

A dimensional approach to understanding the relationship between self-reported Hearing Loss and depression over 12 years: The Three-City study

Running head: Hearing loss and depression dimensions over 12 years

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Objectives: To examine the relationship between hearing loss and depression in older adults longitudinally. This paper uses a dimensional approach to conceptualising depression, with the aim of further enhancing understanding of this relationship.

Method: 8344 community-dwelling adults aged 65 years and above enrolled in the Three-City prospective cohort study were included. Relationships between baseline self-reported Hearing Loss (HL) with the trajectory of different dimensions of depression symptoms over 12 years were examined using linear mixed models. Depression dimensions were determined using the four-factor structure of the Centre for Epidemiology Studies-Depression Scale (CESD): depressed affect, positive affect, somatic symptoms and interpersonal problems.

Results: HL was associated with somatic symptoms of depression both at baseline ($b = 0.07$, $p = .04$) and over 12 years ($b = 0.01$, $p = .04$). HL was associated with poorer depressed affect and interpersonal problems at baseline ($b = 0.05$, $p = .001$, $b = 0.35$, $p < .001$; respectively), but not over follow-up. HL was associated with poorer positive affect symptoms over time ($b = -0.01$, $p = .01$).

Conclusion: HL had varied relationships with different dimensions of depression symptoms, and there were different patterns of adjustment for the dimensions. HL was primarily associated with somatic symptoms, suggesting that shared disease processes might partly underlie the relationship between HL and depression. Targeted assessment and treatment of somatic and positive affect symptoms in older adults with HL might facilitate better wellbeing in this population.

Keywords: sensory loss, hearing impairment, wellbeing, mental health, geriatric psychology

Relationship between self-reported Hearing Loss and depression symptoms over 12 years: The Three-City study

Hearing loss (HL) is one of the most prevalent impairments of older adulthood, affecting up to one third of those aged over 65 (WHO, 2012) and posing a substantial burden of disease and disability (Armstrong, Surya, Elliott, Brossart, & Burdine, 2016; Wittchen et al., 2011). HL has been associated with reductions in quality of life (Eisele et al., 2015; Tsimpida, Kaitelidou, & Galanis, 2018) as well as increased prevalence of a range of psychiatric disorders (Blazer & Tucci, 2018), such as anxiety (Cosh, Nael, et al., 2018; Cosh et al., 2017) and depression (Deal, Reed, Kravetz, & et al., 2019; Han, Lee, Jung, & Park, 2018; Hsu et al., 2016); with up to 1 in 4 older adults with HL reporting clinically-elevated depression symptoms (Cosh, Carriere, et al., 2018). HL has also been shown to increase the risk of experiencing suicidal ideation (Cosh, Carriere, Daien, et al., 2019).

Although an association between HL and depression has been found in both cross-sectional and longitudinal studies, there remains substantial heterogeneity in relation to the strength of this association (Lawrence et al., 2019); and not all research has corroborated an HL-depression relationship in older adults (Mener, Betz, Genther, Chen, & Lin, 2013; Pronk et al., 2014; Tambs, 2004). For example, longitudinal findings regarding older adults with HL have found both an increase in depression symptoms (Kiely, Anstey, & Luszcz, 2013) and increased risk for depression diagnosis over time (Hsu et al., 2016), whereas other studies have suggested no longitudinal relationship (Cosh, von Hanno, et al., 2018; Pronk, Deeg, & Kramer, 2013; Pronk et al., 2014). Furthermore, longer term patterns of adjustment to HL and if depression symptoms remit over time is unclear (Cosh, Helmer, Delcourt, Robins, & Tully, 2019). While some studies show sustained elevation of depression symptoms over time in older adults with HL (e.g., Brewster et al., 2018; Kiely et al., 2013; Yu & Liljas, 2019), other studies have suggested that depression symptoms subside over time (Chou, 2008; Cosh, von Hanno, et al., 2018). Variations in study methodology may partly underlie the large heterogeneity in findings, such as inclusion age and assessment and definition of HL, although adjustment for HL assessment did not attenuate heterogeneity in a recent review (Lawrence et al., 2019).

