Archives of Gerontology and Geriatrics 83 (2019) 126–130

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Moderate hearing loss is related with social frailty in a community-dwelling older adults: The Korean Frailty and Aging Cohort Study (KFACS)

M. Yoo[a], S. Kim[a], B.S. Kim[a], J. Yoo[a], S. Lee[a], H.C. Jang[c], B.L. Cho[d], S.J. Son[e], J.H. Lee[f], Y.S. Park[g], E. Roh[h], H.J. Kim[i], S.G. Lee[j], B.J. Kim[k], M.J. Kim[l], C.W. Won[a,b,*]

[a] Department of Family Medicine, Kyung Hee University Medical Center, kyungheedaero 23, dongdaemun-gu, 02447, Seoul, Republic of Korea
[b] Elderly Frailty Research Center, Department of Family Medicine, Kyung Hee University College of Medicine, kyungheedaero 23, dongdaemun-gu, 02447, Seoul, Republic of Korea
[c] Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam, Republic of Korea
[d] Department of Family Medicine, Center for Health Promotion and Optimal Aging, Seoul National University College of Medicine & Hospital, Seoul, Republic of Korea
[e] Department of Psychiatry, Ajou University School of Medicine, Suwon, Republic of Korea
[f] Catholic institute of U-healthcare, The Catholic University of Korea, Republic of Korea
[g] Department of Family Medicine, Hallym University Chuncheon Sacred Heart Hospital, Chuncheon, Republic of Korea
[h] Division of Endocrinology and Metabolism, Department of Internal Medicine, Korea University, Seoul, Republic of Korea
[i] Department of Family Medicine, Jeju National University School of Medicine, Jeju, Republic of Korea
[j] Department of Physical & Rehabilitation Medicine, Chonnam National University Medical School, Gwangju, Republic of Korea
[k] Department of Psychiatry, College of Medicine, Gyeongsang National University, Jinju, Republic of Korea
[l] East-West Medical Research Institute, Kyung Hee University, Seoul, Republic of Korea

ARTICLE INFO

Keywords:
Hearing loss
Social frailty
Aged
Frailty
Korea

ABSTRACT

Objectives: To determine whether hearing loss is associated with social frailty in older adults.
Methods: Cross-sectional analysis of cohort study data. Hearing was measured using of Pure-tone audiometry. Hearing loss was determined based on the average of hearing thresholds at 0.5, 1, and 2 kHz in the ear that had better hearing. Social frailty was defined based on the summation of the following 5 social components (1. Neighborhood meeting attendance 2. Talking to friend(s) sometimes 3.Someone gives you love and affection 4. Living alone 5. Meeting someone every day). Participants who had no correspondence to the components were considered non-social frailty; those with 1–2 components were considered social prefrailty; and those having 3 or more components were considered social frailty.
Results: The prevalence of non-social frailty, social prefrailty, social frailty was 27.6%, 60.7% and 11.7% respectively. Of the five questions, two components (Neighborhood meeting attendance and Presence of someone who shows love and affection to the participants) were associated with hearing loss ($p < 0.001$). Compared to non-social frailty, the odds ratio of social frailty for hearing loss was 2.24 (95% CI 1.48–3.38) after adjusting for age, residential area, economic status, smoking, depressive disorder and MMSE, and 2.17 (95% CI 1.43–3.30) after further adjustments with physical frailty.
Conclusion: Hearing loss was associated with social frailty even after controlling confounding factors even including physical frailty.

