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Hearing impairment, social support, and depressive symptoms among U.S. adults: A test of the stress process paradigm

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ABSTRACT

Hearing impairment is a growing physical disability affecting older adults and is an important physical health stressor, but few studies have examined it in relation to mental health outcomes and even fewer have considered the role of social support in buffering this relationship. The current study builds on the stress process framework and uses longitudinal data from three waves of the Health and Retirement Study (2006, 2010, 2014) to examine the relationship between hearing impairment and depressive symptoms among U.S. adults aged 50 and older (n = 6075). The analysis uses fixed-effects models to assess this relationship and examine the extent to which social support mediates (buffers) or moderates (interaction) the association. The results found that worse self-rated hearing was associated with a significant increase in depressive symptoms, even after controlling for sociodemographic factors. Social support did not buffer this relationship. Instead, social support interacted with hearing impairment: low levels of social support were associated with more depressive symptoms but only among people with poor self-rated hearing. Among those with excellent self-rated hearing, low levels of social support did not increase depressive symptoms. Moreover, high levels of social support reduced depressive symptoms for those with poor hearing. These findings suggest that hearing impairment is a chronic stressor in individuals' lives, and that responses to this stressor vary by the availability of social resources.

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1. Introduction

Over two decades ago, Verbrugge and Jette (1994) posited that both physical and mental well-being are involved in health decline as individuals age. Since then, research has increasingly noted the importance of jointly assessing mental health and physical health because examining them separately creates an artificial boundary between the two (Kelley-Moore and Ferraro, 2005; Pearlin et al., 2007; Read et al., 2016). Numerous studies have shown that having a physical health condition (e.g. cancer, heart disease, or arthritis) can lead to poorer mental health outcomes (e.g. depression) (Polsky et al., 2005) because it is challenging to individuals' sense of identity and is therefore psychologically stressful (Charmaz, 1983).

A growing, but understudied, physical ailment affecting population health is hearing impairment. It is the third most common chronic condition in older individuals behind hypertension and arthritis (Lin et al., 2011) and is predicted to have a prevalence rate twice that of diabetes by 2025, in part due to an aging population (Cederroth et al., 2013). Recent research projects that 15% of adults aged 20 or older will have a hearing impairment in 2020, with that number climbing to 23% in 2060 (Goman et al., 2017). Moreover, individuals aged 70 or older are expected to be disproportionately affected, which is concerning given that this is a vulnerable population whose size will continue to increase as baby boomers age (Goman et al., 2017).

To date, studies assessing the relationship between hearing impairment and mental health are limited, and those that exist yield mixed results. A comprehensive review of existing research found that most longitudinal studies were based in an international context (e.g. Australia, The Netherlands, Japan, and England) and the two based in the U.S. used the Alameda County Study (Strawbridge et al., 2000; Wallhagen et al., 2001). Of the longitudinal studies, some find that hearing loss results in higher levels of depressive symptoms (Kiely et al., 2013; Saito et al., 2010; Strawbridge et al., 2000; Wallhagen et al., 2001), while others find little or no association between the two (Chou, 2008; Pronk et al. 2011, 2014; Stam et al. 2016). Cross-sectional studies generally find a significant association between hearing impairment and

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more depressive symptoms (Capella-McDonnall, 2005; Kramer et al., 2002), while some report that the association depends on factors such as age, with younger people experiencing more depressive symptoms than older people (Nachtegaal et al. 2009; Tambs, 2004).

At least three factors may be contributing to these mixed results. First, the use of different depression indices could produce conflicting findings because the measures included in the Diagnostic and Statistical Manual of Mental Disorders scale differ from those in the Center for Epidemiologic Studies Depression Scale. Studies using the former scale find a significant association between hearing loss and depression (Strawbridge et al., 2000; Wallhagen et al., 2001), while those using the latter are more mixed (Chou, 2008; Kiely et al., 2013; Pronk et al. 2011, 2014). Second, there are varying follow-up times in longitudinal studies that could affect the ability to find significant results because the impact of hearing loss on depression may be immediate or may take time to emerge (e.g. Kiely et al., 2013; Pronk et al., 2011; Saito et al., 2010). Third, some studies have small sample sizes (Pronk et al., 2011; Stam et al. 2016) that could result in non-significant findings, particularly when multiple covariates are included in the analyses.

