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Multilayered Social Dynamics and Depression Among Older Adults: A 10-Year Cross-Lagged Analysis

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Depression in older adults is associated with decreased physical, cognitive, and social functioning, which in turn, are associated with increased mortality. Research has found that robust social networks can protect against depression, yet it is unclear whether the relationship between social ties and depression is reciprocal. Moreover, links between network connections at different social layers are not well understood. This study uses a representative sample with panel data collected between 2005 and 2016 to identify the influence of social network composition on subsequent depression and explore how various layers of human relationships (e.g., community vs. interpersonal level) influence one another. Results demonstrate multiple links between social connection and depression, and that the evolution of social networks in older adults is complex, with distinct mechanisms leading to positive and negative outcomes. Specifically, community involvement showed consistent benefits in reducing depression. In contrast, intimate partnerships appear to increase susceptibility to depression among older adults through exposure to the severe outcomes of partner loss. In addition, intimate partnerships reduce future interpersonal connections, whereas community involvement increases future interpersonal connections for older adults.

Keywords: social network dynamics, depression, late adulthood, longitudinal analysis, relational layers perspective

Depression in older adults is an important public health problem associated with decreased physical, cognitive, and social functioning, which in turn, are associated with increased mortality (Fiske, Wetherell, & Gatz, 2009). Social connections play a critical role in the maintenance of psychological well-being (Kawachi & Berkman, 2001). For older adults in particular, a lack of social connection has been linked to worse mental health because the elderly face stressful life-course transitions such as physical decline and the loss of loved ones (Tomaka, Thompson, & Palacios, 2006). From the social network perspective, existing research has examined older adults' social connections by assessing social network size (Cornwell & Waite, 2009; Dorrance Hall, Meng, & Reynolds, 2019), frequency of interaction with friends and family (Taylor, Taylor, Nguyen, & Chatters, 2018), and composition of their social networks (Cornwell & Waite, 2009; Fiori, Antonucci, & Cortina, 2006). Although existing scholarship has generated insight into the social precursors of depression among older adults, research has faced limitations in measuring social connections, for example, by primarily focusing on either network size or relational types such as friends and family.

A different approach, organizing social networks into layers of connection, may provide a fruitful lens to understand how older adults' social relationships relate to their psychological well-being. Medical sociologists have proposed that human relationships consist of three layers (i.e., community, interpersonal, and partner/spouse) that represent belonging-bonding-binding relationships respectively, and that they exhibit differentiated effects on mental health (Lin, Ye, & Ensel, 1999). The three layers of human relationships may reflect a deeper structure of one's social connections, as these layers correspond to differences in emotional closeness and willingness to invest time in maintaining the connection (Dunbar, Arnaboldi, Conti, & Passarella, 2015; Saramäki et al., 2014).

Another limitation of existing research in this area concerns the use of cross-sectional designs (e.g., Teachman, 2006), which do not address the temporal order, or the likely causal structure of changes in networks and depression. Although it is generally believed that social connections provide important support resources that reduce older adults' levels of depression (Kawachi & Berkman, 2001), depression may also influence social connections over time (Santini et al., 2020). Older adults with depression may lose interest in social gatherings and withdraw from social relationships (Fiske et al., 2009). Depressive symptoms may burden caregivers and strain close relationships. This study will contribute to the literature by examining the reciprocal effects between social connections (i.e., the three layers of relationships) and depression over time among older adults. Below, the three layers of human relationships are discussed, including how the layers influence one

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This research was conducted as a secondary analysis of data collected by the National Social Life, Health, and Aging Project. The authors presented research related to this article at the 70th annual conference of the International Communication Association. A detailed model output can be accessed at https://osf.io/wxmbf (Meng, Reynolds, & Dorrance, 2020).

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another. Next, the potential reciprocal relationship between the layers and depression in older adults is proposed.

Literature Review

Human relationships can be described as social layers that extend from the community, to interpersonal networks, to a spouse or partner that represents the most intimate connection (Lin et al., 1999). The outer-most layer reflects a broad range of individuals' engagement with others through participation and involvement with community and volunteer organizations. It provides a sense of *belonging* to social groups and fosters general social identity that promotes psychological well-being (Crocker, Luhtanen, Blaine, & Broadnax, 1994; Hagerty, Williams, Coyne, & Early, 1996). The intermediary layer, between the outer-most and inner-most layer, involves regular interpersonal interactions between ego and others. This layer of human relationships requires greater effort to maintain than mere participation. The ego and his or her interpersonal contacts need to invest in the relationship with a reasonable frequency of interaction, which reflects *bonding* relationships through which support resources could flow promoting psychological well-being (Meng, Chung, & Cox, 2016). In the inner-most layer, spouses or partners typically engage in the most intimate and intense interactions with the ego. Spouses or partners constitute *binding* relationships that represent the strongest relational ties with mutual sharing of private information. Spouses or partners are critical social ties with whom the ego forms social attachment and commitment (Ross, 1995). The layers perspective is consistent with distinct psychological needs as motivating factors for relationships of different types (Hardie, Kashima, & Pridmore, 2005; Hawkley, Browne, & Cacioppo, 2005). Figure 1 summarizes each layer.

The Influence of Outer Layers of Relationships on Inner Layers of Relationships

The three layers of human relationships are not necessarily independent from each other. Instead, outer layers of relationships create environments or afford opportunities to construct inner layer relationships. According to Lin and colleagues (1999), participation in community and volunteer organizations increases the likelihood of constructing and maintaining the interpersonal social networks consisting of interactive ties. By sharing the same group memberships and being involved in the same community activities and organizational events, people have more opportunities to create new interpersonal ties such as making new friends as well as to maintain existing ties through regular interaction and communication.

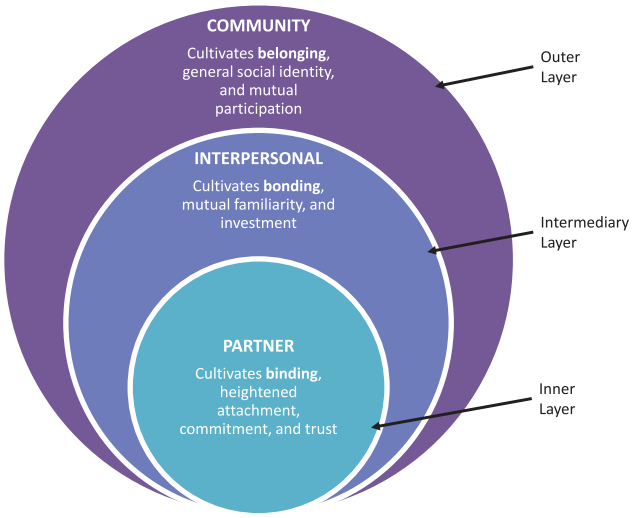

Figure 1. Summary of network-layer characteristics. See the online article for the color version of this figure.

Similarly, the maintenance of interpersonal social networks creates more opportunities for people to find and maintain intimate ties. The intermediary layer of relationships provides a pool of social contacts who may become an ego's spouse or partner. Structural balance theory (Cartwright & Harary, 1956) argues that if A is connected to B, and B is connected to C, then A is more likely connected to C. This theory suggests that an ego's spouse or partner is likely to also know the members in the ego's interpersonal social network, simply because they are all connected to the ego. In turn, the ego and his or her spouse or partner will have more shared social contacts if the ego has a larger interpersonal social network. Shared social contacts may help to strengthen the relationship between the ego and his or her spouse or partner by increasing time spent with common friends. More shared social contacts thus contribute to stronger and more intimate relationships (Granovetter, 1983). Given the above argument, we hypothesize that:

> *H1:* Outer layers of relationships will predict future inner connection. Specifically, (a) people with more community participation will have larger interpersonal networks in the future than people with less community participation; (b) people with a larger interpersonal network will more likely have an intimate partnership than people with a smaller interpersonal network.