1. Introduction

Frailty is a state of increased vulnerability with age due to decreased functional reserves in multiple body systems hence increasing falls, dependence, disability, and mortality. Physical frailty is widely defined, however, the concept of frailty is extending to include aspects of social and cognitive domains. Of these three aspects, social frailty ranks as the least explored concept, despite the social components of frailty being very important, considering that older adults must rely on their social network and social support. Social frailty as well as physical frailty is well known to increase the risk of mortality (Pronk et al., 2011). Various prospective study indicate that older adults with reduced social networks and supports are likely to suffer from functional decline, depression, and risk of dementia and cognitive decline (Bassuk, Glass, &

* Corresponding author at: Elderly Frailty Research Center, Department of Family Medicine, Kyung Hee University College of Medicine, Kyungheedaero 23, Dongdaemun-gu, Seoul, 02447, Republic of Korea.
E-mail address: chunwon62@naver.com (C.W. Won).

https://doi.org/10.1016/j.archger.2019.04.004
Received 7 March 2019; Received in revised form 4 April 2019; Accepted 7 April 2019
Available online 12 April 2019
0167-4943/

Berkman, 1999). Additionally, a longitudinal study showed that social frailty, consisting of living alone, lack of social contacts, and lack of social support, was associated with use of nursing care and the contact numbers of health care professionals (Gobbens, van Assen, Luijkx, & Schols, 2012).

Hearing loss, which is highly prevalent but over-looked in older people, increases the risk of physical frailty (Kamil et al., 2016). The prevalence of hearing loss is on the increasing due to the aging population and the rising use of personal listening devices (Agrawal, Platz, & Niparko, 2008). The number of individuals with impaired hearing from the year 1995–2004 more than doubled to 275 million in Japan (Horikawa et al., 2013). The World Health Organization (WHO) (Stevens et al., 2011) reported that about 328 million adults and approximately one-third of people over the age of 65 suffered from disabling hearing loss globally in 2012. Hearing loss has been associated with the decline of cognitive function, acceleration of cognitive decline (Bae et al., 2018), incident dementia, falls, and slower gait speed (Lin & Ferrucci, 2012; Lin et al., 2013; Lin et al., 2011). Meanwhile, other studies have suggested hearing loss effects on social isolation, loneliness, and depression (Gopinath et al., 2012; Weinstein, Ventry, & Research, 1982).

Despite of this concerns, few studies that have done to investigate the relationship between Hearing Loss (HL) based on audiometric test and social function (Mick, Kawachi, & Lin, 2014), while none has studied the association between HL based on audiometric test and social frailty (Hong et al., 2015).

The purpose of this study was to evaluate the relationship between hearing loss and social frailty in elderly. We hypothesized that participants with HL would be more likely to develop social frailty than those with normal hearing.

2. Methods

2.1. Participants

The subjects involved in the Korean Frailty and Aging Cohort Study (KFACS) were aged between 70–84 years old. The KFACS (Won et al., 2016) is a national, multi-center, cohort study initiated in 2016, which assisted in collection of 3014 community dwelling adults aged 70–84 years old for 2 years, after stratifying based on age and gender. It aims to identify social frailty risk factor and its preventive measures in community-dwelling older adults.

Older adults who did not have serious cognitive impairment, and who provided an informed consent with their own explicit judgement were included. Subjects were recruited from 10 participating medical centers (8 hospitals and 2 public health centers) and were interviewed individually underwent clinical tests. Collected baseline data included demographics, medical, behavioral, biological, psychosocial, and socioecological. Among the 1559 participants in the first year, the 1539 people who completed all questionnaires required for the social frailty and pure-tone audiometry (5,001,000 and 2000 Hz), were included in this study for analysis.

2.2. Measures

2.2.1. Definition of social frailty

To assess social frailty (SF) status, we used a questionnaire that included five components which were validated to predict disability (Makizako et al., 2015). The questionnaires involved the following questions: (1) “Do you attend neighborhood meetings, social gatherings such as senior citizens’ welfare centers, clubs, classes, etc.” (Yes: At least once a month, Sometimes, No: never) (Wenger & Tucker, 2002) (2) “Do you sometimes meet or talk to your friend(s)?” (Yes: Everyday, 2–3 times a week, At least once a week, At least once a month, No: Not once a month, No friends) (Gottlieb & Bergen, 2010) (3) “Is there someone available for you and who shows you love and affection?” (Yes: Some of the time, Most of the time, All of the time, No: None of the time, A little of the time) (Gottlieb & Bergen, 2010) (4) “Do you live alone?” (Yes: Live alone, No: Live with someone) (Makizako et al., 2015) (5) “Do you have any family, relatives or neighbors who meet or talk on the phone every day? (Yes : Every day, No : 2-3 times a week, At least once a week, At least once a month, Not once a month, No family, Relatives, or Neighbors) (Wenger & Tucker, 2002)

