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Abstract

Stress can negatively affect multiple aspects of health, including functional health, among older adults, who are likely to face unique, age-related stressful experiences. Previous research has addressed the protective effects of social relations (i.e., social ties, social participation, social integration) for physical and mental health outcomes, yet few studies have examined functional health. The present study aimed to investigate the longitudinal stress-buffering effects of social integration on late-life functional health. Using three-wave data from 399 older adults (aged 60+), two-level hierarchical linear modeling analysis was conducted and the results indicated that in addition to its main effect on functional (ADL) limitations, social integration moderated the negative effect of stress on the longitudinal trajectory of functional limitations. The findings suggest important directions of future research to identify the mechanisms of such buffering effects over time and develop effective interventions to enhance late-life functional health while promoting social integration.

Keywords: social relations, social integration, stress-buffering effects, functional health activities of daily living

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Detrimental effects of stress on multiple aspects of health during adulthood have been well documented (Cohen, Gottlieb, & Underwood, 2000; Cohen & Wills, 1985; Hawkley & Cacioppo, 2004; Kawachi & Berkman, 2001; Kwag, Martin, Russell, Franke, & Kohut, 2011; Poulin, Brown, Dillard, & Smith, 2013; Thoits, 2010; Uchino, 2009). By late-life, older adults face increased stress due to unique challenges related to normative aging, such as financial strains due to retirement, emotional stress of bereavement, or the psychological toll of physical health declines (Gerstorf, Ram, Lindenberger, & Smith, 2013; Krause, 2005, 2006; Ong, Bergeman, Bisconti, & Wallace, 2006; Scott, Jackson, & Bergeman, 2011), and those stressful experiences may be unavoidable and long-lasting. While stress has been considered a risk factor for declining health, psychosocial factors such as social relationships may be protective and buffer against health problems (Cohen & Wills, 1985; Kawachi & Berkman, 2001). In particular, social integration is important for late-life health and well-being (Berkman, Glass, Brissette, & Seeman, 2000; Blinded for review). The present study addresses the possibly long-lasting relationships among late-life stress, social integration, and functional health.

Negative Repercussions of Stress for Health

Certain life events, major traumas, or even everyday hassles may cause people to experience stress reactions (Cohen, Kamarck, & Mermelstein, 1983; Scott et al., 2011). However, the mere exposure to such events is not necessarily the best gauge of stress, but instead individual responses to the events (i.e., the individual's perceived difficulty in coping) may be more accurate (Cohen et al., 1983; Scott et al., 2011). Although people of any age may face difficulties, older adults face unique stressors such as retirement, caregiving, bereavement, widowhood, financial strain, ageism, loneliness, and chronic health problems (Das, 2013;

Krause, 2005; Ong et al., 2006; Scott et al., 2011; Valle, Weeks, Taylor, & Eberstein, 2013). Perceiving these experiences as difficult to handle may result in increased stress.

The body of research on stress (Cohen et al., 2000; Cohen & Wills, 1985; Hawkley & Cacioppo, 2004; Kawachi & Berkman, 2001; Poulin et al., 2013; Thoits, 2010; Uchino, 2009) suggests that stress is linked to a variety of health outcomes. For example, high stress can potentially undermine feelings of control, reduce healthy behaviors (e.g., exercising, healthy diet), and decrease immune or other physiological functioning (Ng & Jeffery, 2003; Uchino, 2009; Wong & Shobo, 2016), which may be associated with poor physical health and even mortality (Poulin et al., 2013). Stress may even accelerate the physiological aging process, quickening functional losses (Hawkley & Cacioppo, 2004).

Alleviating the negative repercussions of stress for health outcomes is crucial for older adults, who must cope with age-related challenges in addition to daily struggles and stressful life events. Previous research suggests that there are multiple protective factors that have the potential to reduce stress and its negative impact, such as hardiness, physical activity, and supportive social relationships (Cohen & Wills, 1985; Dolbier, Smith, & Steinhardt, 2007; McEwen, 2008). Among those factors, the present study specifically investigates the protective role of social relationships.

