

Manuscript Title: Predictors of hearing loss self-management in older adults

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Abstract

Purpose: To determine the factor structure of a clinical tool for the assessment of hearing loss self-management; and to identify predictors of the total score on the assessment and the extracted factor scores. **Materials and Methods:** Hearing loss self-management assessments were conducted with 62 older adults. The factor structure of the assessment was determined with exploratory factor analysis. Multiple linear regression analyses identified significant contributors to the total score and to each of the extracted factors. **Results:** Three factors were identified, each representing a distinct domain of hearing loss self-management: Actions, Psychosocial Behaviours, and Knowledge. The most common significant predictor was hearing health care experience, which predicted self-management overall and in the Actions and Knowledge domains. Health literacy predicted hearing loss self-management overall and in the Psychosocial Behaviours domain. Actions were additionally predicted by hearing aid self-efficacy and gender, Psychosocial Behaviours by health locus of control, and Knowledge by age. **Conclusions:** The results of the factor analysis suggested that hearing loss self-management is a multidimensional construct. Each domain of hearing loss self-management was influenced by different contextual factors. Subsequent interventions to improve hearing loss self-management should therefore be domain-specific and tailored to relevant contextual factors.

Keywords

chronic health condition, hearing loss, older adults, self-management

Word count = 6,278

Introduction

Hearing loss, a disorder of the ear characterised by a reduction in auditory sensitivity, is the third leading cause of years lived with disability worldwide [1]. While a loss of sensitivity can be ameliorated to some extent with hearing aids or cochlear implants, permanent hearing loss is a chronic health condition that has significant negative effects on communication ability, psychosocial functioning, and quality of life [2, 3, 4]. The idea that the effects of a chronic condition extend beyond the impairment itself underpins the World Health Organization's International Classification of Functioning, Disability and Health, commonly known as the ICF [5]. The ICF conceptualises functioning and disability in terms of their impact on a person at three interrelated levels: the body (structures and functions), the whole person (activities), and the whole person in a social context (participation). As a result of the activity limitations and participation restrictions imposed by a health condition, people with hearing loss – like others with a chronic condition – must acquire and apply a range of strategies to manage its effects on their everyday life, an active and ongoing process known as self-management [6, 7].

A fundamental hearing loss self-management skill for many clients is the handling and management of hearing aids, which includes insertion into and removal from the ear canal, regular battery replacement, cleaning, and manipulation of the volume or program controls. After the initial hearing aid fitting and orientation, the client must put these skills into daily practice independently of the audiologist. However, evidence suggests that clients do not acquire or retain these skills as well as they should. For example, a study by Desjardins and Doherty [8] found that in a sample of experienced, full-time hearing aid users, the majority demonstrated poor performance on at least one hearing aid handling task. Poor hearing aid

self-management can, in turn, give rise to larger consequences, such as irregular usage, decreased satisfaction and benefit, discontinuation of hearing aid use, and disengagement from hearing rehabilitation altogether [9, 10, 11].

At the activities and participation levels of functioning, hearing loss self-management further involves understanding the causes, characteristics, and effects of hearing loss; mastering problem-solving skills for use in communicative situations; monitoring for the development of new problems and responding appropriately; working collaboratively with hearing health care professionals; and managing the effects of the hearing loss on psychosocial wellbeing [12]. However, recent research suggest that these aspects of hearing loss self-management are largely overlooked in routine clinical practice in audiology. For example, Grenness et al. [13] reported that audiologists tend to pose more questions about the medical and surgical history of the client's ears than about the psychosocial or functional difficulties the client is experiencing as a result of the hearing loss. The diagnosis is typically explained to the client in biomedical terms, rather than in terms of expected functional and communicative consequences [14]. Client input is rarely solicited during discussions of rehabilitation strategies and hearing aids are often the sole intervention offered by the audiologist [15, 16, 17]. These clinical practice patterns were reflected in the findings of a recent study in which the Partners in Health scale and the Cue and Response interview, two complementary self-management assessment tools from the Flinders Chronic Condition Management Program™ [18], were evaluated in a group of 30 older adults with hearing loss who had all been receiving hearing health care for ≥ 18 months [12, 19]. As a group, the study participants demonstrated relatively high levels of knowledge about hearing loss, but their knowledge of treatment options was largely confined to hearing aids and other technology-based interventions. The results of the self-management assessment also revealed the presence of

unmet psychosocial needs in the majority of participants, who had no clear plan for addressing them as part of their current rehabilitation program.

In order to interpret the results of a self-management assessment for the purposes of clinical decision-making, clinicians must be alert to factors that may act as barriers or facilitators to good self-management in the individual client [20]. This is because the activity limitations and participation restrictions associated with a health condition do not arise solely from dysfunctioning at the level of the body. Rather, they result from an interaction between the health condition and the personal and environmental factors – collectively termed contextual factors by the ICF – that are present in the person’s life. The ability to self-manage can itself be considered a personal factor; other contextual factors may additionally influence the extent to which people with chronic conditions are able to self-manage their activity limitations and participation restrictions [21]. Consideration of contextual factors during diagnosis and management planning has been shown in other areas of health care to result in improved outcomes for clients with chronic conditions, including better adherence to treatment, fewer missed appointments, fewer unplanned visits to address urgent or emergency needs, increased quality of life, and decreased financial costs to the health care system [22, 23, 24, 25].