The Influence of Inner Layers of Relationships on Outer Layers of Relationships

A natural follow-up question pertains to the influence of inner relational layers on outer relational layers. Literature has suggested that participating in communities and developing interpersonal trust could be reciprocally related (Welch et al., 2005). Having trust in one's interpersonal network may also foster the sense of community and encourage participation in community activities and voluntary organizations (Wellman, Haase, Witte, & Hampton, 2001). For older adults, community involvement may be restricted due to physical and psychosocial limitations. Their interpersonal networks could provide social support, such as being a companion or giving a ride, enabling older adults to engage in community activities (Simplican, Leader, Kosciulek, & Leahy, 2015).

Furthermore, one spouse/partner's relationship with a friend, for example, can be an avenue by which the other spouse/partner expands his or her interpersonal social networks (Stadtfeld & Pentland, 2015). Individuals without a partner may feel out of place in couples-only settings, and couples spending time with other couples is a common way to enjoy social life. Therefore, having a partner may help older adults expand and maintain their interpersonal social networks. Therefore, inner layers of social relationships may promote outer layers.

The literature, however, also suggests an opposite prediction about the influence of inner layers on outer layers of relationships. For example, Socioemotional Selectivity Theory (SST, Carstensen, Isaacowitz, & Charles, 1999) argues that older adults adaptively cultivate their social interactions to maximize emotional gains due to the perception that they have limited time left in their lives. Given that social investments require scarce time and energy, older adults may choose to interact more with known social contacts as they are familiar and can provide predictable and positive interactions (Carstensen et al., 1999). Built on this logic, the literature on widowhood has argued that after the loss of a spouse, the widowed older adults will increase their social participation to meet emotional goals and *compensate* for the loss of their spouse (Donnelly & Hinterlong, 2010; Ferraro, 1984). Supporting this point, older adults who recently experienced spousal loss showed more social participation through voluntary and community organizations (Ferraro, 1984; Li, 2007). This compensation perspective predicts that inner- and outer-layers of relationships may be negatively correlated.

Research has shown that older adults have a preferred order of sources who will provide social support if needed (Penning, 1990). A person's spouse has been consistently ranked in the first place followed by interpersonal ties with whom the one communicates regularly, including children, other relatives, friends, neighbors, and finally organizations (Penning, 1990). Following this logic, older adults with spouses may be less motivated to invest in building or maintaining larger interpersonal social networks or actively participating in community activities. Indeed, research supporting the dyadic withdrawal hypothesis has found that married persons have fewer and fewer friends as they advance through the life course (Kalmijn, 2003). They have increased contact with the friends of their spouse but less individual contact with their own friends (Kalmijn, 2003). Therefore, although the number of overlapping friends for a couple is increasing, each person's unique interpersonal network may be shrinking. Given the ambiguous effects of inner layers on outer layers, we propose the following research question:

> *RQ1:* Will inner layers of relationships be related to outer layers at later time points? Specifically, (a) will people with a partner have more or fewer interpersonal connections in the future than people with no partner, and, (b) will people with more interpersonal connections have more or less community participation in the future than people with fewer interpersonal connections?

Relationship Layers and Depression

Although older adults are at higher risk for depression (Penninx, Deeg, van Eijk, Beekman, & Guralnik, 2000) than the general population (but see Teachman, 2006), the heightened risk may partly result from social challenges such as shrinking networks, or limited mobility that prevents social activities (Fiske et al., 2009). For example, chronic depression is linked with physical decline in older adults (aged 55–85; Penninx et al., 2000). Depression may have a reciprocal relationship with the strength of one's social network; weak social networks may facilitate depression and depression may in turn weaken networks (Santini et al., 2020). Conversely, strong networks may protect from experiences of depressive symptoms, whereas a lack of depressive symptoms may strengthen networks at each relational layer. Prior longitudinal work examining the interactive dynamics between loneliness and depression has used basic indicators of network size (e.g., Cacioppo, Hawkley, & Thisted, 2010), leaving uncertainty about the role of social layers in depression.

At the outermost layer, community provides a sense of belonging to one's broad social groups (Crocker et al., 1994; Hagerty et al., 1996). A sense of belonging is a universal human need; belonging to particular social groups is pervasive to the social world and fundamental to the constitution of daily human life (Calhoun, 2003). The need for belonging generally requires frequent and positive interactions with others who share similar interests, or a similar sense of identity. When the need for belonging is not met, psychological and physical consequences occur such as depression, anxiety, and loneliness. Membership within community and volunteer organizations can provide this sense of belonging. For example, Choenarom, Williams, and Hagerty (2005) found that the sense of belonging was negatively associated with depression.

At the intermediary layer, relationships increase opportunities to receive social support. People without supportive relationships tend to suffer decreased mental wellbeing for several reasons (Cohen, 2004; Thoits, 2011). Research has shown that interpersonal relationships provide substantial social support for older adults, beyond the support provided by spouses and family members (Seeman & Berkman, 1988). Social support protects mental health, in part because people with access to social support are better able to cope with stressors (Cohen & Wills, 1985). Indeed, the stress-buffering effect occurs when a person perceives that their network can provide aid (Kessler & McLeod, 1985). Social networks also provide opportunities for positive interactions such as sharing in quality communication and openness among friends and family members (Dorrance Hall et al., 2019). Openness is an important part of building and maintaining relationships and indicates trust between network members (Greene, Derlega, & Mathews, 2006). When older adults experience openness in their networks, they report lower levels of depression (Dorrance Hall et al., 2019).

Connection at the innermost layer, consisting of an intimate partner or spouse, is widely reported to enhance longevity and mental wellbeing. In an analysis of the benefits of marriage for adults in the United States, Waite and Lehrer (2003) reported that most U.S. adults are married and almost all will marry at some point in their lives. According to Waite and Lehrer, a consistent benefit of marriage is better mental health and longevity. Getting married (and staying married) is associated with psychological benefits for both men and women (Horwitz, White, & Howell-White, 1996; Simon, 2002). Those who are in happy marriages benefit from experiencing love, intimacy, and friendship with a partner who can provide support on a regular basis (Waite & Lehrer, 2003). Although relational satisfaction may vary, there are still benefits in stability and commitment because marriage encourages partners to invest in their relationship, making partners more likely to protect and care for one another. Consistent with these arguments, we expect that

> *H2:* The three layers of connection will be negatively associated with future depression. Specifically, people with (a) more

community participation, (b) larger interpersonal networks, and (c) an intimate partnership will have less depression in the future, relative to others.

Depression may also impact the ability to form or maintain relationships (Santini et al., 2020). Depression is associated with several negative outcomes comparable to major physical health conditions (Ormel et al., 1994; Spitzer et al., 1995). Chronic and emerging depression are linked to greater decline in physical ability over a 3-year period compared to never depressed older adults (Penninx et al., 2000). Depression can also limit older adults' ability to function in several ways (Beekman, Deeg, Braam, Smit, & Van Tilburg, 1997; Gallo, Rabins, Lyketsos, Tien, & Anthony, 1997). Physical and emotional problems may coincide with other challenges such as decreased ability to participate in (and reap the rewards of) social life. Mental health challenges such as depression are associated with social withdrawal (Bell-Dolan, Reaven, & Peterson, 1993; Rubin & Burgess, 2001) which may undermine a person's ability to grow and maintain relationships.