The Stress-Buffering Effects of Social Relationships for Health

A number of researchers (e.g., Cohen & Wills, 1985; Kawachi & Berkman, 2001; Millán-Calenti, Sánchez, Lorenzo-López, Cao, & Maseda, 2013; Ryff & Singer, 2005; Sowislo & Orth, 2013) have suggested that social relationships are protective for various health outcomes due to facilitating health-promoting behaviors (e.g., self-care), emotional processes (e.g., increasing self-esteem and sense of control), and physiological processes (e.g., enhancing neuroendocrine

and immune system functioning). In addition to such direct health benefits, social relationships may moderate the impact of stress on health outcomes. The stress-buffering model (Cohen & Wills, 1985; Cohen et al., 2000) illustrates the protective role of social relationships. According to this model, social relationships may buffer the negative impact of stress on health by moderating emotionally-linked physiological reactions or behavioral reactions (e.g., failures in self-care) triggered by those stressful experiences.

Whereas previous cross-sectional (e.g., Kornblith et al., 2001; Patterson, 2003; Stockdale, Wells, Tang, Belin, Zhang, & Sherbourne, 2007) and longitudinal studies (e.g., Cranford, 2004; Luszczynska & Cieslak, 2005; Mulia, Schmidt, Bond, Jacobs, & Korcha, 2008) have tended to focus on examining potential stress-buffering effects of social relationships for mental health, fewer studies have examined stress-buffering effects for physical or functional health outcomes. Moreover, the extent of this research is limited for older populations, who are likely to face unique stressful experiences as discussed earlier; while some studies have examined potential stress-buffering effects on late-life mental health (e.g., Krause, 2005; Schwarz & Roberts, 2000; Tyler & Hoyt, 2000) and self-rated health (e.g., Krause, 2006), there is a lack of research focusing on stress-buffering for functional health. To attempt to fill the gap in the literature, the present study examines the stress-buffering model particularly for the functional health of older adults as this aspect of health predicts quality of life (Barile et al., 2012; Bentley et al., 2013; Kanwar et al., 2013) and mortality (Keeler, Guralnik, Tian, Wallace, & Reuben, 2010) and is even a stronger predictor of the mortality of the old-old than multimorbidity (Landi et al., 2010). While previous studies (e.g., Everard, Lach, Fisher, & Baum, 2000; Mendes de Leon, Glass, & Berkman, 2003; Perissinotto, Cenzer, & Covinsky, 2012; Shankar, McMunn, Demakakos, Hamer, & Steptoe, 2017) have addressed associations between social relationships and

functional health outcomes in later life, few studies (e.g., Unger, Johnson, & Marks, 1997, indicating the moderating effects of social interactions for the negative impact of widowhood on functional decline) specifically tested the stress-buffering model for functional health among older adults. The present study aims to provide more robust longitudinal evidence by examining the potential stress-buffering effects of social relationships over time, that is whether social relationships moderate the negative effects of stress on trajectories of functional health, using multiple time points.

Moreover, among the literature on social relations and stress buffering, the construct of social relationships is defined inconsistently. As social relationships are multidimensional (Antonucci, Ajrouch, & Birditt, 2013), it is important not to make the assumption that various aspects of social relationships are equivalent. For example, the quantitative and qualitative characteristics of social relationships have distinct effects for health and well-being (Antonucci et al., 2013). As focusing on a single aspect of social relationships can lead to a limited understanding about their potential effects on health, multidimensional aspects of social relationships should be employed when possible. As a multidimensional construct, social integration reflects the complex nature of social relationships. Social integration consists of social engagement with a variety of sources (e.g., close family, extended family, friends, neighbors) and social participation in a variety of contexts (e.g., community, neighborhood) (Blinded for review). This construct encompasses both quantitative (e.g., frequency of social interactions) and qualitative (e.g., satisfaction with social support) characteristics of social relationships. As the present study aims to examine how social relationships, as a multidimensional factor, affect the link between stress and functional health, we focus our research question on the comprehensive construct of social integration.

Study Objectives

The present study seeks to overcome the aforementioned limitations of previous research and expand the research on the stress-buffering effects of social integration for late-life functional health. One unique aspect of this study is to investigate the longitudinal buffering effects of social integration on trajectories of functional health using measures at multiple time points. In addition, by incorporating a multidimensional construct of social integration, the present study aims to better reflect the complex, nuanced nature of social relationships.