Answer of “yes” to the questions 4 and “no” to the questions 1,2,3,5 were considered as SF indicator. One point is given for the presence of the SF indicator, and the sum of each item is 5 points. Subjects with a total score of 3 or more were classified as socially frail, a total score of 1or 2 was classified as socially prefrail group, and subjects without any of the criteria were classified as non-social frailty.

2.2.2. Assessment of hearing loss

The pure-tone audiometry was performed in a booth using frequencies of 500, 1000, 2000 and 4000 Hz. Those who were using hearing aid were allowed to use them for pure-tone average assessment. A pure-tone average (average of hearing thresholds at 0.5,1 and 2 kHz) of greater than 40 dB for the better hearing ear (Baek et al., 2013) was used as our definition of hearing loss. (Association, 1997; Lee, Tong, Yuen, Tang, & Hasselt, 2010; Weiner, Ketzenberger, & Byrns, 2013) (normal hearing $\leq$ 25 dB, mild HL = 26–40 dB, moderate HL = 41–60 severe HL $>$ 60 : World Health Organization)

2.2.3. Covariates

The economic status was conducted on recipients of the National Basic Livelihood Security System and medical beneficial system. The medical history of participants was obtained from the checklist of morbidity. Depressive tendency was evaluated using the Korean version of Short-Form Geriatric Depression Rating Scale (SGDS-K) comprising of 15 questions. A score of eight and above was defined as severe depression as previously studied (Bae & Cho, 2004). The number of prescribed medications the participants has been taking for 3 months or more was defined as the number of medications. Arthritis included rheumatoid arthritis and osteoarthritis. Physical frailty was defined by the Fried frailty index (FFI) which involves five components (Fried et al., 2001).

2.3. Ethical approval

Our research plan was approved by the Institutional Review Board of the Kyung Hee University, and written consent was obtained from subject prior to commencement of the study (approved No. 2019-02-018)

2.4. Statistical analysis

The differences in characteristics based on social frailty category (non-social frailty, social pre frailty, and social frailty) were compared using analysis of variance for continuous data, and chi-square tests for categorical data. The association between hearing loss and social frailty was analyzed using multiple logistic regression analysis. Statistical analysis was performed using IBM SPSS Statistics Version 23.0 (Armonk, NY: IBM Corp.) and significance was defined as P value less than 0.05.

3. Results

3.1. General characteristics of the study population

The participants’ characteristics are shown in Table 1. Out of the 1539 participants who completed the baseline assessment, 425 (27.6%), 934 (60.7%), and 180 (11.7%) subjects were classified as non - social frail, social pre frail and social frail, respectively, based on the social frailty index.

Table 1
General characteristics of participants with non social frailty, social pre frailty and social frailty.