In addition to these mixed findings, extant literature has yet to consider the role of social support in conditioning the relationship between hearing impairment and depressive symptoms. The stress process paradigm posits that social support can alter the relationship between a stressor and depressive symptoms by preventing an individual from perceiving a potential stressor as stressful or by reducing the severity of a reaction to an actual stressor (Cohen and Wills, 1985). Physical health problems are highly stressful for individuals and there is considerable evidence that social support is an important resource that helps them cope more effectively by encouraging engagement in positive health behaviors and reducing reactions to stress (Hollingshaus and Utz, 2013; Milner et al., 2016; Stanton et al., 2007; Waverijn et al., 2017). Hearing impairment is a physical disability that impacts functioning across all domains of daily life (Dalton et al., 2003), yet few studies have treated hearing impairment as a stressor in the stress process model formulation. Thus, the extent to which hearing impairment interacts with other factors, such as social support, to affect mental health remains unexplored (Stam et al. 2016).

The current study contributes to this literature and a growing body of work on the physical-mental health connection in several ways. First, it conceptualizes hearing impairment as a physical health stressor and examines its relationship to depressive symptoms. Second, it builds on the stress process paradigm to explore two ways in which social support could influence the association between hearing impairment and depressive symptoms: by buffering or mediating the original relationship or by interacting with hearing impairment to influence depression at different levels of social support (e.g. low and high levels). Third, it employs longitudinal data from three waves of the Health and Retirement Study (HRS) (2006, 2010, and 2014) to overcome some of the obstacles that have contributed to mixed findings in previous studies. The HRS is nationally representative, spans nine years, and contains large samples that provide sufficient power to apply the stress process paradigm to hearing impairment.

2. Background

2.1. Stress, social support, and health

Stress process researchers distinguish between two types of stressors. First, *life events* are discrete changes in individuals' lives that have negative health consequences. Oft-cited examples include accidents, loss of employment, or widowhood. Second, *chronic strains* are ongoing, long-term difficulties that negatively affect well-being, like living in poverty or having a chronic illness (Pearlin, 1989). Both types of stressors can be sources of *stress proliferation*, a perspective within the stress process paradigm positing that stressors associated with one situation (e.g. chronic illness) may lead to the emergence and accumulation of stressors in other life domains (e.g. financial strain due to the inability to find work) (Pearlin, 1989; Pearlin et al., 1997).

Physical illness has been classified as a chronic strain because it requires the long-lasting management of social and instrumental activities (Pearlin, 1999). Being diagnosed with a physical illness often necessitates adjustments that occur over time and across emotional, behavioral, and other life domains (Stanton et al., 2007). Charmaz (1983) describes physical illness as a form of suffering that can challenge an individual's identity and personal relationships and cause a loss of self-image, rendering it psychologically stressful. Other research supports this idea, finding that physical health conditions such as cancer, heart disease, and arthritis lead to an increase in depressive symptoms among adults (Polsky et al., 2005; Schnittker, 2005). Research has also applied the stress process model to broad definitions of physical disability and finds that having a physical disability is associated with symptoms of psychological distress, including anger, depression, and anxiety (Alang et al., 2014; Brown and Turner 2012; Muramatsu et al., 2010).

Leading explanations for these relationships have focused on theories of stress and coping to understand how individuals adjust to physical illness and disability (Aneshensel, 1992; Stanton et al., 2007). One important theory of stress and coping is the stress-buffering model which is grounded in the stress process paradigm. This paradigm recognizes that the stressors that individuals experience and the resources available to them can alter the health consequences of stressors (Pearlin, 1989; Pearlin et al., 1981; Turner, 2013). Social support is one such resource and the stress-buffering models specifies at least two ways that this alteration may occur. First, higher levels of social support can be protective by buffering (mediating) the effect of the stressor on mental health (Cohen and Wills, 1985). In this scenario, individuals with high levels of social support may be protected against negative mental health outcomes when exposed to stress. For example, social support buffers the effects of stress for parents of pediatric cancer patients because it provides them with more coping options and helps them balance competing demands between work and caregiving (Gage-Bouchard, 2017).