The specific question addressed in the present study was whether social integration moderates the effect of stress on trajectories of functional limitations over time. Despite the lack of prior research on this specific topic, it was hypothesized that the stress-buffering model is also applicable to the longitudinal association between stress and trajectories of functional limitations. Thus, we anticipated that social integration would reduce the effect of stress on decreasing functional health over time. In other words, the protective effects of social integration against functional decline are expected to be more pronounced especially when older adults are experiencing high stress.

Method

Sample and Data

Three waves of data were drawn from the Social Integration and Aging Study (Blinded for review), a community-based study of older adults in a small metropolitan area in the Midwest in the United States. The study consisted of written surveys assessing social integration across various dimensions, social support network structure and quality, health and well-being, and demographic characteristics. Participants were recruited from mailing lists and events of an Area Agency on Aging covering a region consisting of seven counties including a small metropolitan

city and surrounding rural regions. Additionally, participants were recruited through flyers and invitations sent to senior centers, senior housing facilities, and long-term care facilities throughout this region. In 2013 (Wave 1), 413 individuals aged 60 or older were recruited via mail (68%) and in-person (32%). Two years later (at Wave 2 in 2015), the respondents were invited to participate in a follow-up survey via mail, and 307 out of them returned the Wave 2 surveys. In 2017 (Wave 3), participants were again invited to complete a follow-up survey. Among the Wave 2 participants, 245 completed the Wave 3 surveys. The response rates of the Wave 2 and Wave 3 surveys were 81% and 90% (when excluding 32 and 33 who passed away during each of the two-year periods between surveys), respectively. There were differences among those who completed all three waves (i.e., Wave 3 participants) and those who only participated in Wave 1 or just Wave 1 and 2 surveys in age ($F(2, 410) = 19.01$, $p < .001$), level of education ($F(2, 408) = 7.14$, $p < .01$), functional limitations ($F(2, 397) = 28.24$, $p < .001$), and social integration ($F(2, 386) = 14.73$, $p < .001$). Specifically, Wave 3 participants were younger and had fewer functional limitations and higher social integration at Wave 1 than those who completed only the first one or two surveys; they also had higher education than those who completed only the Wave 1 survey. Sex did not differ among Wave 3 participants and the other two groups that participated in only the previous one or two surveys ($\chi^2 = 4.52$, $df = 2$, $p > .10$).

The differences in the measures across waves (i.e., attrition of older participants and those with lower education, poorer functional health, and lower social integration) could lead to obtaining biased results (e.g., inflated standard errors, biased parameter estimates only applicable to those with better well-being) especially if using traditional approaches to dealing with missing data such as listwise deletion (Heck et al. 2014). In order to reduce such bias, the present study included all 399 participants who responded to measures of interest in at least one wave and

examined all available data with maximum likelihood estimation method (Heck et al. 2014), as discussed later, without deleting data of those who did not participate in all three waves. Their average age was 80.3 (SD = 8.3), and a majority (72%) were female. Among these Wave 1 respondents, 306 returned the Wave 2 survey and 244 of them complete the Wave 3 survey. Descriptive statistics are summarized in Table 1.

Predictive Measures

Wave. A time variable was created to indicate the wave at which the data of the predictive and outcome measures were collected. The variable was centered at Wave 1 (i.e., Wave 1 = 0, Wave 2 = 1, Wave 3 = 2), and its one unit represented two years between consecutive waves.

Baseline demographic covariates. Age (in years; centered at age 80), sex (male = 0 and female = 1), education, and marital status at Wave 1 were included as baseline demographic covariates. *Education* was a continuous variable in years ranging from 0 (i.e., no schooling completed) to 17 years (i.e., graduate degree or professional degree). Marital status was coded into a dichotomous variable called *married*: widowed, divorced/separated, or never married (i.e. 'not married') = 0 and married or living with partner (i.e., 'married') = 1.

Perceived stress. The four-item short version of the Perceived Stress Scale (Cohen et al., 1983; Cohen & Williamson, 1988) was used to assess levels of stress. Respondents were asked how often in the past month they have felt: (a) that they were unable to control the important things in their life, (b) confident about their ability to handle their personal problems, (c) that things were going their way, and (d) that difficulties were piling up so high that they could not overcome them. Respondents answered to each item using a 5-point Likert-type scale ranging from 'never' to 'always'. Items b and c were reverse coded so that higher scores would be

indicative of higher stress. The scores of these four items were averaged to create an overall stress score. The scale alphas were .61 at Wave 1, .58 at Wave 2, and .55 at Wave 3. This variable was centered at 2.15 (i.e., its overall mean across waves).