However, research into the effect of contextual factors on chronic condition self-management has traditionally been conducted on clients with diabetes, asthma, and mental illness and the way these conditions are managed in primary care settings. Comparatively limited evidence exists for hearing loss or for clinicians practicing in an allied health context [26, 27, 28, 29]. Further, much of the existing evidence base has focused on treatment adherence, with little attention paid to other domains of self-management, such as coping skills, participation in shared decision-making, and the ability to recognise and manage changes in symptoms. The first aim of this study was to identify the domains of self-management that are relevant to

adults with hearing loss by determining the factor structure of the audiology version of the Flinders Chronic Condition Management Program™ assessment, which has been modified for use with adults with hearing loss. The second aim of the study was to identify those variables that predict the total score on the Flinders Chronic Condition Management Program™ assessment and each of the extracted factor scores.

Materials and Methods

Participants

Sixty-two adults with known hearing loss were recruited. The initial search for participants was conducted on a database of research volunteers maintained by the National Acoustic Laboratories (Sydney, Australia), which is made up of community-dwelling adults who have participated in past hearing research studies and who have provided written consent to be invited to participate in future studies. Of the 289 volunteers on the database, 116 met the inclusion and exclusion criteria. All were invited to participate in the study; 33 agreed. The remaining 29 participants were recruited from local hearing health care providers, an advertisement in a community newspaper, and word of mouth. The inclusion criteria were: (1) between 50 and 85 years of age; and (2) a four-frequency pure-tone average (PTA4; average of pure-tone hearing thresholds at 0.5, 1, 2, and 4 kHz across ears) between 25 and 65 dB HL. The exclusion criteria were: (1) presence of active ear disease; (2) non-English speaking; and (3) additional disabilities, such as dementia, that would preclude participation in a research study.

Materials

Hearing loss self-management

Hearing loss self-management was assessed with the audiology version of the Partners in Health scale and the Cue and Response interview from the Flinders Chronic Condition Management Program™. The original Partners in Health scale is a 12-item questionnaire that assesses self-management in the domains of knowledge, partnership in treatment, recognition and management of symptoms, and coping [18, 30]. Clients are asked to rate each item from 0-8, with higher ratings reflecting better self-management. The aim of the Partners in Health scale is to obtain the client's perspective on his/her self-management without influence from the clinician. The four-factor structure of the scale has been confirmed with Bayesian confirmatory factor analysis [30]. Cronbach's alpha was 0.82 in a sample of 176 adults with a range of chronic conditions, suggesting good internal consistency [31]. The audiology version of the Partners in Health scale, which was used in the current study, was developed because the original scale employs more medical vocabulary (e.g. medication, doctor) than is typically used in an audiology consultation. The wording of each item was therefore revised, and one item removed, as the result of an iterative consultation process with seven adults with hearing loss [19]. Revision of the scale was undertaken with written permission from the developers of the Flinders Chronic Condition Management Program™. The original and audiology versions of the Partners in Health scale are shown in table 1.

The Cue and Response interview is administered by the clinician, using open-ended questions to explore the client's understanding and knowledge of each item on the Partners in Health scale. For example, the cue questions associated with item 10, *I manage the effect of my hearing loss on my social life (e.g. my ability to participate, how I mix with other people, and*

my personal relationships), include *How does your hearing loss affect the way you socialise with other people? Tell me about the people who support you. What aspects of your social life would you like to change?* At the end of the discussion of each item, the clinician provides a rating on the same scale of 0 to 8 that was used in the Partners in Health scale. Client and clinician perspectives are then compared. When there is a discrepancy between clinician and client ratings of 3 or more, this signals an area for further discussion and provides an opportunity for the score to be adjusted. In the end, a single score is agreed upon for each item that reflects the perspectives of both the client and clinician. For the purposes of this paper, this score will be referred to subsequently as the hearing loss self-management score.

Health literacy

Health literacy was measured with the reading comprehension portion of the Australian version of the Short Test of Functional Health Literacy in Adults [32, 33]. The client is presented with several paragraphs of health-related text from which one or two words are missing from each sentence. The task is to fill in each of the 36 blanks with the correct word, which is selected from a list of four choices. In a validation study on 211 adults, Cronbach's alpha was 0.97 for the reading comprehension portion of the Short Test of Functional Health Literacy in Adults, suggesting excellent internal consistency [32].

Health locus of control

The Multidimensional Health Locus of Control scales [34] were used to measure locus of control – the extent to which individuals believe they can influence events that occur in their

lives – in a health context. Three six-item subscales each reflect a different dimension of locus of control beliefs: internality, powerful others, and chance externality. Clients are asked to rate each item on a scale from 1-6. Separate scores are reported for each of the three subscales. The developers of the Multidimensional Health Locus of Control scales report a Cronbach's alpha for the three subscales ranged from 0.67 to 0.77, suggesting acceptable internal consistency [34].