Symptoms of depression, such as decreased interest in social events may signal to one's social network that they need support, but may also interfere with a person's ability to attract social support (Brown, Andrews, Harris, Adler, & Bridge, 1986). For example, depression elicits negative peer responses, including social rejection of the depressed individual (Mullins, Peterson, Wonderlich, & Reaven, 1986). In addition, depressed individuals often fail to seek support directly (Geerts, Bouhuys, & Bloem, 1997). Creating and maintaining relationships is made difficult by depressive symptoms and the social responses they elicit.

At the interpersonal and intimate levels, depression may increase the propensity for conflict communication and erode the ability to provide support to others and reciprocate relational maintenance (Klerman, Weissman, Rounsaville, & Chevron, 1996; Mahon & Yarcheski, 2001), all of which may weaken relationships at the intermediary and innermost network layers. Interpersonal relationships "become disrupted" as a result of depression (Klerman et al., p. 62). In addition, Dorrance Hall et al. (2019) found that criticism from friends and family was linked with depressive symptoms in older adults. The negative consequences of depression on one's social life suggest that it will decrease social engagement over time and lead to greater isolation (Santini et al., 2020). Therefore,

H3: Depression will be negatively associated with the three layers of connection at later time points. Specifically, people with more depression (relative to others) will have (a) less community participation, (b) larger interpersonal networks, and (c) greater likelihood of having an intimate partner in the future.

Method

Participants and Procedures

Data were collected by the National Social Life, Health, and Aging Project (NSHAP; Waite et al., 2007). A representative sample aged 57–85 was selected from households across the United States in 2004. The response rate was 76% at the first wave (W1). Data collection occurred in three waves, with W1 between July 2005 and March 2006, wave 2 (W2) between August, 2010 and May 2011, and wave 3 (W3) between September 2015 and November 2016. Waves were approximately five years apart, and data collection included face-to-face interviews and questionnaires about topics such as their mental and physical health, their social networks, and demographics. The present sample consists of all 3,005 participants recruited during W1 (see attrition analysis below).

In terms of raw sample characteristics, at W1 the mean age was 69.3 years (SD = 7.9, range = 57–85). W2 mean age was 73.4 years (range = 62–91; SD = 7.5). At W3 the mean age was 76.9 years (SD = 6.8, range = 67–95). Regarding sex, 48% were male. In terms of race and ethnicity, 71% identified as White, 17% Black, 10% Hispanic, and the remainder (2%) identified as either Asian, Pacific Islander, American Indian, or Other. Regarding education, 23% had less than a high school diploma, 26% had a high school diploma or equivalent, 29% had some college or vocational training, and 22% had at least a bachelor's degree. In terms of employment status, 31% were working at W1, 21% were working at W2, and 15% were working at W3. Mean household assets were valued at $581,630.5 ($SD$ = 1,550,741, median = $200,000, skewness = 10.0).

Measures

Community-layer connection. Participants answered two items about their community engagement. Participants indicated their level of attendance at "meetings of any organized group [. . . such as] a choir, a committee or board, a support group, a sports or exercise group, a hobby group, or a professional society." Participants also indicated how often they "do volunteer work for religious, charitable, political, health-related, or other organizations." For both items, the 7-point ordinal scale ranged from never (0) to several times a week (6). W1 α = .75; W2 α = .74; W3 α = .75. See Table 1 for descriptive statistics at each wave.

Interpersonal-layer connection. During face-to-face interviews, participants were asked to identify important people in their life, including friends and confidants with whom they interact regularly and discuss important matters, as well as people with whom they live. Based on the list generated by participants, the number of named individuals was calculated to indicate interpersonal-layer connections, however, to exclude the partner-layer, spouses and romantic partners were not counted. As described by Lin et al. (1999), interpersonal connections represent an intermediary layer; in terms of involvement, they are between typical community and partner connections. In the sample, the size of the interpersonal layer ranged from 0–13 (W1), and 0–14 (W2 and W3). See Table 1 for means and standard deviations at each wave.

Partner-layer connection. Participants indicated whether they had a current spouse or romantic partner. This variable was coded 1 if they had a spouse or partner and 0 if they did not. See Table 1 for descriptive statistics at each wave.

Depression. Depression was measured with eight items from the Epidemiologic Studies Depression Scale (Radloff, 1991). Items asked about various symptoms experienced in the past week, for example, feeling depressed, feeling lonely, enjoying life (reverse-coded), having trouble sleeping and eating. For each item, a 4-point ordinal scale ranged from none of the time or rarely (1)

Table 1
Descriptive Statistics

	M (*SD*)					
	Wave 1		Wave 2		Wave 3	
Variable	Weighted	FIML	Weighted	FIML	Weighted	FIML
Connection type						
Partner	.72 (.45)	.66 (.47)	.67 (.47)	.60 (.49)	.64 (.48)	.54 (.50)
Interpersonal	3.73 (1.70)	3.72 (1.76)	4.04 (1.70)	4.05 (1.76)	3.68 (1.51)	3.67 (1.87)
Community	2.42 (1.88)	2.37 (1.90)	2.45 (1.94)	2.30 (1.94)	2.51 (1.98)	2.22 (2.00)
Depression	1.51 (.49)	1.53 (.50)	1.49 (.46)	1.52 (.48)	1.52 (.48)	1.56 (.50)
FHP	.19 (.38)	.16 (.40)	.19 (.40)	.24 (.44)	.23 (.43)	.33 (.51)
Employment status	.35 (.48)	.31 (.36)	.23 (.42)	.18 (.40)	.17 (.38)	.11 (.46)
Age	68.02 (7.69)	69.30 (7.85)	72.25 (7.27)	74.62 (7.86)	75.89 (6.43)	79.51 (7.87)

Note. The weighted estimates adjusted for different response probabilities. The weighted estimate uses listwise deletion (n = 3,005 [W1], n = 2,261 [W2], & n = 1,592 [W3]). FIML uses all 3,005 cases and is unweighted. Partner Layer is a dichotomous variable; the mean represents the proportion of the sample who have an intimate partnership. FHP = functional health problems; FIML = full information maximum likelihood estimation.

to most of the time (4). Confirmatory factor analysis (CFA) with full information maximum likelihood estimation (FIML) was used to test the unidimensionality of these items at each wave. The scale showed excellent fit and reliability: W1, $\chi^2(20) = 104.68$, $p < .001$ *CFI* = .97, *RMSEA* = .04, *SRMR* = .02; W2, $\chi^2(20) = 72.61$, $p < .001$ *CFI* = .97, *RMSEA* = .04, *SRMR* = .03; W3, $\chi^2(20) = 93.62$, $p < .001$ *CFI* = .95, *RMSEA* = .05, *SRMR* = .03; W1 α = .73; W2 α = .73; W3 α = .74. See Table 1 for descriptive statistics at each wave.

Control variables. Several additional variables were used as covariates to better estimate the effects of focal variables. Controls included demographic items such as participant sex, age, race, ethnicity, education, household assets, and employment status, along with a functional health problems scale. For employment status, participants indicated whether they were working at each wave. Both employment status and functional health were treated as time varying. Household assets were treated as time-invariant, capturing a participant's average self-reported assets across all waves. As expected, assets showed an extreme positive skew (>10). In this case, a log-transformed indicator was produced to remove the skew. Prior values of each DV were also used to control for autoregression.