Characteristic	Non Social Frailty (n = 425)	Social Pre frailty (n = 934)	Social Frailty (n = 180)	Total (n = 1539)	P-value
Age, years (mean ± SD)	75.7 ± 4.0	76.4 ± 3.9	76.4 ± 3.9	76.2 ± 3.93	0.010
Male, n (%)	213 (50.1)	423 (45.3)	88 (47.0)	724 (47.0)	0.222
Education, years (mean ± SD)	8.0 ± 4.8	8.4 ± 7.9	7.6 ± 4.9	8.22 ± 6.8	0.237
Low economic status[a,*] n (%)	14 (3.3)	66 (7.1)	32 (17.8)	112 (7.3)	< 0.001
Living in city, n (%)	264 (62.1)	668 (71.5)	154 (85.6)	1086 (70.6)	< 0.001
Current smoker, n (%)	38 (8.9)	42 (4.5)	15 (8.3)	95 (6.2)	0.003
Hypertension, n (%)	230 (54.1)	556 (59.5)	109 (60.6)	895 (58.2)	0.136
Diabetes mellitus, n (%)	86 (20.2)	195 (20.9)	43 (23.9)	324 (21.1)	0.589
Arthritis[b,**] n (%)	108 (25.5)	279 (30.0)	53 (29.6)	440 (28.7)	0.233
Number of prescribed medicine, (mean ± SD)	3.4 ± 3.1	3.7 ± 3.0	3.9 ± 3.0	3.6 ± 3.0	0.203
Depressive disorder[c], n (%)	40 (9.4)	157 (16.8)	54 (30.0)	251 (16.3)	< 0.001
MMSE score[d] (mean ± SD)	25.74 ± 3.17	25.33 ± 3.45	25.07 ± 3.56	25.41 ± 3.39	0.058[d]
Gait speed	1.14 ± 0.26	1.11 ± 0.27	1.12 ± 0.27	1.12 ± 0.27	0.134
Hand Grip Strength	26.4 ± 7.74	25.4 ± 7.60	25.7 ± 7.59	25.7 ± 7.64	0.099
Physical Activity (mets)[*****]	61.08 ± 69.54	44.92 ± 64.49	40.75 ± 64.59	48.82 ± 66.30	0.000
Physical Activity (kcal)[*****]	3911.97 ± 4552.44	2782.73 ± 3876.95	2564.36 ± 4167.59	3063.70 ± 4135.72	0.000
Physical frailty,[***] n (%)	36 (9.1)	92 (10.3)	178 (15.2)	155 (10.6)	0.083
Use of hearing aids,[****] n(%)	15 (3.5)	29 (3.1)	8 (4.4)	52 (3.4)	0.649
Hearing loss, n (%)	36 (8.5)	99 (10.6)	43 (23.9)	178 (11.6)	< 0.001

[d]Kruskal-Wallis test.
Values are presented as mean ± SD or N (%).
Percentages are column percentages.
Normal-hearing PTA ≤ 40 dB in the better hearing ear, Hearing loss PTA > 40 dB on both ears. PTA, pure ton average.
[a] Recipients of the National Basic Livelihood Security System and Medical Beneficial System.
[b] Rheumatoid arthritis and osteoarthritis.
[c] SGDS-K ≥ 8 Significance Tests : One-way ANOVA for continuous variables, Pearson's chi square test for categorical variables.
* 7missing.
** 7missing.
*** 75missing.
**** 1missing.
***** 86 missing.

The median ages of the non-social frail, social pre frail, social frail was 75.7, 76.4, 76.4 respectively. Those social frail group were older, living in city and lower economic status compared with the non-social frail and social pre frail groups ($p < 0.05$). There was a higher prevalence of depression and lower cognitive function in the social frailty group. Social frail group did physical activities the least amount.

Additionally, the social frail group had higher proportion of hearing complications compared to those in the non-social frail and social prefrail groups. However, there was no statistically significant difference among the social frail group, social prefrail group and non-frail group for hypertension, diabetes mellitus, arthritis and the number of prescribed medications. Similarly, physical frailty was not significantly related to the social frail group.

3.2. Hearing loss and each item of social frailty

Table 2 displays the proportion of hearing loss according to each item of social frailty index. Of the 5 items, ti was only item 1 and 3 that showed a statistically significant difference between normal and impaired hearing groups ($p < 0.001$). However, the average of social frail index was higher in the hearing-loss group (average value : 1.17 vs 1.55).