Social support

Social support was assessed with the modified Medical Outcomes Study Social Support Survey [35]. The survey is an 8-item questionnaire that probes the extent to which an individual has access to social support in a variety of situations. Clients rate each item on a scale of 1-5; higher total scores indicate greater availability of social support. An evaluation of the survey's psychometric properties suggests that the instrument is internally reliable (Cronbach's alpha = 0.88-0.93 across different client populations) and is able to reliably discriminate between groups of clients whose actual social resources are known, particularly among older adults [35].

Problem-solving skills

Problem-solving was measured using the Twenty Questions Test, a subtest of the Delis-Kaplan Executive Function System [36]. Clients are shown a set of 30 pictures laid out in a 5 x 6 grid; each picture shows a common, everyday object. Clients are instructed to identify an image chosen by the test administrator by asking as few yes/no questions as possible, to a maximum of 20 questions. Lower scores reflect better problem-solving skills. The Delis-

Kaplan Executive Function System was standardised on a sample of 1,750 Americans ranging from 8 to 89 years of age; internal consistency within this normative population was moderate to high [37].

Cognitive function

Cognitive function was assessed with the Montreal Cognitive Assessment [38], a screening instrument that taps into the domains of visuospatial and executive function, memory, attention, language, abstraction, delayed recall, and orientation to time and place. Item analysis has shown that the test can reliably distinguish adults with mild cognitive impairment from adults with confirmed Alzheimer's dementia as well as from normal controls [38]. The developers of the Montreal Cognitive Assessment reported a Cronbach's alpha of 0.83, suggesting good internal consistency. It has been reported that clients with hearing loss score more poorly on the Montreal Cognitive Assessment than do their normal-hearing peers due to the presentation of some items via an auditory-only modality [39]. However, since removal of these items could negatively affect the validity of the test, and since there is no currently available version that is specifically designed for clients with hearing loss, the original administration and scoring methods were employed. Recommended procedures for administering the Montreal Cognitive Assessment to clients with hearing loss were followed, which included ensuring that clients were wearing their hearing aids during testing, if applicable, and conducting the assessment in a well-lit room with little to no ambient noise [39].

Hearing aid self-efficacy

The Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids [40] is a 24-item measure of self-efficacy for successful use and management of hearing aids. Clients are instructed to report how certain they are that they would be able to cope with a particular listening situation or perform a hearing aid-related skill on a scale of 0-100%. Each of the four subscales (basic handling, advanced handling, aided listening, and adjustment) has good internal consistency, with Cronbach's alpha values ranging from 0.77-0.93 for new hearing aid users and 0.67-0.91 for experienced hearing aid users. In the initial validation study, test-retest reliability was high for both user groups, for the total scale, and for each individual subscale [40].

Demographic data

Information about age, gender, and hearing health care experience was gathered with a questionnaire. Socioeconomic status was determined according to decile rankings assigned to Australian suburbs by the Australian Bureau of Statistics' Socio-Economic Indexes for Areas. Decile rankings range from 1 (lowest) to 10 (highest) and are a measure of economic advantage relative to other areas of Australia. Severity of hearing loss was measured with pure-tone audiometry and reported as the average of the hearing thresholds obtained at 0.5, 1, 2, and 4 kHz across both ears, with higher values indicating greater severity.

[Table 1 here]

Procedure

During one test appointment of approximately two hours, participants independently completed the Partners in Health scale, the demographic questionnaire, the Multidimensional Health Locus of Control scales, and the Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids, while the Cue and Response interview, pure-tone audiometry, the Twenty Questions Test, and the Montreal Cognitive Assessment were administered by the first author (EC), a qualified audiologist with 16 years of clinical experience. The Short Test of Functional Health Literacy in Adults and the modified Medical Outcomes Study Social Support Survey were mailed to the participants between 1 and 5 months after the participants underwent the face-to-face assessments. The study was approved by and conducted under the ethical oversight of the Australian Hearing Human Research Ethics Committee and the University of Queensland Medical Research Ethics Committee and conformed in all respects to the Australian government's National Statement on Ethical Conduct in Human Research [41]. Participants were compensated for their travel expenses.

Statistical analysis

All statistical analysis was performed using IBM SPSS Statistics (v24, 2016). The factor structure of the hearing loss self-management assessment was determined using exploratory factor analysis with the principal components extraction method. One item in the assessment, Healthy Lifestyle, was excluded from the analysis due to its lack of correlation with the other items ($r = 0.16$). Factors were retained if they had an eigenvalue >1 [42] and they appeared above the "elbow" of the scree plot [43, 44], followed by confirmation that the total variance explained was at least 70%. Direct oblimin (i.e. non-orthogonal) rotation was used to allow correlation between the factors [44]. Following rotation, it was confirmed that the rotated

factors had a sensible interpretation. Sampling adequacy was confirmed with the Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity.