Function health problems. Participants indicated how much difficulty they experienced performing functionally important behaviors (dressing themselves, bathing themselves, walking, getting in and out of bed, and using the toilet). For each of the five items, a four-point ordinal scale ranged from *no difficulty* (0) to *unable to do* (3). CFA tested the unidimensionality of these items at each wave. The scale showed excellent fit and reliability: W1, $\chi^2(5) = 44.45$, $p < .001$ *CFI* = .98, *RMSEA* = .05, *SRMR* = .02; W2, $\chi^2(5) = 33.90$, $p < .001$ *CFI* = .98, *RMSEA* = .05, *SRMR* = .02; W3, $\chi^2(5) = 29.46$, $p < .001$ *CFI* = .98, *RMSEA* = .06, *SRMR* = .03; W1 α = .80; W2 α = .79; W3 α = .78. See Table 1 for descriptives.

Analysis Plan

Longitudinal panel data can address processes that unfold over time. Structural Equation Modeling (SEM) is a general framework that enables simultaneous estimation of multiple outcomes. Longitudinal SEM can estimate the predictive power of each variable while holding constant other sources of influence, such as covariates, or prior time-points of each DV. SEM also enables tests of model fit (e.g., Bollen & Brand, 2010; Mueller & Hancock, 2008), and SEM allows comparisons between the magnitude of coefficients across time. We will implement cross-lagged panel models (CLPMs) due to their consistent parameter estimation and flexibility (Orth, Clark, Donnellan, & Robins, in press). Importantly, CLPMs address between-person effects, appropriate for the present research objectives.

In our analysis, we will include the following controls for each DV: age, sex, race, ethnicity, education, household assets, employment status, functional health problems. We will also control for prior values of DVs. Full information maximum likelihood estimation (FIML) will be used due to its relatively low bias and efficiency (Enders & Bandalos, 2001) along with robust standard errors (Chou, Bentler, & Satorra, 1991). Consistent with Bollen, Biemer, Karr, Tueller, and Berzofsky (2016), for univariate descriptives we will use a weighted adjustment generated by NSHAP that accounts for probability of selection and nonresponse rates. For the structural equation models, we will conduct a weighted association test (Fuller, 2011) to determine whether selection probability is associated with any outcomes in the model. If the test reveals no significant association, unweighted models will be estimated for more precise standard errors (Bollen et al., 2016; Winship & Radbill, 1994).

We will use CFA to test the full measurement model, including all waves simultaneously. The measurement model will specify configural and metric equivalence (Dimitrov, 2010) to further test the comparability of measures across time. Because indicator-specific variance is expected across time (Little, Preacher, Selig, & Card, 2007) residuals for the same indicator at each wave will not be constrained, for example, the residuals for item 1 at W1–W3 will be allowed to covary. Because auto-regression is expected, the fit of simple auto-regressive (AR) models with a lag-length of 1 will be tested for each dependent variable. Depending on model fit, larger lag-lengths may be specified for the auto-regressive process. This should help control for auto-regressive effects, and therefore better estimate the influence of other variables (Liew, 2004). Regarding the structural model, paths will we specified according to predictions, with all proposed causes preceding their effects.

Results

Full Measurement Model

CFA was conducted on the full measurement model including the following latent variables at W1–W3: depression (8 indicators), partner layer connection (1 indicator), interpersonal layer connection (1 indicator), and community layer connection (2 indicators), and functional health (5 indicators). In total, the model had 15 latent variables, 51 indicators, and assumed configural and metric equivalence (equivalent items and factor loadings; Dimitrov, 2010). Specifically, identical indicators were used, and factor loadings were constrained to be equal across waves. The model implemented FIML estimation to address missing data. Results showed good fit, $\chi^2(889) = 2620.110$, $p < .001$, *CFI* = .95, *RMSEA* = .02, *SRMR* = .04, consistent with valid measurement. A detailed model output can be accessed at https://osf.io/wxmbf (Meng, Reynolds, & Dorrance Hall, 2020).

Attrition Analysis

Attrition was expected due to the 5-year interval between waves and the age of participants. W2 retained 2,261 participants, corresponding to an attrition rate of 25% between W1 and W2. W3 retained 1,592 participants, indicating an additional 30% attrition between W2 and W3. In total, 53% of W1 participants responded at all three waves. To probe covariates of attrition, correlations were estimated between attrition and both time-invariant and W1 model variables. For this analysis, nonattrition indicates participation in all three waves. SEM was used to enable FIML estimation, as not every participant had a score for every variable. SEM allows latent variables and helps correct for measurement error. Table 2 shows that attrition was associated with many variables in the model.

To further assess the predictors of attrition, a regression model was estimated to control for the influence of each factor. FIML estimation was again used with latent variables for depression, community-layer connection, and functional health problems (all others were manifest). Table 3 displays multiple significant coefficient estimates, with age being the strongest predictor. Unsurprisingly, participants who were older at W1 were less likely to complete the study. Although W1 depression was significantly correlated with attrition, it was not a significant predictor in the regression model, controlling for other factors. Altogether, these results suggest multiple sources of attrition, yet much of the variance was unexplained. As described by Graham (2009) nonrandom attrition reiterates the need to include all such variables in the model and apply a method like FIML estimation to address missingness. We return to this issue in the discussion.

Table 3
Predictors of Attrition

Variable	β
W1 Depression	.04
W1 Partner connection	−.05**
W1 Interpersonal connection	−.02
W1 Community connection	−.09***
W1 Functional health problems	.10***
W1 Age	.30***
W1 Job status	−.04*
Assets	−.10***
Sex	.10***
Education	−.01
Race: Black	−.07
Race: White	−.06
Ethnicity: Hispanic	−.10*
N = 3,005	
R^2 = .19	

Note. β = standardized path estimates. Full information maximum likelihood (FIML) estimation was used. For sex, 0 = female, 1 = male.
* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed).

Descriptive Statistics and Trends

Changes in univariate statistics were expected (see Table 1) due to participants aging over time Although three time-points does limits robust trend analysis, several patterns appear. For example, fewer people have a partner as they advance into old age, with significant decreases between each wave ($p < .001$). Although the interpersonal layer shows no linear trend, the mean fluctuates significantly, increasing from W1 to W2 ($p < .001$) and then decreasing from W2 to W3 ($p < .001$). Depression did not significantly change from W1 to W2, but people were significantly more depressed at W3 versus W2 ($p < .001$). Finally, functional health problems showed a clear increase at W3, compared with W1 & W2 ($p < .001$). To better describe the associations among variables, Table 4 displays the full correlation matrix.

Lag Length Selection for Autoregressive Effects

Before specifying the structural model, the appropriate autoregressive lag length for each outcome was investigated (see Liew, 2004). The interval between each wave is five years. Despite the length, information about participants is expected to predict out-

Table 2
Correlations Between Model Variables and Attrition

Variables	Dep.^{W1}	L1^{W1}	L2^{W1}	L3^{W1}	FHP^{W1}	Age^{W1}	Job^{W1}	Assts.	Sex	Ed.	White	Black	Hisp.
Attrition	.15***	−.16***	−.06**	−.16***	.21***	.36***	−.21***	−.19***	.04*	−.16***	−.01	.03	.03

Note. n = 3,005. W1 = wave 1. Correlations were estimated with full information maximum likelihood (FIML). Attrition = dropping out of study before W3 (dichotomous); Dep. = Depression (latent); L1 = partner layer connection; L2 = interpersonal layer connection; L3 = community layer connection (latent); FHP = functional health problems (latent); Job = employment status; Assts. = average household assets across all waves; sex = biological sex (female = 0, male = 1); Ed. = education level; White = White racial category; Black = Black racial category; Hisp. = Hispanic ethnicity.
* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed).

