hearing Level (Better ear)	2.92 (SD 1.08)	4.48 (SD .84)	3.77 (SD 1.20)	<.01	3.60 (SD 1.19)	2.55 (SD .82)	<.01	2.56 (SD .76)	2.92 (SD 1.09)	.05	2.55 (SD .73)	2.88 (SD 1.06)	.03	2.86 (SD .99)	2.86 (SD 1.06)	.52	3.01 (SD 1.03)	2.85 (SD 1.06)	<.001	3.60 (SD 1.19)	2.55 (SD .82)	<.001
Self-reported health status																						
Excellent	7.5%	8.0%	7.1%	.01	11.6%	6.8%	.01	4.7%	7.6%	.02	4.4%	7.6%	.16	5.9%	7.5%	.22	7.3%	7.5%	.46	5.7%	8.2%	.01
Very good	23.7%	27.2%	21.3%		25.3%	23.4%		17.1%	24.0%		20.2%	23.8%		17.6%	23.8%		21.9%	23.8%		20.3%	25.1%	
Good	33.9%	33.2%	34.4%		32.1%	34.2%		31.8%	34.0%		30.7%	34.0%		23.5%	34.0%		32.0%	34.1%		37.5%	32.4%	
Fair	24.5%	22.3%	25.9%		23%	24.6%		28.7%	24.3%		28.9%	24.3%		41.2%	24.3%		24.7%	24.5%		26.0%	23.9%	
Poor	10.5%	9.3%	11.3%		7.6%	10.9%		17.8%	10.1%		15.8%	10.3%		11.8%	10.5%		14.2%	10.2%		10.6%	10.4%	
Number of leisure activities	1.41 (SD 1.43)	1.35 (SD 1.46)	1.45 (SD 1.40)	.01	1.56 (SD 1.44)	1.41 (SD 1.43)	.92	1.46 (SD 1.44)	1.45 (SD 1.38)	.05	1.40 (SD 1.28)	1.45 (SD 1.44)	.60	1.41 (SD 1.79)	1.45 (SD 1.43)	.14	1.56 (SD 1.30)	1.44 (SD 1.44)	.23	1.56 (SD 1.44)	1.41 (SD 1.43)	<.001
Live alone (Yes)	29.3%	30.0%	28.8%	.50	24.5%	30.1%	.02	33.3%	29.1%	.31	24.6%	29.5%	.26	32.4%	29.3%	.70	30.9%	29.2%	.59	30.1%	29.0%	.54
Attitude to aging score	34.94 (SD 6.45)	34.54 (SD 6.47)	35.19 (SD 6.43)	.06	34.55 (SD 6.47)	34.96 (SD 6.46)	.03	35.59 (SD 6.35)	34.71 (SD 6.48)	.01	10.80 (SD 11.42)	9.92 (SD 15.72)	.58	36.05 (SD 6.22)	34.83 (SD 6.47)	.66	35.38 (SD 6.50)	34.80 (SD 6.46)	.37	34.55 (SD 6.47)	34.96 (SD 6.45)	.12
Age participants feels	10.05 (SD 15.24)	9.94 (SD 18.95)	10.12 (SD 12.26)	<.01	10.50 (SD 13.17)	9.72 (SD 16.47)	.06	9.61 (SD 11.37)	10.01 (SD 16.20)	.47	45.65 (SD 9.04)	44.27 (SD 9.18)	.50	7.73 (SD 8.37)	9.97 (SD 15.63)	.21	9.48 (SD 10.22)	9.99 (SD 15.91)	.88	10.49 (SD 13.17)	9.72 (SD 16.47)	.90

Z-score cognitive function	-0.04 (SD 1.02)	0.02 (SD .98)	.11	.17 (SD .95)	-0.03 (SD 1.01)	<.01	.05 (SD 1.01)	-0.01 (SD .05)	.54	.15 (SD 1.02)	-0.01 (SD .99)	.11	-0.12 (SD .68)	0.01 (SD 1.00)	.49	-0.04 (SD 1.02)	0.01 (SD .99)	.53	-0.04 (SD .98)	0.02 (SD 1.01)	.14
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Note. Bold font indicates significant differences