For the total score on the hearing loss self-management assessment, and for each of the extracted factors, a standard multiple linear regression model was fitted to the data to determine how much variation in hearing loss self-management could be explained by the combined contributions of the independent variables. Variables that displayed a non-normal distribution were transformed prior to the analysis using square root or logarithmic transformations depending on the degree of skewness [45]. Multiple imputation, with pooled results calculated over 30 imputations, was used to compensate for the fact that 35% of the participants did not return their health literacy assessment and 24% did not return their social support questionnaire, both of which had been sent to participants in the post 1-5 months after the face-to-face self-management assessment [46]. For the total score on the hearing loss self-management assessment, and for each of the extracted factors, a univariate linear regression analysis was performed on each independent variable with the aim of identifying those that made significant ($p < 0.1$) individual contributions to the model. Only those independent variables with significant p values were retained for subsequent multivariate analysis. The data set for each regression model was evaluated to ensure it met the necessary assumptions, namely independence of observations, linearity, homoscedasticity, a lack of significant multicollinearity, an absence of outliers, and a normal distribution of residuals [47].

Results

Participant characteristics

Participants ranged in age from 51 to 85 years, with a mean age of 72 years (SD = 7.2 years) and a mean PTA4 of 43 dB HL (SD = 10.3). Twenty-one participants were female and 41 were male. The female participants had a mean age of 71 years (SD = 8.2 years) and a mean PTA4 of 42 dB HL (SD = 8.5). The male participants had a mean age of 73 years (SD = 6.6 years) and a mean PTA4 of 43.7 dB HL (SD = 11.1). Half of the study participants were current recipients of hearing health care and had been so for 1.5 to 37 years. The other half of the participant group had never received hearing health care.

Exploratory factor analysis

Three factors with eigenvalues >1 were extracted, which explained 47.9%, 15.6%, and 11.2% of the total variance, respectively. All three factors were retained after inspection of the scree plot. With three factors, the total percentage of variance explained was 74.7%, which was considered adequate. As shown in table 2, the items Attending Appointments, Adherence, Shared Decision-Making, Taking Action, Accessing Services, and Monitoring Changes loaded onto factor 1, which was named *Actions*. The items Emotional Wellbeing and Social Life loaded onto factor 2, which was named *Psychosocial Behaviours*. The items Knowledge of Treatment and Knowledge of Hearing Loss loaded onto factor 3, which was named *Knowledge*. The sensible interpretation of the extracted factors contributed to the decision to retain a three-factor solution.

[Table 2 here]

Hearing loss self-management assessment total score

Of the 13 independent variables, six were significantly associated with the total score on the hearing loss self-management assessment in the univariate analyses: hearing health care experience, health literacy, health locus of control (powerful others), problem-solving skills, age, and hearing aid self-efficacy (table 3). All six significant variables were entered into a standard multiple linear regression model to predict the total score on the hearing loss self-management assessment. Two of the independent variables, hearing health care experience and health literacy, made significant contributions to the multivariate model. A significant regression equation was found for the final model ($F(2,59) = 16.04, p < 0.0005$), with an adjusted R^2 of 0.33 (table 4). The predicted total score on the hearing loss self-management assessment is equal to $27.68 + 18.14 (\text{HEARING HEALTH CARE EXPERIENCE}) + 9.54 (\text{HEALTH LITERACY})$, where hearing health care experience is coded as 0 = No Experience and 1 = Experience and health literacy is measured in terms of a test score. Higher total scores on the hearing loss self-management assessment indicate better self-management skills. Recipients of hearing health care had total hearing loss self-management scores that were 18.14 points higher than those who had never received hearing health care. Total scores on the hearing loss self-management assessment increased by 9.54 for every one-point increase in health literacy.

Hearing loss self-management assessment: Actions factor

Five independent variables were significantly associated with the Actions factor score in the univariate analyses: hearing aid self-efficacy, gender, hearing health care experience, problem-solving skills, and hearing loss severity (table 3). The variables were entered into a multiple linear regression model. Hearing health care experience, hearing aid self-efficacy, and gender, made significant contributions to the multivariate model. A significant regression

equation was found for the final model ($F(3,58) = 14.32, p < 0.0005$), with an adjusted R^2 of 0.40 (table 4). The predicted Actions factor score is equal to $-2.49 + 1.01$ (HEARING HEALTH CARE EXPERIENCE) $+ 0.02$ (HEARING AID SELF-EFFICACY) $+ 0.54$ (GENDER), where hearing health care experience is coded as 0 = No Experience and 1 = Experience, hearing aid self-efficacy is measured as a percentage, and gender is coded as 0 = Male and 1 = Female. Higher factor scores indicate better self-management skills in the Actions domain. Recipients of hearing health care had Actions factor scores that were 1.01 points higher than those who had never received hearing health care. Female participants had Actions factor scores that were 0.54 points higher than male participants. Actions factor scores increased by 0.02 points for every percentage point increase in hearing aid self-efficacy.