Table 4
Correlations

Variable	Correlation																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Depression W1																									
2. Depression W2	.65																								
3. Depression W3	.61	.67																							
4. Partner W1	−.22	−.18	−.15																						
5. Partner W2	−.20	−.23	−.15	.74																					
6. Partner W3	−.20	−.24	−.26	.69	.79																				
7. Interpersonal W1	.04	.03	−.01	−.17	−.15	−.11																			
8. Interpersonal W2	.01	.03	.02	−.18	−.22	−.18	.37																		
9. Interpersonal W3	.02	.00	.04	−.13	−.17	−.20	.27	.34																	
10. Community W1	−.19	−.17	−.19	.04	.04	.06	.21	.12	.14																
11. Community W2	−.18	−.17	−.19	.04	.05	.08	.18	.11	.15	.84															
12. Community W3	−.29	−.22	−.31	.10	.09	.13	.16	.10	.12	.71	.82														
13. FHP W1	.39	.25	.33	−.13	−.12	−.14	−.04	.01	.00	−.22	−.20	−.29													
14. FHP W2	.35	.32	.42	−.14	−.14	−.18	.01	.01	.03	−.18	−.21	−.29	.72												
15. FHP W3	.34	.33	.44	−.18	−.18	−.24	−.01	.01	.00	−.15	−.20	−.37	.60	.73											
16. Employment W1	−.19	−.14	−.19	.14	.16	.18	−.01	.02	.02	.04	.07	.17	−.21	−.19	−.24										
17. Employment W2	−.15	−.16	−.19	.11	.11	.16	.02	−.01	.04	.10	.10	.18	−.16	−.17	−.21	.53									
18. Employment W3	−.12	−.09	−.14	.09	.10	.15	−.04	−.05	.01	.11	.10	.15	−.08	−.11	−.17	.34	.48								
19. Age	.08	.12	.22	−.26	−.30	−.38	−.03	−.01	.00	.00	−.07	−.20	.13	.17	.30	−.39	−.30	−.26							
20. Sex	−.16	−.15	−.19	.31	.34	.36	−.21	−.21	−.16	−.11	−.08	−.04	−.09	−.09	−.08	.11	.09	.08	−.08						
21. Race-White	−.08	−.05	.04	.11	.08	.07	.02	−.03	.01	.09	.11	.09	−.10	−.07	−.04	.03	.06	.04	.07	.01					
22. Race-Black	.04	.04	−.02	−.15	−.13	−.12	.04	.01	−.03	.02	.00	−.01	.07	.07	.02	−.07	−.08	−.05	−.02	−.04	−.70				
23. Ethnicity-Hispanic	.08	.02	−.02	.01	.02	.01	−.08	.03	.02	−.16	−.18	−.16	.06	.02	.04	.03	−.01	−.03	−.07	.01	−.52	−.15			
24. Assets	−.31	−.25	−.21	.36	.34	.33	.04	−.02	.01	.23	.24	.32	−.23	−.20	−.23	.14	.15	.06	−.11	.16	.36	−.32	−.18		
25. Education	−.20	−.17	−.13	.17	.19	.19	.10	.00	.04	.33	.37	.36	−.18	−.16	−.18	.19	.19	.14	−.19	.10	.28	−.18	−.23	.48	

Note. Correlations were obtained with FIML estimation (n = 3,005). Sex was coded 1 = male, 0 = female. FHP = functional health problems; FIML = full information maximum likelihood.

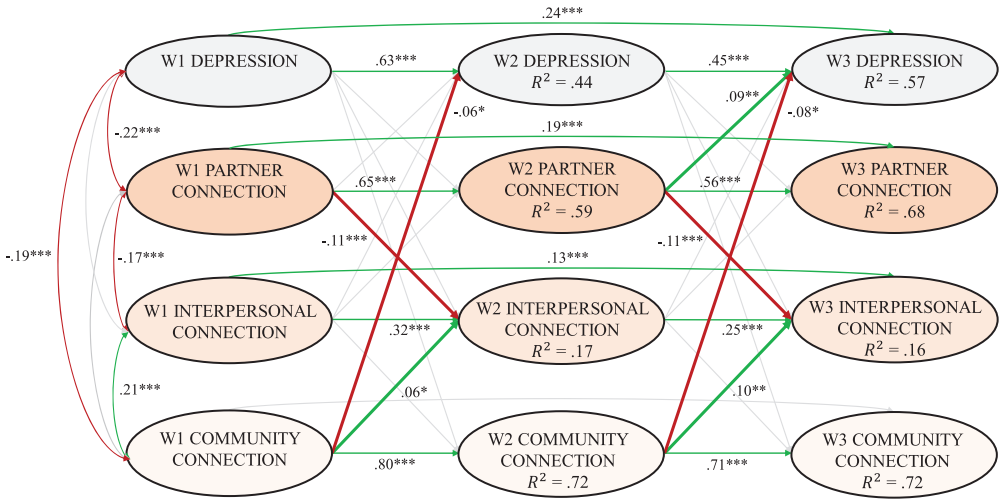

Figure 2. Structural model for waves 1–3. This figure does not display the measurement components included in the model (i.e., latent variable structure and factor loadings) or control variables (age, sex, race, ethnicity, education, household assets, employment status, and functional health problems). Coefficients represent standardized path and correlation estimates. Red arrows indicate negative associations, green arrows indicate positive associations. Nonsignificant estimates are not displayed. * $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed). See the online article for the color version of this figure.

comes at future times. For example, in terms of autoregression, depression at W1 might predict depression at W3. However, if depression is an AR1 process (autoregressive lag-length = 1) then W1 depression should only affect W3 depression through its effect on W2. An AR1 process means that auto-regressive effects extend forward only a single interval (in terms of direct effects).

Likelihood-ratio model-comparison tests were conducted for each outcome. They revealed the AR1 model did not fit the data for depression ($p < .001$), for partner layer connection ($p < .001$), or for interpersonal layer connection ($p < .001$). The covariance matrix revealed that, for these variables, W1 and W3 were more strongly correlated than the AR1 model would predict, suggesting the autoregressive effects occur beyond a single-interval. To account for longer run AR influence, the structural model was specified with AR1 and AR2 paths, increasing statistical control and more accurately reflecting the apparent causal process.

Structural Model and Hypothesis Tests

The structural model was specified with the same four endogenous variables at W2 and W3 (partner connection, interpersonal connection, community connection, and depression). W1 was considered exogenous and no contemporaneous effects were modeled. Figure 2 displays the structural model. The combined measurement and structural model demonstrated good fit, $\chi^2(1201) = 3206.97$, $p < .001$ *CFI* = .95, *RMSEA* = .02, *SRMR* = .04.[1] A detailed model output can be accessed at https://osf.io/wxmbf (Meng et al., 2020).

H1 predicted that outer layer connections would promote inner layer connections, specifically, that (a) community connections will tend to increase interpersonal connection, and (b) interpersonal connection will generally increase partner connections. H1 was partially consistent with the data; the predicted path (a) from community to interpersonal connection was significant and positive for the W1–W2 interval ($\beta = .06$, $p = .025$) and the W2–W3 interval ($\beta = .10$, $p = .001$), however, there was no significant path (b) from interpersonal to partner connection (see Table 5 for unstandardized path estimates).