A further notable variation in study methodology to date is the assessment of depression; which has varied from the use of a range of screening tools (e.g., Golub et al., 2018; Simning, Fox,

Barnett, Sorensen, & Conwell, 2018) to diagnosis of Major Depressive Disorder (e.g., Hsu et al., 2016). Different depression assessment tools focus more on certain types of depression symptoms than others, and this may also partly explain the heterogeneous findings (Cosh, Carriere, Nael, et al., 2019). That is, certain symptoms of depression have varying relationships with mental and physical health conditions (Watson, 2009). For example, vision loss is associated more strongly with affective symptoms over time, rather than interpersonal or somatic symptoms (Cosh, Carriere, Nael, et al., 2019). Thus the symptom focus of the range of assessment tools used might also partly explain the heterogeneity observed to date in the HL-depression literature.

Furthermore, while depression assessment has varied, depression itself has been conceptualised only as a unidimensional diagnostic category in this literature. Such an approach is limited as it fails to capture the large variation in symptoms and presentations seen between different individuals with depression diagnoses (Basso et al, 2013). Different depression dimensions also result in different assessment and treatment needs and outcomes (Shafer, 2006; Soskin, Carl, Alpert, & Fava, 2012; Uher et al., 2012; Wardenaar, Monden, Conradi, & de Jonge, 2015). Unidimensional approaches thus result in the loss of valuable information (Brown & Barlow, 2009). Rather, a dimensional approach is argued to be better suited to understanding the pathogenesis and course of psychiatric disorders, as well as meeting the mental health needs of the older adult population (Bryant et al., 2013; Prisciandaro & Roberts, 2009). Enhanced understanding of possible mechanisms of vision loss and depression, as well as intervention and support for older adults has been found using a dimensional approach (Cosh, Carriere, Nael, et al., 2019). Thus depression and the relationship with HL may also be usefully explored using a dimensional conceptualisation.

The present study is exploratory in nature and aims to further understand the relationship between HL and depression by examining the relationship between HL with depression over 12 years, using a dimensional approach. In doing so, the aim is to better understand the specific mental health needs of older adults with comorbid HL and depression. Specifically, the following questions are explored:

- Is HL associated with each of the dimensions of depression at baseline and over 12 years?
- Is HL differentially associated with the dimensions of depression at baseline?

- Is HL differentially associated with the dimensions of depression over 12 years?

Method

This study forms part of the SENSE-Cog multi-phase research programme, funded by European Union Horizon 2020 programme. SENSE-Cog aims to promote mental well-being in older adults with sensory and cognitive impairments (www.sense-cog.eu/). The first work package of this project aims to better understand the links between sensory, cognitive and mental ill-health in older Europeans.

Sample

Participants were recruited as part of the multi-centre Three-City (3C) study (The 3C Study Group, 2003), a prospective cohort study of community-dwelling French adults aged 65 years and over. A total of 9294 participants were recruited from the electoral rolls in three French cities (Bordeaux, Dijon and Montpellier) between 1999 and 2001. A standardized evaluation including a face-to-face interview and clinical examinations were undertaken at baseline. Participants were followed up at 2-3 year intervals for up to 12 years. Of the initial sample, 7560 (90.6%) participated in at least one wave of follow up over the 12-year period; 116 participants had died before the first follow-up and 1411 by the end of the 12-year period but were included in baseline analyses (for a detailed overview of 3C sampling and methods see The 3C Study Group, 2003). Approval was obtained from the Ethics Committee of the Bicêtre University-Hospital (France) and written informed consent was obtained from each participant.