[Table 3 here]

Hearing loss self-management assessment: Psychosocial Behaviours factor

Univariate analyses revealed that five independent variables were significantly associated with the Psychosocial Behaviours factor score: health literacy, health locus of control (internal), health locus of control (powerful others), social support, and cognitive function (table 3). The variables were entered into a multiple linear regression model. Health literacy and health locus of control (internal) made significant contributions to the multivariate model. A significant regression equation was found for the final model ($F(2,59) = 6.24, p = 0.009$), with an adjusted R^2 of 0.20 (table 4). The predicted Psychosocial Behaviours factor score is equal to $-3.20 + 0.61$ (HEALTH LITERACY) $+ 0.07$ (HEALTH LOCUS OF CONTROL INTERNAL), where both independent variables are measured in terms of test

scores. Higher factor scores indicate better self-management skills in the Psychosocial Behaviours domain. Psychosocial Behaviours factor scores increased by 0.61 for every one-point increase in health literacy and 0.07 for every one-point increase in internal health locus of control.

Hearing loss self-management assessment: Knowledge factor

Five independent variables were significantly associated with the Knowledge factor score: age, health literacy, cognitive function, health locus of control (powerful others), and hearing health care experience (table 3). All five significant variables were entered into a multiple linear regression model. Hearing health care experience and age made significant contributions to the multivariate model. A significant regression equation was found for the final model ($F(2,59) = 13.86, p < 0.0005$), with an adjusted R^2 of 0.30 (table 4). The predicted Knowledge factor score is equal to $-2.95 - 0.92 (\text{HEARING HEALTH CARE EXPERIENCE}) + 0.47 (\text{AGE})$, where hearing health care experience is coded as 0 = No Experience and 1 = Experience and age is measured in years. Lower factor scores indicate better self-management skills in the Knowledge domain. Recipients of hearing health care had Knowledge factor scores that were 0.92 points lower than those who had never received hearing health care. Knowledge factor scores increased by 0.47 for every additional year of age.

[Table 4 here]

Discussion

The ICF conceptualises health and disability as multidimensional, acknowledging that chronic conditions affect not just the impaired body structure or function, but also give rise to activity limitations and participation restrictions [5]. Using hearing loss as an example, a reduction in audibility (impairment of function) may result from a loss of outer hair cells in the cochlea (impairment of structure), which may, in turn, cause difficulty hearing on the telephone (activity limitation) and thus restrict a person's ability to engage in full-time work (participation restriction) [48]. The extent to which a chronic condition affects a person on each of these levels is further influenced by the contextual factors that are present in his or her life. We suggest that self-management, an important contributor to chronic condition outcomes [6, 7], be considered a personal contextual factor since it falls within the "attitudes, basic skills, and behaviour patterns" [49] that can influence the impact of the condition on activities and participation. However, while self-management is an acknowledged and well-researched contextual factor as it influences chronic conditions such as diabetes and arthritis, it remains a relatively underexplored area in the context of hearing loss.

In this study, we measured hearing loss self-management using the Partners in Health scale and the Cue and Response interview, two validated tools that assess self-management holistically [18] and which have been modified specifically for use with adults with hearing loss [19]. Factor analysis of the original Partners in Health scale has demonstrated that among adults with a range of chronic conditions (excluding hearing loss), the scale is composed of four factors: Knowledge, Partnership in Treatment, Recognition and Management of Symptoms, and Coping [30]. In our sample, which included only older adults with hearing loss, the items that loaded onto the Knowledge and Coping factors (which we termed Knowledge and Psychosocial Behaviours, respectively) were the same. This suggests that the self-management skills represented by these factors – which include knowing about one's

condition and its treatment options and managing the emotional and social effects of the condition – are equally relevant for hearing loss as they are for conditions like diabetes and arthritis. However, unlike the original analysis, the Partnership in Treatment items and the Recognition and Management of Symptoms items all loaded onto a single factor in our study, which we named Actions (see table 1). Our results may reflect the lesser importance of symptom monitoring for clients with hearing loss relative to those with other chronic conditions. In contrast to diabetes and asthma, hearing loss tends to be relatively stable for most clients; as such, monitoring tends to be less structured and to take place over a period of months or years, rather than on a daily basis. Similarly, the item Healthy Lifestyle was excluded from our factor analysis because it was poorly correlated with the other items, whereas this item loaded onto the Coping factor in the original analysis. This finding highlights another key difference between hearing loss and many other chronic conditions, namely that hearing loss rarely affects – and is rarely affected by – such lifestyle habits as diet and exercise. Taken as a whole, the results of our factor analysis suggest that while there is considerable overlap between the self-management domains that apply to hearing loss and those that apply to other chronic conditions, there is scope for developing self-management assessments and interventions that are more precisely aligned to the unique nuances of living with a hearing loss.

Not only do contextual factors influence a person's experience of a chronic condition and its associated functional impairments, activity limitations, and participation restrictions, they also interact with each other. In this study we examined the relationships between the identified domains of self-management and a range of other personal factors. While these relationships have been investigated for other chronic conditions, there is a paucity of evidence that relates specifically to older adults with hearing loss. In the present sample of 62

older adults, we found that clients who had previously received hearing health care possessed significantly better hearing loss self-management skills than those who had never received hearing health care, both in the Knowledge and Actions domains as well as overall. However, hearing health care experience was not significantly associated with hearing loss self-management in the Psychosocial Behaviours domain. This finding could reflect the fact that audiologists tend to relay primarily factual information about hearing loss and hearing aids to their clients (e.g. a description of the audiogram, an explanation of a hearing aid's technical specifications) and prioritise technology-based interventions over the recommendation of strategies for managing the psychosocial aspects of living with a hearing loss [15, 16, 17, 50].