RQ1 asked whether inner layer connections would increase outer layer connections. Results did not show that connections are promoted from inner to outer layers, however, there were negative paths suggesting that intimate partnership decreases the number of interpersonal connections. The result was significant for the W1–W2 interval ($\beta = -.11$, $p < .001$) and the W2–W3 interval ($\beta = -.11$, $p < .001$).

H2 predicted that network connections of all types would decrease depression. This prediction was partially supported but partially contradicted by the data. Specifically, there were significant negative paths from (a) community connection to depression (W1–W2: $\beta = -.06$, $p = .038$, W2–W3: $\beta = -.08$, $p = .011$), but not from (b) interpersonal connection to depression. Contrary to predictions, partner connection was associated with increased depression, but only for the W2–W3 interval ($\beta = .09$, $p = .001$). See Table 5 for unstandardized path estimates.

H3 predicted that depression would decrease relational connections at future time points. Results did not support this hypothesis. No significant paths were obtained from depression to either (a) community connection, (b) interpersonal connection, or (c) partner

[1] To determine whether selection probability was associated with any outcomes in the model, the response-adjusted weighting variable was added to structural model as a predictor of each outcome. In the model, there was no significant association between the weighting variable and any outcome variable. Therefore, unweighted models will be estimated for hypothesis tests due to more precise standard errors (Bollen et al., 2016; Winship & Radbill, 1994).

Table 5
Unstandardized Path Estimates

IV	DV	W1→W2		W2→W3	
		B	*SE*	*B*	*SE*
Community	Interpersonal	.059*	.026	.090**	.028
Community	Depression	−.011*	.005	−.014*	.006
Interpersonal	Community	.006	.021	.010	.025
Interpersonal	Partner	−.004	.004	−.001	.004
Interpersonal	Depression	.001	.004	.004	.004
Partner	Interpersonal	−.422***	.085	−.348***	.090
Partner	Depression	−.001	.017	.061**	.019
Depression	Partner	−.041	.032	−.068	.036
Depression	Interpersonal	−.215	.163	−.087	.158
Depression	Community	−.083	.159	−.195	.180

Note. $n = 3005$. IV = independent variable; DV = dependent variable; Partner = partner connection; Interpersonal = interpersonal connection; Community = community connection.
* $p < .05$. ** $p < .01$. *** $p < .001$.

connection. This lack of findings was consistent for the W1–W2 and the W2–W3 interval.

Coefficient Stability

Except for the link between partner connection and depression, the W1–W2 coefficients appear consistent with those from W2–W3. Potential instability of effects warrants further examination, therefore we directly assessed whether paths significantly differed between the two intervals. Likelihood ratio tests allow the assumption of path-equivalence to be tested by comparing the fit of nested SEMs. Results show that coefficients did not significantly differ for the community-to-depression path, $df_\Delta = 1$, $\chi^2_\Delta = .53$, $p = .47$, nor for the partner-to-interpersonal path, $df_\Delta = 1$, $\chi^2_\Delta = .36$, $p = .55$, nor for the community-to-interpersonal path, $df_\Delta = 1$, $\chi^2_\Delta = .75$, $p = .39$. In contrast, the partner-to-depression path differed between the W1–W2 interval and the W2–W3 interval, $df_\Delta = 1$, $\chi^2_\Delta = 7.23$, $p = .007$.

Post Hoc Analyses

Widowhood. To probe the instability of the partner-to-depression path, multiple-group SEM was conducted. In addition, the positive link between partner status and depression at the W2–W3 warrants further investigation. Having a partner later in life may increase depression through exposure to partner loss. Therefore, the parameters were estimated for participants who were widows/widowers at W3 ($n = 441$) and then for those who were not ($n = 1{,}151$). The model revealed a significant interaction, confirmed by a likelihood ratio test showing that the coefficients were significantly different, $df_\Delta = 1$, $\chi^2_\Delta = 18.09$, $p < .001$. For participants who were *not* widows/widowers at W3 there was no significant effect of W2 partner connection on W3 depression, $b = .03$ ($SE = .03$), $\beta = .04$, $p = .30$, but for participants who *were* widows/widowers at W3, W2 partner connection was a positive predictor of W3 depression, $b = .22$ ($SE = .05$), $\beta = .26$, $p < .001$. This suggests the overall positive association between partner connection and subsequent depression is at least in part due to losing a spouse or partner.

A similar interaction was observed for the effect of W1 partner connection on W2 depression. For participants who were *not* widowed at W2 ($n = 1{,}666$), the coefficient was $b = -.05$ ($SE = .02$), $\beta = -.07$, $p = .027$, whereas for participants who *were* widows ($n = 595$), the coefficient was $b = .09$ ($SE = .03$), $\beta = .14$, $p = .007$. The point estimates were each significant in opposite directions, and a likelihood ratio test confirmed the coefficients were significantly different from each other, $df_\Delta = 1$, $\chi^2_\Delta = 19.12$, $p < .001$. There was also a positive correlation between age and having been widowed: for W1, $r = .36$, $p < .001$; for W2, $r = .39$, $p < .001$; for W3, $r = .42$, $p < .001$. These analyses suggest that having a partner earlier in life may reduce depression, but later in life it increases the risk of losing a critical relationship which in turn increases depression.

Because the downstream effects of the spousal relationship are conditional on widowhood, we further explore this phenomenon. Like above, multiple-group SEM was conducted to determine whether the negative partner-to-interpersonal link depends on the loss of a spouse. Results showed significant moderation. For participants who were widows/widowers at W3 there was no significant effect of W2 partner connection on the W3 interpersonal layer, $b = .04$ ($SE = .16$), $\beta = .01$, $p = .78$, but for participants who were *not* widows/widowers at W3, W2 partner connection was a negative predictor of W3 interpersonal ties, $b = -.33$ ($SE = .12$), $\beta = -.08$, $p = .007$. A likelihood ratio test confirmed the coefficients were significantly different from each other, $df_\Delta = 1$, $\chi^2_\Delta = 4.28$, $p = .038$.

Similarly, for participants who were widows/widowers at W2 there was no significant effect of W1 partner connection on the W2 interpersonal layer, $b = -.04$ ($SE = .29$), $\beta = -.01$, $p = .89$, but for participants who were *not* widows/widowers at W2, W1 partner connection was a negative predictor of W2 interpersonal ties, $b = -.45$ ($SE = .11$), $\beta = -.10$, $p < .001$. A likelihood ratio test confirmed the coefficients were significantly different from each other, $df_\Delta = 1$, $\chi^2_\Delta = 4.44$, $p = .035$. These results suggest that the negative effects of the spousal relationship on interpersonal connections do not persist after losing a spouse.

Age. Table 4 shows that age is associated with multiple outcomes; it may also play a moderating role by changing the association between connections at different layers. To address this possibility, a median split created two age categories (*median* = 69 years at W1). SEM was used to fit the model to both groups. Results showed that all significant paths from the primary analysis remained in the same direction for each age group, however, two additional significant paths were revealed. For the older group, W1 depression was associated with reduced *interpersonal-layer* connection at W2, $b = -.80$, $SE = .27$, $\beta = -.13$, $p = .003$, but there was no effect at the W2–W3 interval, $b = -.03$, $SE = .25$, $\beta = -.01$, $p = .89$. For the younger group, W2 depression was negatively associated with *partner-layer* connection at W3, $b = -.14$, $SE = .06$, $\beta = -.08$, $p = .014$, but there was no effect at the W1–W2 interval, $b = -.05$, $SE = .04$, $\beta = -.04$, $p = .22$.