Second, the stress-buffering model posits that social support can be protective by interacting with (moderating) the stressor itself. In this scenario, social support has a stronger protective effect on depressive symptoms under conditions of high stress compared to conditions of low stress (Cohen and Wills, 1985). For example, one study found higher levels of depression among students with low social support compared to those with high social support, but only under conditions of high stress not under conditions of low stress (Wang et al., 2014).

To date, few studies have conceptualized hearing impairment as a stressor linked to health outcomes. Put in terms of the stress process model, hearing impairment is a stressor that gives rise to the accumulation of additional stressors in the form of stigma, discrimination, social and emotional loneliness, and social withdrawal (Erler and Garstecki, 2002; McGee, 2015; Mick et al., 2014; Pronk et al., 2013). Under the stress-buffering model, social support could provide the coping resources necessary to mediate the association between hearing impairment and depressive symptoms. Additionally, if social support interacts with hearing impairment (moderation), individuals with hearing impairment who have higher levels of social support will be protected against an increase in depressive symptoms. The current study fills this gap in the

literature by applying the stress process model to the relationship between hearing impairment, social support, and depressive symptoms. Fig. 1 provides a diagram of how hearing impairment fits into the stress process paradigm (adapted from Turner, 2013).

2.2. Evidence on hearing impairment and mental health

One way in which hearing impairment behaves as a stressor is through its effect on mental health outcomes. Depression is typically the most common outcome of interest, usually measured by self-reported depressive symptoms using the Center for Epidemiologic Studies Depression Scale, and to a lesser extent with the Diagnostic and Statistical Manual of Mental Disorders to assess major or clinical depression (Kiely et al., 2013; Pronk et al. 2011, 2014; Strawbridge et al., 2000; Wallhagen et al., 2001). Findings from these studies have been mixed.

In some cross-sectional studies, researchers find a significant association between hearing impairment and depressive symptoms (Capella-McDonnall, 2005; Ishine et al., 2007; Kramer et al., 2002). More recently, a nationally representative survey revealed that 11.4% of U.S. adults with a self-reported hearing loss reported moderate to severe depression, with an additional 19.1% reporting mild depressive symptoms (Li et al. 2014). However, other cross-sectional research reports that whether hearing impairment is associated with depression may depend on the ages of participants (younger age is associated with higher levels of depressive symptoms) (Nieman et al., 2016; Tambs, 2004) and how hearing impairment is measured (audiometrically measured hearing impairment is associated with depressive symptoms) (Lee et al., 2010).

Studies using longitudinal data also yield mixed results. Three factors may be contributing to these mixed results. First, the use of different depression indices results in conflicting findings. Measuring depressive symptoms using the scale from the Diagnostic and Statistical Manual of Mental Disorders yields a significant association with hearing (Strawbridge et al., 2000; Wallhagen et al., 2001). Alternatively, using the Center for Epidemiologic Studies Depression Scale sometimes yields a significant association (Kiely et al., 2013) but sometimes does not (Chou, 2008; Pronk et al. 2011, 2014).

Second, varying follow-up times may affect the ability to find significant findings. With short follow-up periods (between one and three years), studies predominantly find an association between hearing and depressive symptoms (Saito et al., 2010; Strawbridge et al., 2000; Wallhagen et al., 2001), but Chou (2008) reports no association. Studies with medium length follow-up periods (up to six years) tend not to find an association (Pronk et al. 2011, 2014; Stam et al. 2016), but Gopinath et al. (2012) report a significant relationship. With the longest follow-up period of sixteen years, Kiely et al. (2013) report a significant association between hearing and depressive symptoms.

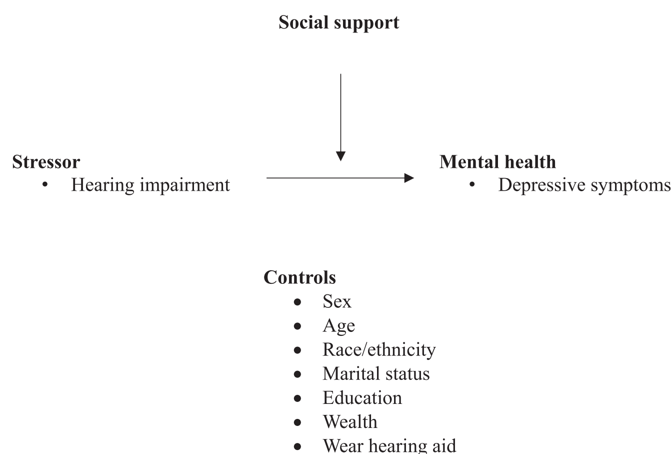

Fig. 1. The stress process framework with Health and Retirement Study variables.