Social integration (as a moderator). The Social Integration in Later Life Scale (SILLS; Blinded for review) was used to assess levels of social integration. The SILLS consists of four dimensions of social integration: frequency–social ties, frequency–social activities, satisfaction–social ties, and satisfaction–social activities. For frequency subscales, respondents indicated how often they spent time with certain social ties or engaged in social activities on a 5-point Likert-type scale ranging from 'never' (1) to 'very frequently' (5). Five items were included in the frequency–social ties subscale (i.e., frequency of getting together with family, speaking to family on the phone, getting together with friends, speaking to friends on the phone, visiting with neighbors) and five items in the frequency–social activities subscale (i.e., frequency of attending meetings of a group, attending a religious service, attending a community event, volunteering, going on an outing). For satisfaction subscales, respondents indicated how satisfied they were with certain social ties and social activities on a 5-point Likert-type scale ranging from 'very dissatisfied' (1) to 'very satisfied' (5) for the satisfaction items. Four items were included in the satisfaction-social ties subscale (i.e., satisfaction with relationships with close family, extended family, friends, and neighbors) and four items in the satisfaction-social activities subscale (i.e., satisfaction with involvement in recreation/leisure activities, participation in social gatherings, involvement in or connection to their community, and participation in religious or spiritual activities). The mean score of the items in each of the four dimensions was calculated to create each subscale, and then the four subscales were summed to create an overall score. This overall, summed scale (i.e., SILLS) has been evaluated with demographic and social network measures

used in the literature on social integration and suggested to have adequate scale validity as a scale for the multidimensional construct of social integration specific to older adults (Fuller-Iglesias & Rajbhandari, 2016). The scale alphas were .87 at Wave 1, .90 at Wave 2, and .89 at Wave 3. This variable was centered at 14.81 (i.e., its overall mean across waves).

Outcome Measure: Functional Limitations.

Limitations in activities of daily living (ADLs) was assessed using the Older Americans Resources and Service scale (Fillenbaum, 2013). Respondents indicated the level of assistance they need, 'without help' (0), 'with some help' (1), or 'someone must do this for me' (2), for carrying out nine activities such as driving and shopping (i.e., instrumental ADLs) and eating and dressing (i.e., basic ADLs). The scores for the nine items were summed to create an overall score for ADL limitations.

Analysis Strategy

Two-level hierarchical linear modeling analysis was conducted with maximum likelihood estimation method using all available data from the 399 participants with IBM SPSS version 25 (IBM, 2018) to address the research question. Level-1 repeated-measured, time-variant variables (i.e., time/wave, stress, social integration) and level-2 individual-level, time-invariant variables (i.e., baseline demographic characteristics) were included as predictors for the outcome of functional limitations (which were repeated-measured at three waves).

In the model, the individual-level intercept and wave, or time slope (i.e., a change rate over time in the outcome), were treated as random. Significant random effects of intercept and time slope would indicate that the level and trajectory of the outcome (i.e., functional limitations), respectively, varied among individuals, which could not be explained by the included variables in the model. The possibility that the time slope was curvilinear was explored

in preliminary analysis with a hierarchical linear model that included both linear and quadratic components of the time slope. The results of the preliminary analysis indicated that the quadratic effect of time was not significant (suggesting the trajectory should be linear), so it was determined that only the linear time variable should be included in the subsequent analysis. The main effects of the two levels of predictors and covariates as well as the three-way interaction of time, stress, and social integration (i.e., stress-buffering effects of social integration over time) and its lower two-way interactions were entered in the model. Assessing this three-way interaction was intended to examine the potential systematically varying effect on trajectories of functional limitations (depending on levels of stress and social integration) rather than random or unexplained variance. For further investigations of the three-way interaction, trajectories of functional limitations were depicted using the estimates of main effects and interactions for those with different levels of stress and social integration. As post-hoc analyses, alternative hierarchical linear models were constructed by replacing the predictors of interest with ones re-centered at specific values or conditions (i.e., high or low levels of stress and social integration) to examine the effects with these conditions (Hoffman, 2015).