Health literacy emerged as another important factor influencing hearing loss self-management, with significant effects on the Psychosocial Behaviours domain as well as the total score. The relationship between health literacy and self-management among older adults with hearing loss reinforces what has been reported for adults with diabetes, asthma, and chronic obstructive pulmonary disease, namely that those with higher levels of health literacy demonstrate better self-management knowledge and skills [51, 52, 53, 54]. In the context of hearing loss, a link has also been demonstrated between poor health literacy and a reduced ability to manage the daily tasks associated with using and caring for hearing aids [55], an important component of hearing loss self-management for the majority of clients.

The variable influence of these personal factors on hearing loss self-management underscores the need for the clinician to consider such factors on an individual basis so that interventions can be tailored to the activity limitations and participation restrictions that are experienced by each client. Selection of an appropriate self-management intervention may be further influenced by whether relevant contextual factors are fixed, i.e. intrinsic to the individual, or

potentially modifiable. In addition to hearing health care experience and health literacy, health locus of control, age, gender, and hearing aid self-efficacy emerged as significant contributors to individual domains of hearing loss self-management in the present study. While fixed factors such as health literacy, health locus of control, age, and gender may influence the form and content of the chosen self-management intervention, a modifiable factor like self-efficacy could be targeted for intervention in and of itself. Indeed, leading self-management education programs, such as the Flinders Chronic Condition Management Program™ and the Stanford Program, explicitly incorporate activities to enhance client self-efficacy, with the expectation that improved self-efficacy will lead to better self-management [21, 56].

The proportion of variance in hearing loss self-management that could be predicted by the independent variables was relatively low, as indicated by adjusted R^2 values that ranged from 0.20 to 0.40. This finding suggests at least two possible conclusions. First, it is likely that there are a number of other factors exerting influence on hearing loss self-management that were not measured in the present study. For example, health beliefs have been shown in studies of other chronic conditions to influence a client's ability to self-manage [57]. There is increasing evidence that health beliefs influence client outcomes within hearing health care, with recent studies reporting that clients who perceive fewer barriers to living successfully with a hearing loss demonstrate greater rates of hearing aid uptake and more regular hearing aid usage [58, 59, 60]. Second, despite findings that many contextual factors are common to a range of chronic conditions and population subgroups, the influence they exert may not necessarily be predictable or straightforward. For example, in a qualitative study of adults with end-stage renal disease, Griva et al. [61] found that while family members provided both tangible and emotional support for self-management, social pressures could also conspire to

reduce adherence to dietary restrictions and medication schedules at events that centred on food.

The results of this study should be considered in the context of several limitations. First, health literacy and social support were assessed by mailing the Short Test of Functional Health Literacy in Adults and the modified Medical Outcomes Study Social Support Survey to the participants between 1 and 5 months after their self-management had been assessed face-to-face. Approximately half of the participants received their health literacy and social support questionnaires 1-2 months after the self-management assessment; the other half did so 3-5 months after the self-management assessment. It is unknown to what extent this delay could have affected the results. The psychometric characteristics of the Short Test of Functional Health Literacy in Adults that have been published to date do not include a measure of test-retest reliability [32]. However, stability coefficients reported by the developers of the modified Medical Outcomes Study Social Support Survey suggest a high degree of repeatability over the course of one year [62]. A change in circumstances since the self-management assessment, such as a change in social support availability or neurological changes as the result of a stroke, cannot be excluded. As a result of how these two measures were administered, a proportion of the health literacy and social support data was missing because not all participants returned their questionnaires. While this was compensated for statistically using multiple imputation, it is possible that the influence of these variables on self-management could have been over- or underestimated in the regression analyses.

Second, cognitive function was assessed with the Montreal Cognitive Assessment, an instrument that has been found to overidentify impaired cognitive function in adults with hearing loss due to the number of items that are administered via an auditory-only modality

[39]. While it is possible that this may have occurred with our sample, we took a number of steps to mitigate this effect. The experimenter who conducted the cognitive assessments, a qualified audiologist with 16 years of experience working with older adults with hearing loss, ensured that testing was conducted in a quiet, well-lit room and that where possible, participants were wearing appropriate amplification, two strategies recommended by Dupuis et al. [39]. We also note that the average PTA4 in our participant group was 43 dB HL (SD = 10.3), which corresponds to a mild to moderate hearing loss. Individuals with moderate hearing loss, even unaided, would typically be able to understand clearly spoken speech in an environment without background noise [63]. During data analysis, the scores on the Montreal Cognitive Assessment were analysed as a continuous variable; participants were not classified on the basis of these scores as having impaired versus unimpaired cognitive function. We further note that the correlation between the Montreal Cognitive Assessment score and hearing loss severity was not significant ($r = -0.20$, $p = 0.12$).