Depression Measures

The 20-item Centre for Epidemiology Studies-Depression scale (CESD) (Radloff, 1977) was used to examine depression symptoms at baseline and each follow-up time point. A four-factor structure of the CESD has been proposed by Radloff and is commonly replicated (Radloff, 1977; Shafer, 2006). The factors represent four phenomenologically and psychometrically distinct dimensions of depression symptoms (Devins, Orme, Costello, & Binik, 1988; Leventhal, Ramsey,

Brown, LaChance, & Kahler, 2008; Shafer, 2006). The factor structure has been validated (Shafer, 2006) including in community dwelling older adults (Gellis, 2010) and a population of community dwelling French adults (Morin et al., 2011). The symptom dimensions represent: somatic symptoms (S) assessed by 7 items (poor appetite, restless sleep, could not get going, concentration difficulties, everything an effort, bothered by things, talked less than usual); depressed affect (DA) assessed by 7 items (felt sad, crying spells, could not shake the blues, depressed, lonely, fearful, felt as though life is a failure); positive affect (PA) assessed by 4 items (hope about the future, enjoyed life, felt as good as others, felt happy); and interpersonal problems (IP) which is assessed by two items that examine (people dislike me, people were unfriendly). The scores for each item were summed for the different dimensions. In this study, PA items were not reverse scored (as needed when calculating total CESD scores), therefore lower scores are indicative of more severe depression. For the other dimensions, higher scores indicate greater symptom severity.

Hearing Loss

Self-reported Hearing Loss was assessed during the standardized face-to-face interview which was administrated by trained psychologists or nurses at all time points. HL was determined by the response to the question “do you hear what is said in everyday conversation?” Participants were given four response categories (yes without difficulties; some difficulties hearing someone who speaks normally; difficulties hearing someone who speaks loudly; no/deafness). HL was classified as self-reported difficulty understanding a conversation (normal or loud speaking), deafness or inability to hear a conversation.

Socio-demographic and health variables

Socio-demographic and health-related information was collected during the standardised interview at baseline, including variables such as education level (elementary schooling, secondary school, higher education), monthly income (low <€760, €760-2280, >€2280, withheld/missing), and marital status. Alcohol consumption (<12 grams, 12-36 grams, >36 grams per day), tobacco use (current-, past -, or non-smoker) and falls during the past 12 months were also assessed. During the

detailed medical questionnaire history myocardial infarction and use of psychotropic medication (ATC classification codes: N05A-C, N06A-B) in the past month was obtained. A composite score representing functional ability (Barberger-Gateau, Rainville, Letenneur, & Dartigues, 2000) was calculated based on a range of scales assessed during the medical questionnaire: the Rosow-Breslau scale, the Lawton-Brody Brody Instrumental Activities of Daily living (IADL) scale and the Katz Index of Independence in Activities of Daily Living (categorized as autonomous; dependent for mobility; mobility and IADL limitations; and dependent in 3+ areas; missing). A medical examination assessed height, weight, diabetes (fasting blood glucose ≥ 7 mmol/L and/or anti-diabetic treatment), and blood pressure was measured using a digital electronic tensiometer OMRON M4. Hypertension was defined using the 140/90 mmHg threshold or treatment with blood-pressure lowering drugs. Cognitive functioning was also assessed using the Mini Mental State Examination (MMSE; < 24 , ≥ 24).

Statistical Analysis

Socio-demographic and health characteristics were compared according to presence of HL using chi-squares and Mann Whitney tests as appropriate. The relationship between baseline HL and depression dimension symptoms over 12 years were assessed using linear mixed models with full maximum likelihood estimation. Linear mixed models allow for estimation of the average rate of change over time, whilst allowing for individual variability in outcomes and exposures. Individual trajectories overtime were entered as random effects using a random intercept, with covariates such as study centre, sex and age added as fixed effects (for further details and equations see; Raudenbush & Bryk, 2002). Due to non-normal distribution, dimension scores were transformed using the estimated link function (Proust-Lima, 2015). Transformed scores were then converted to z-scores for subsequent analyses.