Table 2. The odds ratios from the multivariate logistic models for five of the categories of the hearing health-seeking behaviour

	Category i	Category ii	Category iii	Category iv	Category vi
	‘Do not report hearing difficulties’	‘Report hearing difficulties’	‘Told a healthcare professional about hearing difficulties’	‘Referred for a hearing assessment’	‘Accepted a hearing aid’
	OR (CI)	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Sex (Male)	.68 (.55, .84)	.81 (.59, 1.11)	.79 (.49, 1.29)	1.29 (.74, 2.28)	1.03 (.67, 1.59)
Age	.98 (.97, .99)	.97 (.95, .99)	.97 (.94, 1.01)	.91 (.87, .95)	.98 (.95, 1.01)
Wealth					
First Quartile (Lowest income)	-	-	-	-	-
Second Quartile	.86 (.64, 1.17)	1.31 (.82, 2.10)	.61 (.29, 1.26)	.61 (.26, 1.42)	.77 (.42, 1.42)
Third Quartile	.85 (.64, 1.17)	1.14 (.71, 1.85)	1.23 (.63, 2.39)	1.30 (.60, 2.84)	.87 (.47, 1.62)
Fourth Quartile (Highest income)	.75 (.54, 1.05)	1.01 (.61, 1.68)	.81 (.38, 1.70)	1.05 (.46, 2.40)	.84 (.44, 1.60)
Education					
University or higher	-	-	-	-	-
qualification post primary	1.12 (.83, 1.50)	1.10 (.72, 1.68)	.96 (.48, 1.92)	1.20 (.56, 2.56)	1.02 (.58, 1.79)
No qualification post primary school	1.11 (.78, 1.60)	.79 (.47, 1.35)	1.46 (.67, 3.17)	1.54 (.62, 3.83)	1.28 (.65, 2.51)
Audiometric hearing level (Better ear)	.46 (.40, .52)	.50 (.42, .59)	.55 (.43, .70)	.44 (.32, .60)	.63 (.52, .76)
Self-reported health status (Poor)	-	-	-	-	-

Excellent	1.10 (.63, 1.92)	4.08 (1.78, 9.37)	.79 (.24, 2.59)	.47 (.12, 1.88)	1.27 (.42, 3.84)
Very good	1.69 (1.08, 2.64)	2.80 (1.37, 5.72)	1.02 (.43, 2.45)	.89 (.31, 2.55)	1.48 (.64, 3.41)
Good	1.31 (.86, 1.99)	1.75 (.89, 3.42)	.70 (.32, 1.55)	.56 (.22, 1.56)	1.15 (.54, 2.46)
Fair	1.05 (.68, 1.62)	1.64 (.82, 3.29)	.71 (.31, 1.64)	1.40 (.52, 3.77)	1.30 (.59, 2.87)
Number of leisure activities	.94 (.87, 1.02)	.86 (.76, .98)	.78 (.63, .97)	1.02 (.82, 1.27)	1.01 (.87, 1.18)
Live alone (Yes)	1.13 (.88, 1.44)	1.35 (.93, 1.97)	1.09 (.61, 1.94)	1.53 (.78, 3.00)	1.01 (.61, 1.66)
Attitude to aging score	.99 (.97, 1.00)	1.02 (.98, 1.04)	1.03 (.99, 1.07)	.99 (.94, 1.03)	1.03 (.99, 1.06)
Age participant feels	.99 (.99, 1.00)	.99 (.98, 1.01)	1.01 (.99, 1.03)	1.02 (.99, 1.04)	.99 (.98, 1.02)
Z-score cognitive function	.98 (.97, .99)	.99 (.97, 1.01)	1.02 (.99, 1.05)	.99 (.96, 1.02)	.99 (.97, 1.02)

Note. Bold font indicates significant differences