Third, two of the factors identified in the factor analysis, Knowledge and Psychosocial Behaviours, consisted of only two items. Standard practice in exploratory factor analysis dictates that at least three items should load on each extracted factor to ensure the solution is statistically robust [44]. Conceptually, however, the three-factor solution presented here seemed the most sensible interpretation of the data. The items that loaded onto each factor have a great deal in common with each other but very little in common with the other items. For example, the Knowledge of Health Condition and Knowledge of Treatment items, which loaded onto the Knowledge factor, represent a set of self-management activities that are distinct from those represented by the Psychosocial Behaviours and Actions factors. We note that in the factor analysis conducted by Smith et al. [30] on the original Partners in Health scale, two of the extracted factors (Recognition and Management of Symptoms and

Knowledge) also consisted of only two items. However, this may reflect a weakness of the original self-management assessment itself and suggests that there is scope for its further refinement.

Fourth, the study sample was relatively small and uniform in terms of socioeconomic status, race, and ethnicity, both of which limit generalisability. It is possible that a larger and more diverse group of participants would have yielded different results.

Conclusion

Hearing loss self-management is a multidimensional construct, encompassing the domains of Actions, Psychosocial Behaviours, and Knowledge. Our findings suggest that there is considerable overlap between the domains of self-management that are relevant for hearing loss and those that apply to other chronic conditions, such as knowing about one's condition and its treatment options and managing the social and emotional effects of the condition on everyday life. Other aspects of self-management, however, such as monitoring for and responding to changes in one's condition and maintaining healthy lifestyle habits, appeared less relevant to hearing loss than they are for chronic conditions that require daily monitoring or exert an effect on physical functioning, such as diabetes and arthritis.

Our results further suggest that hearing loss self-management, a personal contextual factor in its own right, interacts with other personal factors, including previous hearing health care experience, health literacy, hearing aid self-efficacy, gender, health locus of control, and age. The relationship between these factors and hearing loss self-management varied according to the specific self-management domain under analysis. Interventions to improve hearing loss

self-management should thus be domain-specific and tailored to the personal factors that are relevant for the individual client.

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Declaration of Interest

The authors report no conflicts of interest.

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Tables

Table 1. The original and audiology versions of the Partners in Health scale and Cue and Response interview.

Topic	<u>Original version</u>		<u>Audiology version</u>	
	Item	Factor	Item	Factor
Knowledge of Health Condition	1. Overall, what I know about my health condition is	Knowledge	1. Overall, what I know about my hearing loss is	Knowledge
Knowledge of Treatment	2. Overall, what I know about the treatment (including medications) of my health condition is	Knowledge	2. Overall, what I know about the management of my hearing loss is	Knowledge
Adherence	3. I take medications or carry out the treatments asked by my doctor or health worker	Partnership in Treatment	3. I manage my hearing loss as asked by my hearing health professional	Actions
Shared Decision-Making	4. I share in decisions made about my health condition with my doctor or health worker	Partnership in Treatment	4. I share in decisions made about my hearing loss with my hearing health professional	Actions
Accessing Services	5. I am able to deal with health professionals to get the services I need that fit with my culture, values, and beliefs	Partnership in Treatment	5. I am able to deal with hearing health professionals to get the services I need that fit with my culture, values, and beliefs	Actions
Attending Appointments	6. I attend appointments as asked by my doctor or health worker	Partnership in Treatment	6. I attend appointments as asked by my hearing health professional	Actions

Monitoring Changes	7. I keep track of my symptoms and early warning signs (e.g. blood sugar levels, peak flow, weight, shortness of breath, pain, sleep problems, mood)	Recognition and Management of Symptoms	7. I keep track of any changes in my health condition (e.g. sudden or gradual drop in hearing, pain or infection in my ears, hearing aids stopped working, problems handling or inserting my hearing aids)	Actions
Taking Action	8. I take action when my early warning signs and symptoms get worse	Recognition and Management of Symptoms	8. I take action when I notice these changes	Actions
Physical Activity	9. I manage the effect of my health condition on my daily activities and physical activities (e.g. walking, hobbies, and household tasks)	Coping	<i>Item not included in assessment</i>	NA
Emotional Wellbeing	10. I manage the effect of my health condition on how I feel (e.g. my emotions and my spiritual wellbeing)	Coping	9. I manage the effect of my hearing loss on how I feel (e.g. my emotions and my spiritual wellbeing)	Psychosocial Behaviours
Social Life	11. I manage the effect of my health condition on my social life (e.g. my ability to participate, how I mix with other people, and my personal relationships)	Coping	10. I manage the effect of my hearing loss on my social life (e.g. my ability to participate, how I mix with other people, and my personal relationships)	Psychosocial Behaviours
Healthy Lifestyle	12. Overall, I manage to live a healthy lifestyle (e.g. no	Coping	11. Overall, I manage to live a healthy lifestyle (e.g. no	<i>Item removed prior to</i>

smoking, healthy food,
moderate alcohol, regular
physical activity, sleep well,
manage stress and worry)

smoking, healthy food,
moderate alcohol, regular
physical activity, sleep well,
manage stress and worry)

*principal
components
analysis*

Table 2. Rotated pattern matrix for exploratory factor analysis with direct oblimin rotation of the hearing loss self-management assessment. The items that load onto each factor are shown in bold.