For each symptom dimension, 2 models were run. The first adjusted for study centre, as well as pertinent socio-demographic covariates of depression amongst older adults including sex, income, marital status, education, and use of psychotropic medication (see e.g. Blazer, 2003; Pennix, Leveille, Ferrucci, van Eijk, & Guralnik, 1999). The second model further adjusted for known health-related variables of falls in past 12 months, BMI, diabetes, hypertension, smoking status, alcohol consumption, and history of myocardial infarction, as well as cognitive function (MMSE), and

functional activity limitations. Analyses were conducted using SAS 9.4 (SAS Institute, Inc., Cary, NC). Interactions between HL with gender and income were also assessed.

Results

Of the 9294 participants recruited, 950 were missing baseline CESD and/or HL data and were thus excluded from analysis resulting in a sample of $n = 8344$ (for model 1; an additional 76 were missing covariate data, resulting in a final $n = 8268$ for model 2). The participants were predominantly female 60.4% ($n = 5043$) and median age was 73.7 (IQR = 69.8 – 78.0) years. At baseline, prevalence of HL was 38.5% ($n=3212$). Those with HL were older, less educated, more likely to use psychotropic medication, and reported poorer health behaviours, such as consuming more alcohol and being more likely to be a past smoke (see Table 1). Older adults with HL were also in poorer physical health on the assessed covariates, including history of falls, history of myocardial infarction, diabetes, and hypertension. Those with HL were also in poorer cognitive health as assessed by the MMSE and were less independent with regards to functional ability. Participants with HL had higher depression scores on the CESD (Median = 8, IQR = 4 - 14) than those without HL (Median = 7, IQR = 3 -14).

At baseline, HL was not related to positive affect in either model (see Table 2), although there was a significant, albeit it small, association with worse positive affect over time (Model 2: $b = -.01$, $p = .01$). HL was associated with poorer depressed affect at baseline (Model 2: $b = .05$ $p = .01$), however, this relationship was not significant over time in either model 1 ($b = .01$, $p = .48$) or model 2 ($b = .00$, $p = .24$). Likewise, HL was related to interpersonal problems at baseline (Model 2: $b = .35$, $p = <.001$), but this relationship was not significant longitudinally (Model 2: $b = -.01$, $p = .45$). However, HL was associated both cross-sectionally and over 12 years with an increase in somatic symptoms (Model 2: $b = .07$, $p = .04$, $b = .01$, $p = .04$, respectively), although the effect was smaller over time than the baseline effect. All tested interactions were not significant.

Discussion

Using a dimensional approach to examining depression, this study extends the previously heterogeneous findings (Lawrence et al., 2019) regarding HL and depression in older adults. Notably, HL had varied relationships with the different symptom dimensions examined both at baseline and over the 12 years of follow up. In particular, HL was associated with increased somatic symptoms both cross-sectionally and over time, whereas HL was not as closely related to affective symptoms, with small associations seen only at baseline (DA) or overtime (but not baseline: PA). Additionally, there was some evidence of possible adjustment for depressed affect and interpersonal problems, which was not observed for somatic symptoms or positive affect. These varied relationships indicate that the HL-depression relationship is more nuanced than prior unidimensional research has reported, and might partly explain the prior variation in HL and depression findings. Such findings further provide a clearer picture of the needs of older adults with comorbid HL and depression.

The present study highlighted that only somatic symptoms were associated with HL both at baseline and over 12 years. There was some reduction in strength of the effect over time, however, some elevation of somatic symptoms continued to be observed over the 12 years. Positive affect was not related to HL at baseline, but there was some evidence of a worsening of positive affect symptoms over time. It has previously been argued that increased somatic symptoms of depression may be indicative of a common biological or aging pathway that underlies both the physical ill-health and depression (Anderson, Berk, & Maes, 2014). Therefore, the association found with somatic symptoms might indicate a shared disease process as the mechanism by which HL and depression are associated; however, further exploration of mechanisms is needed. Concomitantly, the association with somatic symptoms may reflect a broader pattern of older adults reporting somatic depression symptoms more so than cognitive-affective symptoms of depression (Cosh, Helmer, et al., 2019). The poorer positive affect over time might reflect social limitations arising from communication challenges in HL. Positive affect is related to social connectedness and support (Brown & Barlow, 2009; Steptoe, Dockray, & Wardle, 2009), thus increased isolation from wider networks and loneliness observed in HL (Pronk et al., 2013; Pronk et al., 2014) might explain increased depression symptoms (Penninx, Leveille, Ferrucci, van Eijk, & Guralnik, 1999). A resultant reduction in ability to engage in a range of pleasurable activities due to HL might further explain a worsening of positive affect symptoms over time; with reduced pleasurable events and behavioural inactivity commonly understood in the aetiology and maintenance of depression. It has been proposed that