Third, small sample sizes can contribute to non-significant findings, particularly when multiple covariates are included in the analyses. Studies with less than one thousand participants tend to find no association between hearing and depressive symptoms (Pronk et al., 2011; Stam et al. 2016), while studies with over two thousand participants tend to find an association (Gopinath et al., 2012; Strawbridge et al., 2000; Wallhagen et al., 2001). Finally, a comprehensive review of existing literature found that most of the longitudinal studies assessing the relationship between hearing impairment and depressive symptoms were based in an international context, namely Australia, the Netherlands, Japan, or England. The two studies that were based in the U.S. both used the Alameda County Study (Strawbridge et al., 2000; Wallhagen et al., 2001).

2.3. Current study

The current study aims to contribute to existing research by addressing some of the limitations in previous studies on the relationship between hearing impairment and mental health. Drawing on the stress process framework, the analysis conceptualizes hearing impairment as a physical health stressor and examines its relationship to an important mental health outcome (depression). Then the analysis examines the extent to which social support effects this relationship, thereby answering a recent call for studies to include mediators and moderators, such as social support, in longitudinal analyses of the hearing impairment and mental health relationship (Stam et al. 2016). Specifically, a large, longitudinal sample is used to address the following questions: 1) to what extent does hearing impairment lead to increased levels of depressive symptoms?; 2) to what extent does social support mediate this relationship?; and 3) to what extent does social support interact with hearing impairment to influence its relationship to depressive symptoms?

3. Data and methods

3.1. Data

This study uses data from the Health and Retirement Study (HRS) to address these questions. The HRS is a longitudinal, nationally representative survey of U.S. adults over the age of 50 and their spouses that has been conducted every two years since 1992. The original core sample design of the HRS is a multi-stage area probability sample of households. The HRS monitors changes in cognitive, physical, and functional health that are associated with aging. The core survey, which is asked of every participant in each survey wave, includes questions about employment, retirement, income, wealth, family structure, health, and health care utilization.

The HRS supplements the core survey with separate modules. In 2006, the HRS included a module on life satisfaction and psychological well-being called the Leave-Behind Participant Life Style Questionnaire (Smith et al., 2013). Of the participants who completed a face-to-face core survey in 2006, a randomly selected half was given the leave-behind survey. In 2008, another randomly selected half was given the leave-behind survey. Participants were eligible for the leave-behind survey in every other wave, meaning that participants eligible in 2008 were eligible again in 2012, while participants eligible in 2006 were eligible again in 2010 and 2014.

The core HRS is comprised of 37,495 individuals. The analytic sample for this study is restricted to individuals who were assigned the leave-behind survey beginning in 2006 (n = 18,469). For a longitudinal analysis, the sample is further restricted to individuals who completed the leave-behind survey in 2006, 2010, and 2014. In 2006, 8565 people were eligible for the leave-behind survey (response rate of 88.15%), 7684 in 2010 (response rate of 81.05%), and 6296 in 2014 (response rate of 83.23%). Individuals who were not eligible for the leave-behind survey were removed (eligible n = 8565), as were individuals who did not return the survey, resulting in a sample of 6311 participants. Finally, individuals were excluded if they were under the age of 50, had died, or failed to respond to the items comprising the outcome variable (depressive symptoms), resulting in a final sample of 6075 individuals.

3.2. Depressive symptoms

The main outcome variable is depressive symptomology based on a summed score of responses to eight questions that are a modification of the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). Items in the scale ask about feeling depressed, feeling that everything was an effort, having restless sleep, feeling lonely, feeling sad, not being able to get going, feeling happy, and enjoying life. Participants reported whether the eight statements were true much of the time during the past week (yes; no). Summed scores range from zero to eight, with higher scores indicating more depressive symptoms. The shortened CES-D scale shows good internal consistency (α range from 0.77 to 0.83) (Steffick, 2000).