Results

The unstandardized estimates of fixed effects (including main effects and interactions) and random effects in the hierarchical linear model are summarized in Table 2. As standardized estimates were not available in the hierarchical linear modeling analysis with IBM SPSS version 25 (IBM, 2018), the estimated change per standard deviation in functional limitations (i.e., ADLs) by one standard deviation increase of each predictor was computed for a comparison of the relative size of the main effects, which is summarized in Table 3. (All estimates mentioned below in this section are unstandardized estimates.)

The Akaike information criterion (AIC; smaller values suggest better quality of model) indicated that the hierarchical linear model improved by including the predictors of stress and social integration (as the AIC decreased from 4,340 to 4,177) and adding the interactions of time, stress, and social integration (as the AIC further decreased to 4,168). Of the variance left unexplained by just including the time variable and demographic covariates, the inclusion of the predictors of stress and social integration (before adding the interactions) accounted for 17% of the variance in the level of functional limitations between individuals. Of the variance left unexplained by just the main effects of predictors and covariates, the inclusion of the interaction accounted for 8% of the variance in the slope/trajectory of functional limitations between individuals.

The fixed and random effects of the individual-level intercept indicated that the average level of functional limitations with reference conditions (i.e., an 80 year-old woman with 12 years of education and average levels of stress and social integration) was 1.77, which significantly varied among individuals ($p < .001$). The results for the time slope (i.e., effect of wave) also indicated a significant positive fixed effect (0.48, $p < .001$) and random effect (variance: 0.91, $p < .001$) indicating that functional limitations increased over time on average and the trajectory varied among individuals. The fixed main effects of sex and education were not significant indicating that these covariates did not predict functional limitations. The significant main effect of social integration (-0.24, $p < .001$) and marginal main effect of stress (0.27, $p < .10$) showed that lower social integration and higher stress were associated with greater functional limitations at Wave 1 (i.e., the reference condition). In addition to these main effects, the three-way interaction of wave, stress, and social integration was significant (-0.14, $p < .01$), which indicated that the variance in trajectories of functional limitations among

individuals could be explained by their different levels of stress and social integration (as well as other unknown factors as shown in the significant random effect of the time slope reported earlier). Further exploration of this interaction was conducted post-hoc.

Investigations for the Three-Way Interaction of Wave, Stress, and Social Integration

The effect of the three-way interaction of wave, stress, and social integration is depicted in Figure 1 by drawing the predicted trajectories for hypothetical people (Hoffman, 2015) aged 80 at Wave 1 with 12 years of education and high and low levels (i.e., one standard deviation above and below the overall mean) of stress and social integration based on the estimates of the fixed effects in Table 2. As shown in Figure 1, the trajectories (or time slopes) appeared to differ between those with high and low social integration if they experienced high stress; whereas, they appeared similar if their stress was low. This interpretation was supported in post-hoc analysis with alternative hierarchical linear models using re-centered variables. Results from the model with stress re-centered at its high level (i.e., one standard deviation above its mean) showed a significant two-way interaction of wave and social integration (-0.15, $p < 01$; detailed results available upon request) indicating that social integration moderated the time effect on functional limitations (i.e., affecting the trajectories). Even if older adults with high social integration experienced high stress, their functional limitations increased less than those with low social integration (or even increased little as indicated in the non-significant main effect of wave [0.31, $p = .059$] when including social integration re-centered at its high level) over four years. In contrast, results from the model with stress re-centered at its low level (i.e., one standard deviation below its mean) showed a non-significant two-way interaction of wave and social integration (0.06, $p > .10$; detailed results available upon request) indicating that social integration did not moderate the time effect on functional limitations nor affect the trajectories.

Discussion

The present study aimed to provide additional longitudinal evidence for the stress-buffering effects of social integration on late-life functional health. This study used a sample of relatively old people (whose mean age was approximately 80 years) and multiple time points of measures. Although there has been a broad literature on the stress-buffering effects of social relationships on health outcomes, the present study was unique in 1) examining longitudinal buffering effects, 2) focusing on the functional health outcome for older adults, an aspect of health which has been investigated less intensively than mental health, and 3) using a complex measure of social integration that encompasses multiple aspects of social relationships.