Discussion

Summary of Results

The current study examined how social networks influence depression in older adults, and how older adults' networks evolve

over time. This study applied a network layer perspective to obtain novel results. In this aging population, community connections appear to reduce future depression. This result is especially interesting given the 5-year interval between waves and the stability of the effect, suggesting a long-lasting benefit. Results also show that influence among relationship layers goes in multiple directions. Specifically, our results indicate that intimate partnerships negatively influence the size of interpersonal networks. On the other hand, the community layer has an opposite effect on the interpersonal layer, as greater community connection increases a person's interpersonal network. In addition, beneficial effects of partner connection on mental health appear to dissipate in old age. Contrary to predictions, we found that having a partner later in life may increase the risk of future depression, relative to those who have no partner. Our post hoc analysis shows the risk of losing a partner increases with age, and that losing a partner significantly increases depression. We found some evidence that depression influences social ties among older adults, but the effect was inconsistent, and appears to depend on several factors that warrant further study.

Theoretical Implications

Interconnections among the three layers of social relationships. The present study found the only influence from outer relationship layers to the inner layers was the positive effect of community participation on interpersonal networks. This finding is consistent with the literature on civic participation such that community involvement creates opportunities for expanding one's interpersonal networks and facilitates trust in interpersonal ties (Welch et al., 2005). Other literature has found that weak ties promote effective maintenance of close relationships among older adults (Huxhold, Fiori, Webster, & Antonucci, 2020). In the present study, however, neither community participation nor the size of interpersonal networks was correlated with having a spouse or a partner. This may indicate that engaging in shared community activities is not a particularly important factor for maintaining intimate relationships (Derlega, 1984; Davis & Oathout, 1987). Although older adults are likely to expand their interpersonal networks via their partners (Kalmijn, 2003), their own interpersonal networks may shrink at the same time because of limited time and energy invested in regular communication with their own interpersonal relationships. This explanation is consistent with our findings for H2.

The only significant inner-to-outer layer effect was the negative association between intimate partnership and the size of future interpersonal networks. This finding is consistent with the dyadic withdrawal hypothesis (Johnson & Leslie, 1982; Kalmijn, 2003), and social compensation mechanisms (Ferraro, 1984; Ferraro, Mutran, & Barresi, 1984; Rook & Schuster, 1996). Older adults who have lost a spouse or intimate partner may require more interpersonal contact to meet their emotional needs. Interpersonal-layer contacts who are familiar with older adults could provide reliable and predictable social interactions that facilitate emotional gains. At the same time, research on the dyadic withdrawal hypothesis shows that increased romantic involvement leads to decreased involvement with other social connections (Johnson & Leslie, 1982). Furthermore, as spousal/partner relationships grow over years, couples may spend more time with their shared friends and less time with their own friends, with whom partners do not share a connection. This is consistent with general findings that older adults with more close relationships tend to have fewer distant relationships in the future (e.g., "weak ties"; Huxhold et al., 2020). The present results extend the literature by applying the relational layers perspective and showing that intimate, interpersonal, and community ties play distinct roles in social network dynamics.

Layers of relationships and depression. Across the three waves of observations, layers of social relationships had significant effects on depression, but depression did not seem to have a general effect on social relationships. The post hoc analysis revealed that depression can have a negative impact on the partner layer or interpersonal layer, however, this finding was inconsistent across waves and contingent upon other factors such as age. These findings accord with an extensive literature on the impact of relationships and social networks on mental well-being (Kawachi & Berkman, 2001), and reveal a lack of consistent reciprocal effects of depression on social relationships among older adults. These findings highlight how embeddedness within social networks shapes the psychological well-being of older adults (Taylor et al., 2018). In cases where depression does lead to less interpersonal-layer and partner-layer connection, future research could identify which mechanisms precipitate the effect. For example, the experience of depression may lead to social withdrawal (Rubin & Burgess, 2001) or may increase social rejection from peers.

In our findings, involvement in community organizations and in volunteering (e.g., the outer-most layer) consistently showed benefits for older adults' mental wellbeing. Based on past research and theorizing, community involvement induces a sense of belonging for people, which is a universal human need (Baumeister & Leary, 1995). The findings of this study support previous research and theorizing that has championed the importance of engaging in one's community for mental health. This finding is especially important to replicate in this older adult sample as mobility tends to decline as people age, making it more difficult to attend community meetings and spend time volunteering outside the home (Cornwell, Laumann, & Schumm, 2008). According to Cornwell and colleagues, community involvement uniquely predicts wellbeing (beyond interpersonal relationships) because of the resources available in group-level and community forums. Indeed, groups such as religious organizations offer both a sense of belonging and opportunities to give back through volunteering (e.g., Li & Ferraro, 2006). Therefore, community involvement may enhance wellbeing by increasing material and social resources, as well as by strengthening collective identity (Hawkley et al., 2005). At the same time, outer-layer relationships may produce less ambivalence than inner-layer relationships, as suggested by Huxhold et al. (2020). In particular, community involvement may attract people with common goals (Bang & Ross, 2009) and organize activities around a shared purpose. In turn, this may enable social support with less relational investment and less potential for conflict.

Partner connection and loss. Contrary to expectations, having a partner offered only limited protection against depression in future years when controlling for prior depression and other relational layers. The potential benefit of partnership on mental health diminished and even reversed as people advanced into late adulthood, and having a partner seems to increase the risk of depressive symptoms later in life. Our post hoc analysis suggests this effect is

due to the increased risk of partner mortality in old age, coupled with the substantial increase in depressive symptoms that result when a partner passes away. Although the main effect was unexpected, it is consistent with aspects of prior literature on the effects of loss (e.g., Kalmijn, 2017), and the present results extend knowledge about how relationships influence depression.

Prior research has found that intimate partnership can promote mental health (e.g., Simon, 2002; Waite & Lehrer, 2003), but recent scholarship increasingly highlights the complexity of processes responsible for the effect (Kalmijn, 2017). Much of this research, however, has focused on younger adults. The present finding, that the link between intimate partnership and depression changes over time, demonstrates a need to design research for specific demographics. The benefits of partnership may come with a deferred cost; for example, Simon (2002) also found that losing a partner is associated with increased depression, and Kalmijn (2017) found the negative effects of relationship loss were stronger than the beneficial effects of having a relationship. The asymmetry between having and losing a partner may be exacerbated for older adults. Despite attempts to compensate socially after the loss of an intimate partner (Ferraro, 1984; Ferraro & Farmer, 1995), people may perceive less opportunity to make new life partners as they age, they may have less functional ability to do so, and, it may be impossible to replace a relationship that involved a lifetime of shared experiences.

The impact of partner loss also speaks to the dyadic withdrawal and social compensation mechanisms (Carstensen et al., 1999; Johnson & Leslie, 1982). Connection at the partnership layer was associated with fewer interpersonal ties in the future, but the effect was only observed when the partner remained alive. When the partner relationship is lost through widowhood, it no longer displaces interpersonal connections. Future research could assess whether the impact of partner loss disproportionately affects individuals who have fewer interpersonal connections or less ability to form new ones. In addition, research could further explore gendered effects of widowhood (e.g., Lee, DeMaris, Bavin, & Sullivan, 2001; Umberson, Wortman, & Kessler, 1992), and differences in social networks between men and women after relational loss.