3.3. Hearing impairment

Assessing hearing impairment in community-based settings is complicated, as it is most often diagnosed with the use of auditory tests. Such tests require expensive equipment, trained technicians, and strict controls on background noise (Bagai et al., 2006). Instead, the core HRS survey asks every participant to report self-rated hearing (excellent, very good, good, fair, or poor) in each wave. If participants wear a hearing aid, they are asked to rate their hearing while wearing a hearing aid as usual. Prior research comparing self-reported hearing to objective measurements has found a high correlation between the two (Sindhusake et al., 2001).

3.4. Social support

The social support scale assesses participants' perceptions of the social support available from their family, friends, spouse or partner, and children (Cohen, 2004). The scale is comprised of three questions asked about each of the four types of significant other for a total of twelve items (response scale from a lot, some, a little, to not at all). Specifically, participants are asked how often they can open up to each type of significant other (four items), how often they can rely on those significant others (four items), and how much those significant others understand the way the participants feel about things (four items) (α in all three waves is 0.77). Higher scores indicate higher levels of social support. The variable is included in statistical models in continuous form, but presented in the descriptive table in three categories (low, medium, and high social support).

3.5. Control variables

Prior research has identified several social status characteristics that are associated with mental health and stress exposure, and these are included in the analysis as controls (Aneshensel et al., 2013; Lee and Bierman, 2016). These include gender (male; female), age (continuous), race/ethnicity (non-Hispanic white; non-Hispanic black; non-Hispanic other race; Hispanic), marital status (married or partnered; separated, widowed, or divorced; never married), and two measures of socioeconomic status (SES). Educational attainment is coded as less than high school; high school or equivalent; some college; or college and above. Because income is a less useful measure of SES in late life due to exiting the labor force (Marmot, 2015), wealth (logged continuous variable) measures total household assets while subtracting out debt (Bugliari et al., 2016). Finally, since hearing aid use can reduce the odds of depressive symptoms (Mener et al., 2013), the analysis includes a dichotomous measure in the models (1 = use hearing aids).

3.6. Analysis

Table 1 presents descriptive statistics for the sample by interview wave. Table 2 uses fixed effects models to estimate the association between hearing impairment and depressive symptoms within individuals over time. A fixed effects model is a longitudinal model that treats unobserved, time-invariant variables that differ across individuals as a set of fixed parameters that can be swept out of the equation (Allison, 2009). The model controls for variables that either cannot or have not been measured and allows those variables to have an association of any kind with the measured variables. Thus, the model captures only within-individual differences (i.e. change), which makes it less subject to unobserved confounding than other models while simultaneously reducing its efficiency. The main requirements of a fixed effects model are that the dependent variable is measured on at least two time points for every individual and that the predictor variables change in value across those time points for a large set of the sample (Allison, 2009).

The basic fixed effects model can be expressed as follows:

Table 1
Sample characteristics, by interview wave.

	Wave 1	Wave 2	Wave 3
	n = 6075	n = 5041	n = 4226
CES-D	1.34	1.29	1.24
Self-rated hearing			
Excellent	15.24%	15.49%	15.89%
Very good	25.83%	26.36%	27.16%
Good	35.80%	35.81%	35.63%
Fair	17.06%	16.47%	15.96%
Poor	6.06%	5.87%	5.36%
Social support (mean)	14.26	14.22	14.19
Low social support	5.70%	5.80%	5.95%
Medium social support	89.15%	89.21%	89.22%
High social support	5.14%	4.99%	4.83%
Wear hearing aid	13.33%	13.17%	12.05%
Marital status			
Married/partnered	64.65%	65.30%	65.98%
Separated/divorced/widowed	32.51%	31.90%	31.19%
Never married	2.84%	2.80%	2.83%
Female	59.14%	59.49%	60.57%
Age	70.87	70.54	69.94
Race/ethnicity			
NH white	79.27%	79.52%	79.32%
NH black	12.01%	11.81%	11.80%
NH other	1.91%	1.97%	2.03%
Hispanic	6.81%	6.70%	6.84%
Education			
<high school	16.81%	15.59%	14.86%
High school/GED	37.94%	38.00%	37.81%
Some college	22.60%	23.06%	23.14%
College or more	22.65%	23.34%	24.20%
Wealth (median)	$216,598.00	$224,000.00	$233,000.00

Table 2
Fixed effects regression coefficients for depressive symptoms.