3.3. Multivariate analysis

Multiple logistic regression models were used to analyze associations between social frailty and hearing loss (Table 3). In model 1, which was unadjusted, participants with hearing loss had an increased risk of social frailty incidence in comparison with non-social frail and social prefrail participants (OR:2.85; 95% CI: 1.94–4.19). In model 2, this association was attenuated after adjusting for age, site of residence, economic status, smoking, depressive symptoms, MMSE (OR:2.24; 95% CI: 1.48–3.38). However, after adjusting for physical frailty and physical activity amount, the odds ratio of hearing loss for social frailty remained (OR: 2.18; 95% CI: 1.43–3.31).

4. Discussion

This study investigated the association between hearing loss and social frailty in older adults. The results show that older adults with moderate-to-severe hearing loss, as measured by an objective audiometric test, had 2.13 increased risk of being socially frail compared to individuals normal hearing.

We established that hearing loss is associated with lower frequency of social meeting attendance and increased feeling of unhelpfulness from family or friends, which indicate social isolation. Persons who have insufficient social network or relationships could be considered as isolated. Social isolation has been shown to be a risk factor of mortality, cognitive and functional decline in older adults. Previous research have implicated hearing loss in the development of social isolation (Pronk et al., 2011, Chia et al., 2007). Hearing loss is shown to have a negative impacts on the use of community and informal supports (Schneider et al., 2010), and on activities of daily living of people with disability (Gopinath et al., 2011).

We found that social frailty group presented more depressive and lower cognitive function. Social frailty, more than that physical frailty, is known to be strongly associated with incidences of depressive symptoms among elderly (Tsutsumimoto et al., 2017). Social frailty and hearing problems were independently associated with multiple-domain MCI (Bae et al., 2018). However, when we adjusted with the depressive disorder and MMSE for logistic regression, the odds ratio of hearing loss for social frailty remained statistically significant.

Table 2
Hearing loss and each item of social frailty.

	Normal Hearing n = 1361	Hearing loss n = 178	P*
1. Attend local / neighborhood meetings, social gatherings such as senior citizens' associations (welfare centers), clubs, classes,etc.? (No)	345 (25.3)	71 (39.9)	< 0.001
2. Meet or call to friend(s) sometimes (No)	177 (13.0)	26 (14.6)	0.556
3. Someone available to you who shows you love and affection (No)	220 (16.2)	50 (28.1)	< 0.001
4. Living alone (Yes)	336 (24.7)	53 (29.8)	0.143
5. See or talk with your family, relatives, and neighbors every day (No)	516 (37.9)	76 (42.7)	0.220
Social frailty score*	1.17 ± 1.04	1.55 ± 1.19	< 0.001

Values are presented as n (%).
Percentages are column percentages.
Normal-hearing PTA ≤ 40 dB in the better hearing ear, Hearing loss PTA > 40 dB on both ears. PTA, pure ton average.
Significance Tests : Pearson's chi square test.
* Social frailty score : The sum of social frailty score is 5 points. This column shows the average of social frailty scores in normal hearing group and hearing loss group.

Table 3
Multivariate logistic regression results showing associations between hearing loss and social frailty.

	OR	95% CI	p
Model 1	2.846	1.935 – 4.186	< 0.001
Model 2	2.239	1.481 – 3.384	< 0.001
Model 3	2.178	1.434 – 3.306	< 0.001

OR, Odds ratio; CI, confidence interval.
Significance set at p < 0.05.
Model 1: unadjusted.
Model 2: adjusted for age, living in city, economic status, smoking, depressive disorder, MMSE.
Model 3: adjusted for age, living in city, economic status, smoking, depressive disorder, MMSE, physical frailty, Physical Activity(kcal) per week.

Also, older adults with reduced social networks and support are in danger of increased risk of dementia while the risk of Alzheimer disease was more than doubled in lonely persons (Bassuk et al., 1999). Hearing loss itself has been shown to be predictive of dementia, and it is possible that social isolation is an intermediate mediator in the pathway to dementia (Schneider et al., 2010).