Item	Rotated Component Coefficients		
	Factor 1	Factor 2	Factor 3
	<i>Actions</i>	<i>Psychosocial Behaviours</i>	<i>Knowledge</i>
Attending Appointments	0.899	-0.010	0.165
Adherence	0.874	-0.055	-0.126
Shared Decision-Making	0.840	-0.071	-0.106
Taking Action	0.783	0.044	0.078
Accessing Services	0.780	0.013	-0.181
Monitoring Changes	0.471	0.234	-0.412
Emotional Wellbeing	0.073	0.854	0.062
Social Life	-0.100	0.846	-0.044
Knowledge of Treatment	0.043	-0.125	-0.903
Knowledge of Hearing Loss	-0.019	0.108	-0.893

Table 3. Mean values of each variable, with the standard deviation shown in parentheses, for the participant group (N = 62). For the independent variables, univariate p values indicate the significance of the association between each independent variable and the total and factor scores on the hearing loss self-management assessment. Variables for which $p < 0.10$ were considered significant and are marked with an asterisk.

Variable		Univariate p values			
		Hearing loss self-management total score	Actions factor	Psychosocial Behaviours factor	Knowledge factor
Hearing loss self-management total score	59.8 (17.2)				
Age (years)	72.1 (7.2)	0.03*	0.16	0.18	0.01*
Gender (M:F ratio)	66:34	0.15	0.09*	0.83	0.84
Socioeconomic status	8.3 (2.4)	0.64	0.61	0.44	0.63
Hearing loss severity (dB HL)	43.0 (10.3)	0.17	0.09*	0.51	0.63
Social support	32.5 (6.3)	0.53	0.81	0.03*	0.26
Health literacy	35.2 (1.4)	0.08*	0.22	0.02*	0.18
Cognitive function	26.1 (2.8)	0.25	0.76	0.06*	0.02*
Hearing aid self-efficacy (%)	83.4 (11.6)	0.008*	0.006*	0.38	0.22
Health locus of control – internal	26.4 (3.9)	0.70	0.69	0.05*	0.35
Health locus of control – chance	15.9 (5.4)	0.47	0.94	0.09*	0.18
Health locus of control – powerful others	21.5 (5.9)	0.04*	0.14	0.10*	0.06*
Problem-solving skills	12.1 (2.3)	0.08*	0.08*	0.46	0.11
Hearing health care experience (years)	5.0 (7.8)	<0.0005*	<0.0005*	0.12	<0.0005*

Note. Higher values on the hearing loss self-management total score, Actions factor score, and Psychosocial Behaviours factor score indicate better self-management, while higher values on the Knowledge factor score indicate poorer self-management. The variable hearing health care experience was converted to a dichotomous categorical variable (experience/no experience) prior to the regression analyses. Scores on the health locus of control chance and powerful others variables have been reversed so that higher values on all locus of control measures indicate a more internally oriented locus of control.

Table 4. Multiple linear regression models for the hearing loss self-management assessment total score and the *Actions*, *Psychosocial Behaviours*, and *Knowledge* factors.

Variable	Hearing loss self-management total score (adj. $R^2 = 0.33$)						
	B	SE _B	β	t	p	95% CI for B Lower bound	95% CI for B Upper bound
Hearing health care experience	18.14	3.62	0.53	5.02	<0.0005	10.90	25.38
Health literacy	9.54	3.41	0.30	2.81	0.02	2.71	16.37
Variable	<i>Actions</i> factor (adj. $R^2 = 0.40$)						
	B	SE _B	β	t	p	95% CI for B Lower bound	95% CI for B Upper bound
Hearing health care experience	1.01	0.20	0.51	4.98	<0.0005	0.60	1.42
Hearing aid self-efficacy	0.02	0.01	0.25	2.45	0.02	0.01	0.04
Gender	0.54	0.21	0.26	2.56	0.01	0.12	0.95
Variable	<i>Psychosocial Behaviours</i> factor (adj. $R^2 = 0.20$)						
	B	SE _B	β	t	p	95% CI for B Lower bound	95% CI for B Upper bound
Health literacy	0.61	0.22	0.33	2.74	0.02	0.16	1.06
Health locus of control – internal	0.07	0.03	0.26	2.17	0.04	0.01	0.13
Variable	<i>Knowledge</i> factor (adj. $R^2 = 0.30$)						
	B	SE _B	β	t	p	95% CI for B Lower bound	95% CI for B Upper bound
Hearing health care experience	-0.92	0.21	-0.46	-4.31	<0.0005	-1.34	-0.49
Age	0.05	0.02	0.34	3.15	0.003	0.02	0.08

Note. * $p < 0.05$; B = unstandardised regression coefficient; SE_B = standard error of the coefficient; β = standardised coefficient