communication difficulties resulting from HL might lead to difficulties in relationship functioning and conflict in key relationships (Hovaldt, Lund, Lehane, & Dammeyer, 2019; McDonnall, 2009), with such interpersonal challenges thought to potentially underpin depression onset in older adults with HL. Notably, the current findings indicated only a cross-sectional association with interpersonal problems, suggesting that this may not be a key mechanism of ongoing depression amongst older adults with HL. This finding is consistent with Norwegian research that suggested that adjustment for interpersonal functioning did not attenuate the relationship between HL and depression (Cosh, von Hanno, et al., 2018).

Prior examinations of depression in HL have yielded mixed and heterogeneous results. Differing methods of depression assessment have been shown to produce different HL-depression findings both cross-sectionally and longitudinally (Cosh, Carriere, et al., 2018; Gopinath et al., 2009). Such variation depending on mode of depression assessment might partly reflect that different depression measures focus on different symptoms more than others. Resultantly, variation in symptom severity and strength of associations might reflect that varied dimensions are being assessed in different measures.

Adjustment following HL onset has been less commonly explored to date. However, cross-sectional but not longitudinal relationships with HL and depression outcome have previously been observed (Chou, 2008; Cosh, von Hanno, et al., 2018), potentially indicative of adjustment. Adjustment has not been corroborated in all longitudinal studies, however (e.g., Hsu et al., 2016). Our findings suggest that only two (of the four) symptom dimensions showed evidence of adjustment without dedicated intervention, suggesting that HL may not have a long-term deleterious effect in these symptom areas. Thus, it appears that there may be differential patterns of adjustment across different symptoms of depression. Depressed affect was significant only at baseline, possibly indicating an adjustment to the HL itself; consistent with findings from vision loss literature (Senra et al., 2015). Interpersonal problems also appeared to remit over time. It is plausible that those with HL were able to modify or improve communication skills within close relationships (McDonnall, 2009), potentially resulting in adjustment in this area over 12 years. Supporting this notion, an intervention to enhance communication skills was shown to reduce depression symptoms in adults with HL (Oberg, Bohn, & Larsson, 2014).

In depth assessment of depression in following onset of HL for all older adults is not typically part of many clinical geriatric guidelines (Tatum, Talebreza, & Ross, 2018). However, targeted assessment of somatic depression symptoms may be particularly beneficial for this population given that depression symptoms often go unnoticed in older adults (Teresi, Abrams, Holmes, Ramirez, & Eimicke, 2001) and somatic symptoms (such as poor sleep and changes in appetite) are often viewed as normative parts of aging, rendering older adults less likely to seek help for depression. Increased awareness and understanding of somatic symptoms and the need to assess these amongst health practitioners may be valuable. Given that as many as 1 in 4 older adults with HL present with comorbid depression, and another 1 in 5 are also likely to develop depression following HL onset (Cosh, Carriere, et al., 2018), addressing mental health assessment and referral needs is pertinent. Underscoring the critical need for enhanced assessment and referral, is that reduced help seeking is typically observed in those with HL (Sheppard & Badger, 2010) and that comorbid depression in HL may heighten risk of incident dementia (Cosh, Helmer, et al., 2019). Relatedly, few mental health referrals are provided for those with HL (Hallam, Ashton, Sherbourne, & Gailey, 2006); thus enhancing confidence to discuss mental health with patients amongst diverse health practitioners including audiologists would also be valuable for facilitating referral for comorbid depression (Ekberg, Grenness, & Hickson, 2014).