A conceptual diagram to show the relation of hearing loss, social frialty, physical frailty, and cognitive impairment are illustrated in Fig. 1.

The strength of this study lies in the comparatively large sample size of 1539 participants, therefore, it can represent community-dwelling elderly aged between 70 and 84 in Korea. In this study, prevalence of social frailty was 11.7%. It compares favorably to the results of other studies (social frailty, 10.2% in Japan (Makizako et al., 2015), 11.1% in Japan (Tsutsumimoto et al., 2017)). Secondly, hearing status was based on the pure tone audiometry, which is an objective method of measurement to evaluate hearing loss in primary care and outpatient settings. To our knowledge, this study is the first one to report an association between objective hearing loss and social frailty. We used a stringent definition of hearing loss of more than 40 dB, a level generally considered able to benefit from hearing aid use. (Lee et al., 2010) The results of this paper suggest that optimal hearing health could help maintain social participation and reduce the risk of social frailty.

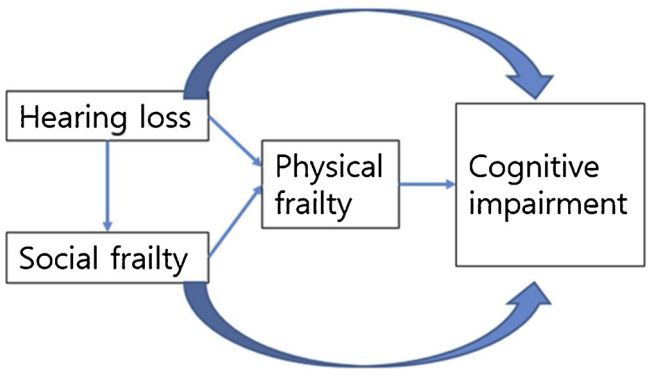

Fig. 1. conceptual diagram to show the relation of hearing loss, social frailty, physical frailty, and cognitive impairment.

However, the current study had several limitations. First, this study was cross-sectional stud, and we were unable to identify whether there was a causal relationship between hearing problem and social frailty. Future studies investigation the relationship between hearing loss and social frailty using prospective longitudinal data would be helpful. Secondly, since this study is a multi-center study, pure-tone audiometry was not performed by an audiologist. However, those who manipulated the audiometry were nurses or medical laboratory technician who had been educated on the use of audiometry.

Thirdly, Yamada and Arai suggested a Social frailty scales based on Bunt's 'Social Production Function theory' (Bunt, Steverink, Olthof, van der Schans, & Hobbelen, 2017), which consists of general resources (financial difficulties), social resources (living alone), social behavior (lack of social activity), and fulfillment of basic social needs (influential contact with neighbors). The authors also considered adding low economic income into the social frailty questionnaire, but due to high missing answer for that, we ended up forgiving it up.

Finally, the 5 questions used in this research were adopted from Makizako's suggestion for social frailty, but have not been validated as a questionnaire to diagnose social frailty in Korea. However, two of the 5 questions, "someone available to show you love and affection?" and "any family, relatives or neighbors who meet or talk" had need validated in Korea for social support assessment (Jeon, Jang, & Park, 2012). There have been no validation study for 3 other questions and these should be limitations to this study.

In conclusion, hearing loss was associated with increased odds of social frailty in univariate analysis and multivariate analysis after adjusting for demographic, socioeconomic and medical factors.

Authors contributions

1 Conceptualization: CW. Won, S. Kim
2 Data curation: 10 participating medical centers (8 hospitals and 2 public health centers), S. Kim, M. Yoo
3 Formal analysis: M. Yoo, S. Kim
4 Funding acquisition: CW. Won
5 Investigation: all
6 Methodology: CW. Won, S. Kim, M. Yoo
7 Writing:

Original; M. Yoo
Review & Edit: CW. Won, S. Kim, M. Yoo

Funding

This research was supported by a grant by the Korea Health Technology R&D Project through the Korean Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number: H15C3153).