	Model 1		Model 2		Model 3		Model 4	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Worse self-rated hearing	0.063**	0.018	0.054**	0.019	0.054**	0.018	0.282***	0.062
Controls								
Age			−0.001	0.003	−0.001	0.003	−0.001	0.003
Marital status (reference: married)								
Divorced/widowed			0.545***	0.055	0.518***	0.056	0.515***	0.055
Never married			−0.013	0.220	−0.053	0.221	−0.063	0.220
Log of wealth			−0.001	0.009	−0.001	0.009	−0.001	0.009
Use hearing aids			0.111	0.072	0.111	0.072	0.117	0.072
Social support					0.014**	0.005	0.058***	0.012
Interaction								
Social support*hearing							−0.016***	0.004
Constant	1.17***	0.051	1.07***	0.256	0.901**	0.264	0.280	0.310

*p < 0.05, **p < 0.01, ***p < 0.001.
Note: Sex, race, & education not included because they are time-invariant.
SE = standard error.

$$y_{it} = \mu_i + \beta hearing_{it} + \gamma x_{it} + \alpha_t + \varepsilon_{it}$$

where y_{it} is the number of depressive symptoms for an individual *i* at time *t*, and x_{it} is the vector of control variables. The parameter βhearing represents the effect of the focal analysis measure (self-rated hearing), or the change in self-rated hearing from 2006 to 2014. The μ_i term accounts for both observed and unobserved stable traits between individuals while the α_t term accounts for year fixed effects, therefore capturing trends that are constant across individuals over time. For ease of interpretation, Fig. 2 presents a graph of the interaction between hearing impairment and social support. Missing values were imputed using multiple imputation with chained equations in Stata 14.2 (StataCorp 2015).

4. Results

4.1. Describing the sample

Table 1 presents characteristics of the sample over the three waves of data. The mean level of depressive symptoms slightly decreases over time, from 1.34 in wave 1 to 1.29 in wave 2 to 1.24 in wave 3 (range from zero to eight). Over one fifth of the sample has fair to poor hearing in each wave (23.12%, 22.34%, and 21.32%). The mean level of social support is consistent across waves, decreasing slightly from 14.26 to 14.22 to 14.19 (range from zero to twenty-eight). Women are slightly better represented (59.14%, 59.49%, and 60.57%), which is consistent with literature that has found that women have lower levels of mortality at older ages than men (Deeg, 2016). The sample is predominantly comprised of non-Hispanic whites (around 80% in each wave). This is not necessarily problematic for this study, as research reports that hearing loss prevalence varies across racial/ethnic groups, with whites experiencing a disproportionate burden of hearing loss (Agrawal et al., 2008). Further, although blacks are more likely to have their hearing tested and whites are more likely to wear hearing aids (Nieman et al., 2016), researchers suggest that this is not reflective of differential socioeconomic status, but rather to some protective effect of black race (Lin et al., 2011).

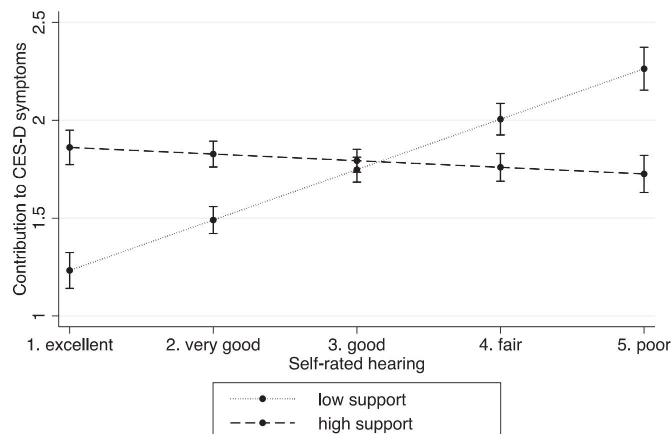

Fig. 2. Hearing ability, social support, and depressive symptoms.