Evidence regarding treatment of comorbid depression in HL remains limited (Cosh, Helmer, et al., 2019), however, the present findings suggest that a focus on treating somatic symptoms of depression may particularly useful for this population, given that interventions specifically targeted to certain symptom dimensions can improve treatment efficacy (Soskin et al., 2012). A need to focus treatment on somatic symptoms is further underscored by recent evidence suggesting that somatic symptoms pose an increased risk for suicidal ideation (Fang et al., 2019), with older adults with HL already at risk of suicidal ideation (Cosh, Carriere, Daien, et al., 2019). In addition, given the worsening of positive affect, interventions might also valuably focus on targeting positive affect in addition to somatic symptoms, as these dimensions appear less likely to remit over time without dedicated intervention. Given that communication barriers frequently limit access to mental health support for those with HL (Sheppard & Badger, 2010; Turner, Windfuhr, & Kapur, 2007), specific and targeted intervention for this population may also be beneficial. E-mental health or online interventions

are feasible in this population (Molander et al., 2018) and might be best suited to circumventing communication challenges associated with HL.

The present findings further highlight differential mental health trajectories observed in older adults with sensory losses. The current results contrast with examination of symptom dimensions evident in vision loss (Cosh, Carriere, Nael, et al., 2019), which found vision was more closely associated with affective but not somatic symptoms. Likewise, HL has been found to have a bi-directional association with anxiety, whereas vision loss showed no association (Cosh, Nael, et al., 2018). Therefore, these different patterns of mental wellbeing across sensory losses may further indicate that different mechanisms underlie comorbid mental health symptoms between sensory losses; potentially resulting in additional vulnerability for those with dual sensory losses.

Strengths and Limitations

Strengths of this study include the large sample size and length of follow up, which allowed for the longer-term trajectories of depression dimensions to be explored. A further strength is the use of linear mixed models, which take into account the within-subject dependency between repeated observations, and thus allow for average rate of change as well as the individual change trajectories to be estimated over time (Raudenbush & Bryk, 2002). Further, mixed models are robust to missing data and are thus well suited to longitudinal analyses.

The use of a dimensional approach expands previous understanding of the HL-depression relationship. However, limitations of this approach include that, although the model of depression dimensions adopted has empirical support, there remains ongoing debate regarding how to operationalise and conceptualise depression dimensions (van Loo, de Jonge, Romeijn, Kessler, & Schoevers, 2012). It is possible that other dimensional models or depression measures would result in different associations with HL. Moreover, while the four-factor structure of the CESD has been widely replicated, the CESD was originally designed as a general measure of depression rather than to assess specific dimensions (Shafer, 2006). Relatedly, the interpersonal problems dimension was assessed by only two items and few participants endorsed any IP symptoms. These items may not best reflect the interpersonal problems commonly experienced by older adults with depression and

thus findings related to the IP dimension may not reflect the full range of interpersonal dysfunction in older adults with HL. Positive affect items are positively worded - with an absence of positive affect indicative of depression; and thus may reflect a different response style. However, distribution of responses on the PA subscale in our study was similar to response distributions for DA and S subscales.

Baseline measures of HL do not account for time since HL-onset, thus baseline results may partially reflect patterns of adjustment already being observed in some individuals; however, linear mixed models allow individual observations and exposures to vary randomly across individuals. A further limitation of the study is that HL was self-reported. Such self-reports may represent underestimates of actual HL, due to perceptions that hearing decline is a natural part of aging. Conversely, those who have depression might be more likely to self-report HL. Although relationships remained significant after adjustment for cognitive functioning, the extent to which underlying cognitive decline might have influenced self-reported HL or might be reflected in depression scores cannot be ascertained. Additionally, those who have depression might be more likely to self-report HL, or concentration deficits associated with depression might increase the likelihood of difficulty hearing a conversation. Although, from longitudinal analyses, it appears that the HL-depression association extends beyond only self-reporting bias. However, given the lack of dimensional approaches and prior heterogeneous findings regarding HL and depression over time, with the large sample and length of follow up, this study provides valuable insight. Ongoing research with objective assessments of HL to corroborate findings would also be valuable.