Conflict of interest

The authors declare no conflicts of interest in relation to this study.

Acknowledgements

We would like to thank all of the participants who took part in this study and the staff of the KFACS office who assisted with the recruitment of participants.

References

Agrawal, Y., Platz, E. A., & Niparko, J. K. (2008). Prevalence of hearing loss and differences by demographic characteristics among US adults: Data from the National Health and Nutrition Examination Survey, 1999-2004. *Archives of Internal Medicine, 168*(14), 1522–1530.

Association, A. S.-L.-H. (1997). *American Speech-Language-Hearing Association.* The Association.

Bae, J. N., & Cho, M. J. (2004). Development of the Korean version of the Geriatric Depression Scale and its short form among elderly psychiatric patients. *Journal of Psychosomatic Research, 57*(3), 297–305.

Bae, S., Sangyoon, L., Sungchul, L., Songee, J., Keitaro, M., Hyuntae, P., et al. (2018). *The role of social frailty in explaining the association between hearing problems and mild cognitive impairment in older adults*.

Baek, H. J., Shim, H.-Y., & Kim, J. J. A. (2013). *An Analysis of Characteristics for Word Recognition Scores in Geriatric Hearing Loss . 9*(1), 49–59.

Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine, 131*(3), 165–173.

Bunt, S., Steverink, N., Olthof, J., van der Schans, C. P., & Hobbelen, J. S. M. (2017). Social frailty in older adults: A scoping review. *European Journal of Ageing, 14*(3), 323–334.

Chia, E.-M., Wang, J. J., Rochtchina, E., Cumming, R. R., Newall, P., & Mitchell, P. (2007). Hearing impairment and health-related quality of life: The Blue Mountains Hearing Study. *Ear and Hearing, 28*(2), 187–195.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., et al. (2001). Frailty in older adults: Evidence for a phenotype. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 56*(3), M146–M157.

Gobbens, R. J., van Assen, M. A., Luijkx, K. G., & Schols, J. M. (2012). The predictive validity of the Tilburg Frailty Indicator: Disability, health care utilization, and quality of life in a population at risk. *Gerontologist, 52*(5), 619–631.

Gopinath, B., Hickson, L., Schneider, J., McMahon, C. M., Burlutsky, G., Leeder, S. R., et al. (2012). Hearing-impaired adults are at increased risk of experiencing emotional distress and social engagement restrictions five years later. *Age and Ageing, 41*(5), 618–623.

Gopinath, B., Schneider, J., McMahon, C. M., Teber, E., Leeder, S. R., & Mitchell, P. (2011). Severity of age-related hearing loss is associated with impaired activities of daily living. *Age and Ageing, 41*(2), 195–200.

Gottlieb, B. H., & Bergen, A. E. (2010). Social support concepts and measures. *Journal of Psychosomatic Research, 69*(5), 511–520.

Hong, J. W., Jeon, J. H., Ku, C. R., Noh, J. H., Yoo, H. J., & Kim, D.-J. J. M. (2015). The prevalence and factors associated with hearing impairment in the Korean adults: The 2010–2012 Korea National Health and Nutrition Examination Survey (observational study). *Medicine, 94*(10).

Horikawa, C., Kodama, S., Tanaka, S., Fujihara, K., Hirasawa, R., Yachi, Y., et al. (2013). Diabetes and risk of hearing impairment in adults: A meta-analysis. *The Journal of Clinical Endocrinology and Metabolism, 98*(1), 51–58.

Jeon, G.-S., Jang, S.-N., & Park, S.-J. (2012). Social support, social network, and frailty in Korean elderly. *Annals of Geriatric Medicine and Research, 16*(2), 84–94.