The results of the present study supported the hypothesis that social integration would buffer the effects of stress on functional health over time. In addition to its direct effect on levels of functional limitations, social integration moderated the negative effect of stress on longitudinal trajectories of functional limitations; thus, for individuals experiencing high stress, greater social integration was associated with smaller increases in functional limitations over four years than those with lower social integration. The findings suggested protective effects of social integration for maintaining good functional health over time especially under highly stressful circumstances. At the same time, these findings also indicated increased risk of more rapid functional decline associated with high levels of stress in the case of lacking social integration in later life. As seen in Figure 1, the rates of increase in functional limitations appeared similar among older adults except for those with high stress and low social integration (whose initial levels of functional limitations also differed as indicated in the main effects of stress and social integration). Although social integration did not seem to matter much for the rate of functional decline when experiencing lower stress, the protective effect of social

integration (or perhaps detrimental effect of lack of social integration) for functional health increased over time under highly stressful circumstances.

The stress-buffering model could at least partially account for why the effect of social integration (or lack of it) increased over time with high stress levels. It may be the case that perceiving and experiencing high stress levels decreases healthy behaviors (e.g., exercising, healthy diet, self-care), yet such healthy behaviors can be promoted by social integration (e.g., being a part of a community that promotes self-care, etc.) or potentially undermined by a lack of social integration (Cohen & Wills, 1985; Cohen et al., 2000; Hawkley & Cacioppo, 2004; Uchino, 2009). For example, when faced with highly stressful circumstances, an individual with low social integration might stop exercising due to lack of social support partners, whereas an individual with better social integration might have social support partners that encourage them to continue in healthy behaviors (like exercise) despite life stressors. If such different patterns of behaviors were maintained over years, disparities in functional health between older adults who are more and less socially integrated could expand due to the protective effects of long-term physical activity on functional limitations (Paterson & Warburton, 2010). As another possible explanation, ADLs may involve not only physical conditions but also psychological factors. Particularly, stressful experiences may decrease self-efficacy or belief in one's abilities to engage in physical activities (McAuley, Szabo, Gothe, & Olson, 2011), which can in turn influence perceptions of physical disability and functional decline and then negatively affect ADLs (Feltz & Payment, 2005; Hellstrom, Lindmark, Wahlberg, & Fugl-Meyer, 2003; Rejeski, Miller, Foy, Messier, & Rapp, 2001; Seeman, Unger, McAvay, & de Leon, 1999). In contrast, social integration may provide psychological benefits, for instance, enhancing self-efficacy (Avlund, Lund, Holstein, & Due, 2004). Even if such psychological factors may not affect functional

limitations immediately or concurrently, they may lead to altering the trajectories of functional limitations (i.e., reducing the rates of functional decline) under highly stressful circumstances. As the findings of the present study do not yet address these speculated mechanisms, future research is needed to investigate such protective mechanisms of social integration.

As a contribution to the literature, the present study provided some evidence for the longitudinal nature of the stress-buffering effects of social integration for functional health, thereby emphasizing the longitudinal nature of the theoretical construct of stress buffering (Cohen et al., 2000). The findings suggest that the protective effects of social integration may be extended over time by affecting trajectories of functional limitations, rather than concurrent levels of the functional health outcome, under highly stressful situations. At the same time, the findings also emphasize the potential risks of a lack of social integration for increasing functional decline when older adults are faced with high stress. These longitudinal implications are unique as previous research has mainly focused on examining the stress-buffering effects of social relationships on mental health and has lacked thorough investigations of their buffering effects on functional health, especially over time. The present study suggests that staying socially integrated has potential benefits for maintaining functional health over time especially when older adults are facing high levels of stress.

Limitations and Future Research

There were several limitations to the present study. One of them related to the measure that assessed stress levels. The four-item short version of the Perceived Stress Scale (PSS-4) was used in the Social Integration and Aging Study in order to reduce the time burden for participants taking the survey; however, the internal consistency of this scale (.55 to .61) was relatively low. PSS-4 as well as its 14- and 10-item versions have been widely used to measure stress for a

variety of populations (Ezzati et al., 2014). Ezzati et al. (2014) reported a similar Cronbach's alpha (.66) for the PSS-4 among their community-based sample of older adults; however, they found better psychometric properties for the longer versions of the PSS with internal consistency coefficients higher than .80. While having its advantage of practicality, the PSS-4 could suffer from lower internal consistency. In addition, while the dataset for the present study was selected due to its inclusion of its multidimensional measures of social integration focusing on older adults, the great majority of this community-based sample were Caucasian, reflecting the specific geographic area where participants were recruited. Future studies should seek to replicate this study with more racially and geographically diverse samples to better generalize the findings. Furthermore, future research should examine the potential mechanisms of the longitudinal stress-buffering effects of social integration for functional health. Having a better understanding of the mechanisms will lead to developing potentially effective interventions to promote late-life functional health along with social integration.