Conclusions

The present findings provide a more comprehensive picture of depression in older adults with HL and the associated mental health care needs of this population. Varied patterns of association with different symptom dimensions might help to account for the heterogeneity seen in extant HL-depression research. Increased assessment of somatic symptoms and interventions targeting somatic symptoms and positive affect might enhance wellbeing among older adults with self-reported HL.

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Disclosure of interest

The authors report no conflict of interest

Data Availability

Raw data were generated as part of the Three-City study and data can be accessed upon request of the Three-City steering committee. Derived data supporting the findings of this study are available from the corresponding author [SC] upon reasonable request.

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Table 1: Baseline characteristics of the study population by hearing loss. Three-City Study 1999-2001, N=8344.

	No hearing loss n= 5132		Hearing Loss n= 3212		p
Age: Median, IQR	72.4	69.0 – 76.5	73.2	69.5 – 77.4	<.001 ^a
Female (n, %)	3395	66.2	1648	51.3	<.001
Depression symptoms (CESD): Median, IQR	7	3 - 14	8	4 - 14	<.001
Psychotropic medication use	1422	27.7	981	30.5	.003
Education (reference: high)					
Low	1256	24.5	908	28.3	<.001
Mid	2931	57.2	1707	53.1	<.001
Income (reference = high)					
Low (<€760)	276	5.7	185	5.8	.24
Mid (€760-€2280)	2864	59.3	1769	55.1	.26
Withheld/missing	302	5.9	213	6.6	.09
Married	3047	59.4	1955	60.9	.09
Smoking(reference: non-smoker)					
Current smoker	297	5.8	174	5.4	.25
Past smoker	1542	30.1	1232	38.4	<.001
Alcohol consumption (reference: high)					
Low (>10 grams per day)	3071	59.84	1776	55.3	<.001
Moderate (10-40 per day)	1760	34.29	1171	36.5	.02
Falls in past 12 months	936	18.3	651	20.3	.01
Functional ability (reference: autonomous)			3329		
Dependent for mobility	1803	36.2	1269	39.5	<.001
Mobility and IADL limitations	319	6.4	367	11.4	<.001
Dependent in 3+ areas	30	0.6	34	1.1	.02
Missing	145	2.8	105	3.3	.25
Hypertension	3914	76.3	2563	79.8	<.001
Myocardial infarction	213	4.2	197	6.1	<.001
MMSE (<24)	49	0.9	58	1.8	.001
Diabetes	385	7.5	294	9.2	.004

IQR: interquartile range, ^a = determined by Mann Whitney test, all other p values determine by Chi square tests

Except for age and CESD score, results are presented as n, %.

Table 2: Association between baseline Hearing Loss and Dimensions of Depression Symptoms (z-score after data transformation) in older adults (≥ 65). Three-City (3C) Study

	Model 1 N=8344			Model 2 N= 8268		
	B	SE	p	B	SE	p
Positive affect						
Baseline	0.04	0.034	0.30	0.03	0.034	0.42
Evolution with time	-0.01	0.002	0.01	-0.01	0.002	0.01
Depressed affect						
Baseline	0.11	0.033	<.001	0.05	0.033	0.01
Evolution with time	0.01	0.002	0.48	0.00	0.002	0.24
Interpersonal Problems						
Baseline	0.42	0.108	<.001	0.35	0.114	<.001
Evolution with time	-0.02	0.019	0.28	-0.01	0.020	0.45
Somatic Symptoms						
Baseline	0.15	0.032	<.001	0.07	0.033	0.04
Evolution with time	0.01	0.002	0.04	0.01	0.002	0.04

Model 1: adjusted for sex, age, centre, education, marital status, income, psychotropic medication use

Model 2: adjusted for sex, age, centre, education, income, marital status, psychotropic medication use, MMSE, functional ability, falls, BMI, hypertension, diabetes, smoking, alcohol consumption, and history of myocardial infarction

B = standardised beta

SE = standard error