4.2. Results from fixed effects models

Table 2 presents the fixed effects regression coefficients identifying factors associated with depressive symptoms. Sex, race, and education are not included because they are time-invariant. Model 1 provides evidence regarding the first research question, whether hearing impairment leads to increased levels of depressive symptoms. In Model 1, having worse hearing is significantly associated with higher levels of depressive symptoms ($p = 0.001$). Specifically, each one unit move from better to worse hearing (on a five-point scale from excellent to poor) is associated with a 0.063-point increase in the number of depressive symptoms.

Models 2 and 3 provide evidence regarding the second research question, whether social support mediates the relationship between hearing impairment and depressive symptoms. Adding time-varying control variables (age, marital status, wealth, and hearing aid usage) in Model 2 slightly buffers the association between hearing impairment and depressive symptoms, but the relationship persists ($p = 0.003$). Marital status is the only statistically significant control variable. Specifically, being separated, divorced, or widowed is associated with more depressive symptoms compared to people who are married ($p < 0.001$).

The significant relationship between hearing impairment and depressive symptoms persists after adding social support in Model 3, and the coefficient remains the same as in Model 2 (0.054; $p = 0.004$). Similar to the previous model, being separated, divorced, or widowed is associated with more depressive symptoms ($p < 0.001$). Higher levels of social support are associated with more depressive symptoms ($p = 0.009$). While this finding seems counterintuitive, as it might be expected that social support would *decrease* depressive symptoms, Model 4 clarifies the relationship between social support and depressive symptoms.

Model 4 includes control variables, social support, and an interaction term between social support and hearing impairment, as per the stress-buffering model, to address the final research question regarding the moderating role of social support. Having worse self-rated hearing ($p < 0.001$), being separated, divorced, or widowed ($p < 0.001$), and having higher levels of social support ($p < 0.001$) are all associated with more depressive symptoms. However, Model 4 shows that social support *interacts* with hearing impairment to influence levels of depressive symptoms ($p < 0.001$). The results indicate that having higher levels of social support and worse self-rated hearing results in lower levels of depressive symptoms. Thus, the presence of social support lessens the burden of hearing impairment, suggesting that it creates a multiplicative, rather than additive, effect on the relationship between hearing impairment and depressive symptoms.

Fig. 2 provides a graphical representation of the interaction term. For individuals with the lowest level of social support, moving from excellent hearing to poor hearing results in a roughly one symptom increase in CES-D symptoms. In other words, low levels of social support increased depressive symptoms, but only among those with poor hearing. Among people with excellent self-rated hearing, low levels of social support did not increase depressive symptoms. For people with high levels of social support, moving from excellent to poor hearing results in a reduction in the number of CES-D symptoms. Thus, high levels of social support are protective for people with worse self-rated hearing.

5. Discussion

Hearing impairment is an important and growing social and physical health problem, especially among older adults (Ciorba et al., 2012). It has also been linked to poor mental health outcomes, namely depression, though the findings on this point have been mixed. The goal of this study was to treat hearing impairment as a stressor in an effort to highlight the mental health implications for an aging society at increasing risk of hearing impairment. Indeed, approximately one fifth of the participants in this study reported fair to poor hearing, which is consistent with other population-based studies of adults aged 50 and older (Chou et al., 2011). This age group is also vulnerable in terms of social isolation and a lack of social support, which is a resource that has been shown to mitigate the negative effects of poor health (Cheng, 2017; Milner et al., 2016; Muramatsu et al., 2010; Waverijn et al., 2017). An additional goal of this study was to examine the extent to which social support influences the relationship between hearing impairment and depressive symptoms.

The results suggest that hearing impairment has a direct effect on depressive symptoms, and that this relationship persists even after adding status characteristics associated with mental health and stress exposure. Individuals with worse self-rated hearing had higher levels of depressive symptoms. These findings clarify some of the conflicting literature regarding hearing impairment and depressive symptoms, some of which reports an association between the two (Kiely et al., 2013; Saito et al., 2010; Strawbridge et al., 2000; Wallhagen et al., 2001) and some of which does not (Chou, 2008; Pronk et al. 2011, 2014; Stam et al. 2016). Specifically, the use of a large, nationally representative sample ($n = 6075$) provides sufficient power to overcome some of the methodological obstacles that have contributed to these mixed results.