Kamil, R. J., Betz, J., Powers, B. B., Pratt, S., Kritchevsky, S., Ayonayon, H. N., Harris, T. B., Helzner, E., Deal, J. A., Martin, K., Peterson, M., Satterfield, S., Simonsick, E. M., Lin, F. R., & Health A. B. C. study (2016). Association of hearing impairment with incident frailty and falls in older adults. *Journal of Aging and Health, 28*(4), 644–660.

Lee, A. T., Tong, M. C., Yuen, K. C., Tang, P. S., & Hasselt, C. A. (2010). Hearing impairment and depressive symptoms in an older Chinese population. *Journal of Otolaryngology - Head & Neck Surgery, 39*(5).

Lin, F. R., & Ferrucci, L. (2012). Hearing loss and falls among older adults in the United States. *Archives of Internal Medicine, 172*(4), 369–371.

Lin, F. R., Metter, E. J., O'brien, R. J., Resnick, S. M., Zonderman, A. B., & Ferrucci, L. (2011). Hearing loss and incident dementia. *Archives of Neurology, 68*(2), 214–220.

Lin, F. R., Yaffe, K., Xia, J., Xue, Q.-L., Harris, T. B., Purchase-Helzner, E., Satterfield, S., Ayonayon, H. N., Ferrucci, L., & Simonsick, E. M. (2013). Hearing loss and cognitive decline in older adults. *JAMA Internal Medicine, 173*(4), 293–299.

Makizako, H., Shimada, H., Tsutsumimoto, K., Lee, S., Doi, T., Nakakubo, S., Hotta, R., & Suzuki, T. (2015). Social frailty in community-dwelling older adults as a risk factor for disability. *Journal of the American Medical Directors Association, 16*(11), e1007–e1011.

Mick, P., Kawachi, I., & Lin, F. R. (2014). The Association between Hearing Loss and Social Isolation in Older Adults. *Otolaryngology–head and Neck Surgery: Official Journal of American Academy of Otolaryngology-Head and Neck Surgery, 150*(3), 378–384.

Pronk, M., Deeg, D. J., Smits, C., van Tilburg, T. G., Kuik, D. J., Festen, J. M., et al. (2011). Prospective effects of hearing status on loneliness and depression in older persons: Identification of subgroups. *International Journal of Audiology, 50*(12), 887–896.

Schneider, J., Gopinath, B., Karpa, M. J., McMahon, C. M., Rochtchina, E., Leeder, S. R., et al. (2010). Hearing loss impacts on the use of community and informal supports. *Age and Ageing, 39*(4), 458–464.

Stevens, G., Flaxman, S., Brunskill, E., Mascarenhas, M., Mathers, C. D., & Finucane, M. (2011). Global and regional hearing impairment prevalence: An analysis of 42 studies in 29 countries. *European Journal of Public Health, 23*(1), 146–152.

Tsutsumimoto, K., Doi, T., Makizako, H., Hotta, R., Nakakubo, S., Makino, K., Suzuki, T., & Shimada, H. (2017). Association of social frailty with both cognitive and physical deficits among older people. *Journal of the American Medical Directors Association, 18*(7), 603–607.

Weiner, F. F., Ketzenberger, K. E., & Byrns, G. J. (2013). *American Speech-Language-Hearing Association*.

Weinstein, B. E., Ventry, I. M., & Research, H. (1982). Hearing impairment and social isolation in the elderly. *Journal of Speech and Hearing Research, 25*(4), 593–599.

Wenger, G. C., & Tucker, I. J. H. (2002). Using network variation in practice: Identification of support network type. *Health & Social Care in the Community, 10*(1), 28–35.

Won, C. W., Lee, Y., Choi, J., Kim, K. W., Park, Y., Park, H., et al. (2016). Starting construction of frailty cohort for elderly and intervention study. *Annals of Geriatric Medicine and Research, 20*(3), 114–117.