Pragmatic Implications

This study offers several practical implications for older adults and those who work with older adults. The composition of social networks can be assessed and intervened upon. Although the present study cannot prescribe any intervention, it is clear that differences in one's social world impact older adults mentally (Cornwell, 2009; Wright & Brown, 2017) and physically (Uchino & Garvey, 1997; Uchino, Berg, Smith, Pearce, & Skinner, 2006). Some research has explored social interventions (e.g., Garrison & Howe, 1976), but there is a need to further address this possibility. In cases where functional health is a concern, or where depression is severe, there may be greater need to intervene. Interventions could involve assessment of older adults' networks at the three relationship layers. Once the strength of each layer has been assessed, interventions could be put in place to strengthen older adults' network to provide mental health protection. Future research is needed to identify the conditions and individual characteristics under which particular interventions are most effective. To aid in generating interventions to test in future work, several simple network interventions are suggested below.

First, our study suggests that community involvement leads to more interpersonal connections at later time points. This indicates that people who lack midlayer relationships may benefit from spending more time taking part in community organizations or volunteering. They may also be coached on building relationships to take acquaintances from the outer-most layer to friendships from which they can solicit and receive support. New relationships are not immediate replacements for the deeper connections of established friendships, but can be the foundation for creating genuine relationships when properly invested in. Community involvement, which provides a general sense of belonging, was also consistently related to lower levels of depression, indicating this layer is especially important for interventions. Interventions may encourage older adults to sign up for community organizations or volunteer opportunities, may provide those opportunities, or may remove barriers for attending those opportunities such as offering rides or bringing meetings or groups to the older adults' nearby community.

Second, our study found that having a partner was negatively associated with the size of interpersonal social networks over time. Previous literature has claimed the importance of having friends for psychological well-being among older adults (Fiori et al., 2006). These competing pieces of information suggest that older adults might benefit from being reminded that they should continue to invest in their intimate partnership while being sure they do not sacrifice high quality interactions with their friends. Those who work with older adults may facilitate time spent with other couples in order to achieve both ends or provide activities designed to encourage time spent with friends and not just partners.

Limitations and Future Directions

This study adopted a network perspective to examine how social relationships develop over time and influence depression in older adults. The contributions of this study help explain the belonging-bonding-binding function of social layers, and the different routes by which relationships exacerbate or protect against depression. Strengths of the present research include the longitudinal nature of the data and the national representativeness of the older adult sample. Nonetheless, some limitations should be considered. Although the present results reinforce the utility of the "layers" approach to classifying social ties (e.g., Lin et al., 1999), more nuanced distinctions may be fruitful in future research. From inner-most to outer-most, layers tend to differ in multiple ways, including the level of closeness involved, mutual trust, interdependence, relational satisfaction, and the frequency of interactions. Given that each layer serves particular social functions, questions remain about which aspects of these relationship layers are responsible. For example, perhaps the belongingness function of community ties requires a level of closeness to individual community members. A more comprehensive investigation of relational quality would better address such questions. There would also be value in more detailed descriptions of relational characteristics across time, such as closeness (Berscheid, Snyder, & Omoto, 1989), satisfaction (Emmers-Sommer, 2004), and compatibility (Huston & Houts, 1998).

The quality of relationships also varies within a given layer. For example, in the present data, the interpersonal layer included people who were either close friends, confidants, or living together (excluding spouses and romantic partners). As conceptualized by Lin et al. (1999), interpersonal connections occupy an intermediary level between partners and the community layer. These interpersonal relationships inevitably take many forms, and therefore differences between interpersonal networks may less precisely indicate the availability of support and companionship. Likewise, partner-level connections exhibit a range of characteristics across dyads (e.g., Park & Rosén, 2013), and relationships may alleviate or amplify depression, depending on the communication behavior they contain (Dorrance Hall et al., 2019). A relationship can be a source of positive or negative opportunity at any level. The present study describes general tendencies at the relational and individual level, but the role of social interaction is less understood. Despite the limitations, we argue that a structural approach is consistent with a communication-centered one. Observing the effect of relationship layers provides further rationale for studying the dyadic quality and communication in each relationship. In this way, future research can add complexity to better understand the present results. The socials layers approach offers a degree of nuance while retaining parsimony.

The nature of the sample represents a limitation in several respects. As the attrition analysis revealed, many participants did not participate in all three waves, and many factors were associated with the likelihood of dropping out of the study. The present study followed recommendations of Graham (2009) to include covariates of attrition in regression models, and to use FIML estimation. Nonetheless, much is unknown about the participants who dropped out, and the exact cause of attrition. This limitation will remain pernicious in research that relies on voluntary participation over many years, especially for older participants; in our sample, age was the strongest predictor of dropout.

The present data have the benefit of a 10-year span (with 5-year intervals), allowing a glimpse of the long-run dynamics of depression and relational development. Arguably, the ability to predict future outcomes is more remarkable as the interval increases. On the other hand, short-term effects would not be detectable in the current data. With a faster sampling rate and more time-points, trajectories and effects could be described in more detail. For example, using 1-year intervals, Kalmijn (2017) showed both long and short-term associations between relationship developments and mental health. Null findings in the present study may not indicate a true lack of effect, but merely processes unfolding at different timescales. For example, beginning and ending a relationship may have both immediate and long-lasting effects, but mental health issues may gradually impact relationships, consistent with the social allergens perspective (Cunningham, Barbee, & Druen, 1997).

The use of three waves in the present study is an advantage that allows tests of coefficient instability across time, however, additional analytic techniques would be possible with more intervals (Orth et al., in press). With more points there is greater ability to evaluate and account for trends at the aggregate or individual level. Recent research has developed methods of analyzing within-person effects (Berry & Willoughby, 2017; Hamaker, Kuiper, & Grasman, 2015; McArdle, 2009). For example, individuals with equally high depression may respond differently depending on their own prior experience with such symptoms, leading to different relational outcomes. The present study controlled for prior states but focused on between-person effects, given the research objectives.

Although the present sample is representative of a particular cohort, future generations will likely enter old age with different racial, economic, educational, technological, and relational characteristics. Specifically, the racial composition of the present sample does not reflect the demographics of younger Americans, where minorities comprise a larger proportion (Aguirre & Turner, 2009). The present study statistically accounted for the effects of race and ethnicity; however, research could explicitly examine group differences among older populations. This should be increasingly important as diversity increases.

Ongoing technological changes are of theoretical interest due to their potential to influence relationships and depression. As adoption of social-networking platforms becomes widespread from an early age (Quinn & Oldmeadow, 2013), future generations may have greater ability to maintain or form new relationships throughout adulthood. On the other hand, there is concern that social media use may increase depression (Lin et al., 2016), perhaps by promoting unfavorable social comparison. In addition, social media use may be linked with deficits in social skills (Jin & Park, 2013), although it is unclear whether these effects substantially impact older adults. For future generations, relational development and community involvement may increasingly be an online phenomenon. As new technologies emerge, they inevitably change the social environment, requiring new research to document evolving contexts and determine what assumptions remain valid.

Conclusion

As the number of older adults increases, the social dynamics affecting mental health among the elderly are important to understand. Depression is a condition with severe negative consequences and older adults are particularly vulnerable to its effects. Social connections provide opportunities that can promote or harm mental health, and this process occurs at multiple relational layers. This study used longitudinal data to examine the process over time. Community involvement showed consistent benefits in reducing depression. In contrast, intimate partnerships appear to increase susceptibility to depression among older adults, specifically through exposure to the severe outcomes of partner loss. Importantly, relationships at different layers influence one another. In general, intimate partnerships reduce future interpersonal connections, while community involvement increases future interpersonal connections for older adults. Although the mechanisms involved in these processes deserve additional exploration, the present findings give practical and theoretical guidance regarding the social dynamics of depression among the aging population.

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