The second goal of the study was to test whether social support mediated or moderated the association between hearing impairment and depressive symptoms. The likelihood of experiencing an increase in depressive symptoms did not change once social support was added, offering little support for the idea that it buffered the relationship between hearing impairment and poor mental health. In contrast, the results found that social support interacted with hearing impairment to influence mental health. Among those with worse self-rated hearing, high levels of social support reduced depressive symptoms while low levels of social support resulted in higher levels of depressive symptoms. Low levels of social support did not increase depressive symptoms among people with excellent hearing. This finding indicates that social support was most beneficial for those with worse hearing. Therefore, social support plays a significant role in moderating the relationship between hearing impairment and depressive symptoms. Overall, these findings suggest that hearing impairment is a chronic stressor in individuals' lives, and that responses to this stressor vary by the level of social resources available.

The fact that social support has consequences for mental health may not be surprising, but it is an important finding in the context of hearing impairment. Hearing impairment has a strong impact on individual well-being in that it is associated with social withdrawal and social and emotional loneliness (Mick et al., 2014; Pronk et al., 2013). Such a finding is particularly significant when combined with an aging population that is also at risk for social isolation. While it is encouraging that results from this study suggest that social support has mental health benefits for people with hearing impairment, a recent review finds that people still tend to deny that they have trouble hearing (Barker et al., 2017), be it due to stigma, a lack of coping mechanisms, or a lack of ways to disclose their hearing loss to others. This suggests that many people with hearing impairments may not be benefiting from sufficient levels of social support.

There are several ways to increase access to such support for people with hearing impairment. First, earlier identification of hearing impairment and/or the use of assistive technology may help individuals remain engaged. Second, audiologic (hearing) rehabilitation programs could include educational training for significant others regarding ways to support socially the person with hearing impairment (Preminger and Meeks, 2010). Audiologists, primary care physicians, friends, and family are key resources and should be the targets of such rehabilitation programing.

Further, findings from this study suggest that sociology can provide important insights into the study of hearing impairment by extending the use of the stress process model to incorporate hearing impairment as a stressor. Previous research has treated functional limitations as a stressor, in general, and a chronic, ongoing strain, in particular, and reports that these limitations have negative consequences for mental health and can lead to the proliferation of other stressors (Pearlin, 1999; Pearlin et al., 1997). Hearing impairment is another source of stress or chronic strain that is experienced by many older adults. However, a comprehensive review of the literature found that no other study has applied the stress process model to hearing impairment. Moreover, looking only at the main effect between hearing and mental health is not sufficient for understanding this relationship. Instead, as per the stress-buffering model, research should explore how social support and other resources *interact* with hearing impairment to influence mental health.

This study is not without limitations. First, analysis is restricted to three waves. Questions about social support were added to the HRS in 2006, so data from prior waves could not be analyzed. Second, the sample is limited to noninstitutionalized individuals. Institutions that may have a significant number of people with hearing impairment, such as hospitals or retirement homes, are excluded. Third, measures of the age of onset or duration of hearing impairment were not included. Measures of the timing and duration of events are increasingly recognized in stress research as important for outcomes (Bierman and Statland, 2010), and including such measures could strengthen the application of the

stress process in this study. Finally, a potential limitation of this study is that it does not include younger participants. Hearing impairment may be more distressing at younger ages, suggesting that the results from this study may underestimate the nature of the relationship between hearing impairment and depressive symptoms.

6. Conclusion

Research projects that the older population will increase from 40 to 72 million between 2010 and 2030 (Vincent and Velkoff, 2010), underscoring the importance of examining the connection between mental and physical health in the context of aging. This population is vulnerable to social isolation, which is magnified by having a hearing impairment. As shown by the stress-buffering model, social support is particularly important for people with hearing impairment because it lowers depressive symptoms at high levels but increases depressive symptoms at low levels. Thus, findings from this study suggest both the need for increased vigilance regarding hearing impairment among older adults and the need for research that treats hearing impairment as a physical health stressor. Building on this study, future research could assess how social support influences the relationship between hearing impairment and other mental and physical health outcomes. Since social support is an external resource, research might also consider the role of internal resources, such as mastery and self-esteem, in shaping the relationship between hearing impairment and mental health. Finally, future research could also explore how hearing impairment affects not only the individuals, themselves, but also close significant others such as spouses or children (Borren et al., 2015).

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