Conclusion

In conclusion, the present study provided longitudinal evidence for the multifaceted protective role of social integration for late-life functional health. In addition to its effect on levels of functional limitations, social integration was found to moderate the negative effect of stress on the trajectory of functional limitations. While the stress-buffering model (Cohen & Wills, 1985; Cohen et al., 2000) suggested the protective role of social relationships for reducing potentially detrimental impacts of stress on health in general, the present study highlights the extended stress-buffering effects of social integration for longitudinal change in late-life functional health. This study suggests that social integration may be important especially for highly stressed older individuals as it seems to play a role for helping maintain their health while

counteracting the negative impacts of stress and preventing rapid functional decline over time. The findings indicate important directions of future research to identify the mechanisms of the longitudinal stress-buffering effects of social integration, which will contribute to the development of effective interventions to enhance late-life functional health while promoting social integration.

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Table 1

Descriptive Statistics of Participants Selected for the Present Study (N = 399)

		Wave 1	Wave 2	Wave 3
Number of Participants		399	306	244
Age		M = 80.3 (SD = 8.3)	M = 81.5 (SD = 8.1)	M = 82.3 (SD = 7.8)
Sex (Female)		288 (72%)	224 (73%)	183 (75%)
Years of Education		M = 13.0 (SD = 2.5)	M = 13.2 (SD = 2.2)	M = 13.3 (SD = 2.2)
Marital Status	Married	145 (36%)	102 (33%)	77 (33%)
	Living with Partner	6 (2%)	6 (2%)	5 (2%)
	Widowed	185 (46%)	148 (49%)	120 (51%)
	Divorced/Separated	38 (10%)	32 (10%)	24 (10%)
	Never Married	25 (6%)	17 (6%)	10 (4%)
	No Response	-	1 (N/A)	8 (N/A)
Stress		M = 2.1 (SD = 0.7)	M = 2.2 (SD = 0.8)	M = 2.2 (SD = 0.6)
Social Integration		M = 14.6 (SD = 2.1)	M = 15.0 (SD = 2.2)	M = 15.0 (SD = 2.1)
ADL Limitations		M = 2.1 (SD = 3.0)	M = 2.2 (SD = 3.4)	M = 2.4 (SD = 3.4)

Note: The percentage for marital status is calculated using only valid responses (rounding to the nearest whole number).

Table 2

Two-Level Hierarchical Linear Model: Estimates of Effects for Functional Limitations (ADLs)

	Estimate	S.E.	p-value
Fixed Effects:			
Intercept	1.77	0.26	< .001
Wave (centered at Wave 1)	0.48	0.08	< .001
Age at Wave 0 (centered at 80)	0.15	0.02	< .001
Sex (Male = 0, Female = 1)	0.33	0.30	.262
Education (centered at 12 years)	0.06	0.05	.312
Stress (centered at 2.15)	0.27	0.14	.054
Social Integration (SI; centered at 14.81)	-0.24	0.05	< .001
Wave x Stress	0.21	0.12	.074
Wave x SI	-0.04	0.04	.258
Stress x SI	0.09	0.06	.164
Wave x Stress x SI	-0.14	0.05	< .01
Random Effects (Variances):			
Intercept	6.10	0.60	< .001
Wave	0.91	0.28	< .001

Notes. Level-1 covariance structure: diagonal; the above estimates are unstandardized.

Table 3

Estimated Change per Standard Deviation (SD) in Functional Limitations (ADLs) for the Two-Level Hierarchical Linear Model

	Estimated Change per SD in ADLs By One SD Increase of Predictor (By One Unite Increase for Wave and Age)	
Wave	N/A	(0.15 per wave)
Age at Wave 0	0.39	(0.05 per year)
Stress	0.06	
Social Integration	-0.16	

Notes: Estimated changes for non-significant nor marginal main effects (i.e., sex, education) and all interactions are excluded; the standard deviations computed from all three waves of data were used for ADLs, stress, and social integration; the estimated change by one standard deviation increase of wave was not calculated as it would be practically meaningless.

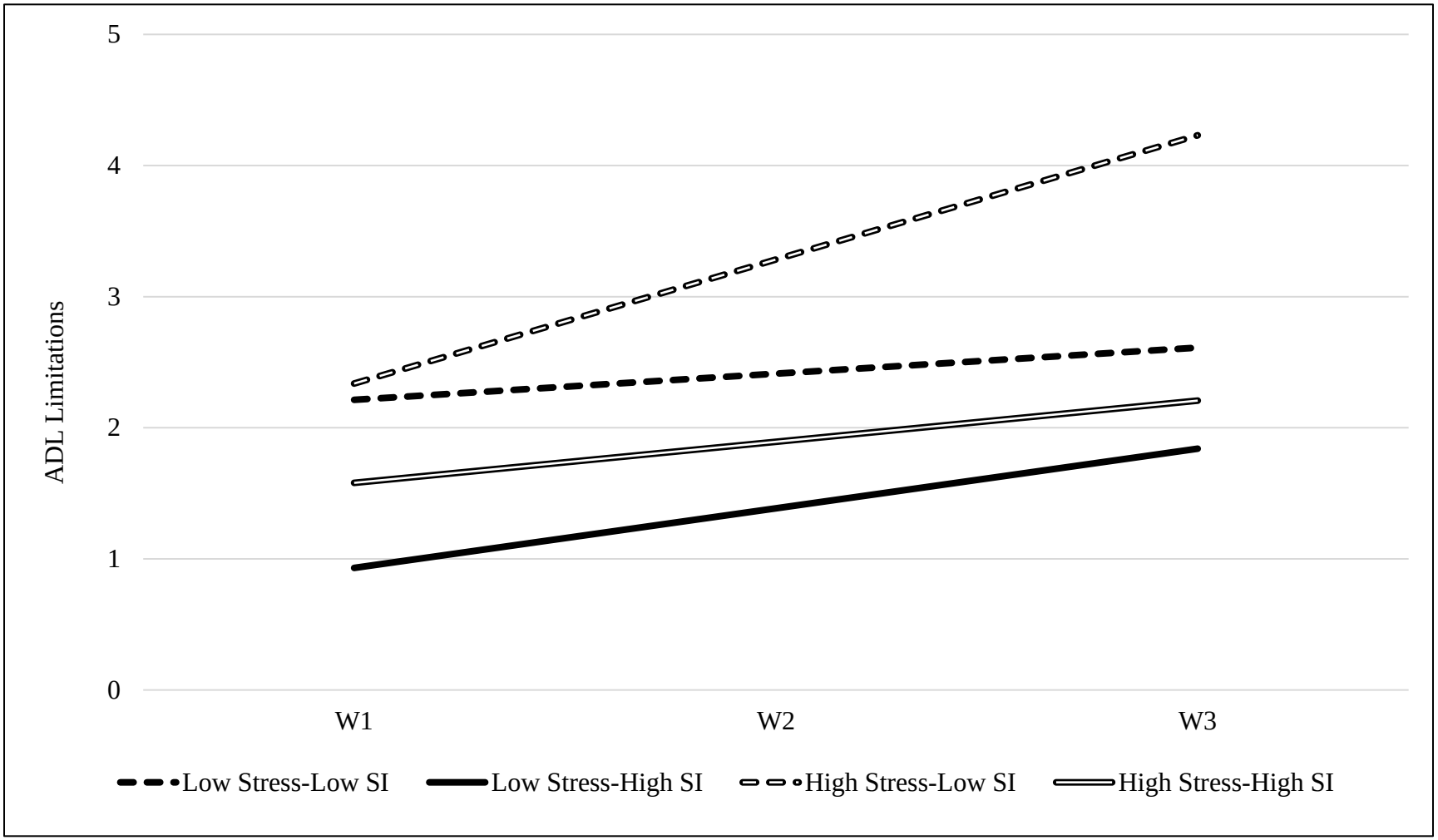

Figure 1. Trajectories of ADL limitations for individuals with low and high levels (one standard deviation below and above the overall mean) of stress and social integration (SI). Note: The reference conditions are 80 years in age and 12 years of education and the average scores between sexes are used.