Examining the Longitudinal Bi-directional Associations of Friend Engagement, Social Functioning, and Depression

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The data that support the findings of this study are openly available at the Wisconsin Longitudinal Study's website: https://researchers.wls.wisc.edu. The script for processing the raw data and running the models, as well as the output files are available here: https://osf.io/wbkam/?view_only=5643f099a7e04037a5eb2537e858536f. We have no conflicts of interest to disclose.

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Abstract

Various components of social functioning predict depression and these associations can vary by gender. Bi-directional associations may be important to consider as social factors may influence depressive symptoms while depressive symptoms may impact social factors. Most previous longitudinal research examining bi-directional effects has traditionally used the cross-lagged panel model (CLPM), which has some inherent weaknesses. This study sought to apply a more comprehensive analysis to examine bi-directional associations between friend engagement, social functioning, and depressive symptoms. Random intercept cross-lagged panel models (RI-CLPM) were tested on three waves from the Wisconsin Longitudinal Study (N = 5,890). Average levels of social functioning were positively associated with friend engagement and negatively associated with depression. Fluctuations in social functioning and friend engagement were negatively associated with same-wave depressive symptoms. Lastly, depression was predicted by previous fluctuations in social functioning, although the findings varied by gender. This study showed that the relationships between social factors and depression are apparent within and across large time intervals, even while controlling for between-person associations. These findings add further support to the need to attend to social life as a predictor of depression in older adults. Future research could improve upon this research by examining the characteristics of the friendship interactions and including more diverse samples.

Keywords: friend engagement; social interaction; social functioning; depression; longitudinal; bi-directional

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The World Health Organization states that approximately 280 million individuals in the world suffer from a depressive disorder, and that it is the leading cause of disability (World Health Organization, 2021; Friedrich, 2017). A diagnosis of major depression is typically warranted when one or both of the two core symptoms (depressed mood and lack of interest) are present along with other symptoms such as feelings of worthlessness or guilt; concentration problems; fatigue; psychomotor agitation; sleep impairment; weight changes; and recurrent thoughts of death or suicidal ideation (American Psychiatric Association, 2022). The number of symptoms and their frequency can determine the severity of the depressive episode. Looking beyond diagnosable disorders, even subclinical symptoms can still have negative impacts on functioning (Cujipers et al., 2014). Overall, depressive symptoms interact to create problems in daily living (American Psychiatric Association, 2022; Mohebbi, et al., 2019). Studies indicate that prevalence rates of major depressive disorder tend to be lower among the older population, but rates of minor depression and subclinical levels of depressive symptoms tend to increase from middle adulthood to older adulthood (Blazer, 2003; Butchtemann, Luppa, & Heller, 2012). In light of these trends, it is important to better understand what factors might be related to depression for older adults. The present study examines the bi-directional associations of depression with friend engagement and social functioning to provide insight into one important factor that may contribute to depression.

Social Factors and Depressive Symptoms

Various theories have emphasized the relationship between social factors and depressive symptoms. Cruwys et al. (2014) emphasize the need for social identification, claiming that

"depression is a fundamentally social disorder" (p.215). Evolutionary theory argues that depressive states are evolved reactions that were adaptive in our species history, acting as a signal to others that one is not receiving enough social support (Nettle, 2004). Further, the widely tested interpersonal therapy model argues that mental health is largely dependent on having positive interpersonal relationships with others, in part because they buffer the effects of stress and adversity (Lipsitz & Markowitz, 2013). Taken together, there are theoretical reasons to expect that depression and friend engagement are related.

In line with the theoretical arguments above, a number of empirical studies, using a variety of research designs, have investigated social factors as predictors of depressive disorders and depression symptoms. The constructs of loneliness, social functioning, and social support represent more subjective aspects of one's social life (e.g. a person can *feel* lonely even if they have a substantial number of social interactions), while rates of social interaction or social network size are more behavioral conceptualizations. Some cross-sectional research indicates that social support and loneliness are the stronger predictors of mental health (Freak-Poli et al., 2021; Matthews et al., 2016), with loneliness consistently predicting depressive symptoms in older adults in cross-sectional and longitudinal research (Erzen & Çikrikci, 2018; Van As et al., 2021). Nonetheless, along with loneliness and social connection, the more behavioral aspects of social life such as number of social gatherings or phone contacts also predict depressive symptoms and distress (e.g. Phongsavan et al., 2013).

While theory argues that people who are not socially engaged or who feel lonely may not experience the benefits of a healthy social life and can develop depressive symptoms, at the same time, symptoms of depression such as low energy, anhedonia, guilt, and low mood, might lead people to withdraw socially. As expected, some empirical studies show bi-directional effects of

loneliness and social functioning with depressive symptoms across shorter time periods (i.e. across four months; Groarke et al., 2021) and longer time periods (i.e. across 13 years in Van Zuptphen et al., 2021; across 10 years in Santini et al., 2020; Robitaille et al., 2012). However, the bi-directional findings linking loneliness and depressive symptoms are not without exceptions, with some studies only showing depressive symptoms predicting social factors (McHugh Power, Hannigan et al., 2020; See also McHugh Power, Tang, et al., 2020) and others only showing social factors predicting depressive symptoms (Cacioppo, Hawkley & Thisted, 2010; Domènech-Abella et al., 2021; Reynolds, Meng & Hall, 2020). Additional research, especially applying advanced analyses (see "Present Study" section), is needed to help the nature of the associations between social factors and depressive symptoms.

Gender, Age, and Social Factors

Current knowledge about how gender might impact the relationship between social factors and depressive symptoms is somewhat limited. In terms of gender differences in depression, women across the globe experience depression at a higher rate than men (Seedat et al., 2009). Regarding social interaction, some research indicates that women tend to engage in a wider range of social relationships (Fuhrer & Stansfeld, 2002), which predicts fewer depressive symptoms (Santini et al., 2015), possibly because social support needs can be better addressed by a diverse network or because diverse networks offer more opportunities to *provide* social support which also protects from depression (Fiori & Denckla, 2012). At the same time one meta-analysis did not find gender differences in friendship or family network sizes (Wrzus et al., 2013). Differences in the reported number of friends apparently varies by both the respondents' age and gender (Gillespi, Lever, Frederick, & Royce, 2015). Some research has also found gender differences in the associations between social factors and mental health (Lee & Lee,

2011; Phongsavan et al., 2013), but not consistently (Lee & Ang, 2020; Schwartz & Litwin, 2019; Wu et al., 2022). As such, the lack of consensus on potential gender differences deserves further investigation as the results may inform targeted intervention efforts.

Age may also be important to consider as social selectivity theory suggests that the types of relations people engage in changes over the lifespan (Carstensen, 1995). Younger adults emphasize relationships based on knowledge related goals over emotionally supportive ones, while the opposite is true for older adults (Lockenhoff & Carstensen, 2004). Having a healthy social life during older adulthood may help people cope with the substantial changes that often attend older adulthood related to retirement, finances, health problems, and loss (Haslam et al., 2018). Kiely et al., (2021) found that personal friend engagement predicted later mental health and vice versa, but only for individuals over age 50. In sum, social relationships may have a particularly important role for older adults, which should be investigated further.

The Present Study

There are a few common limitations in many previous studies. Cross-sectional studies fail to assess the longitudinal nature of potential relationships between social factors and depression. Longitudinal studies have often failed to examine the bi-directional nature of social factors and depression – using one variable as a predictor of the other variable over time (for exceptions, among others, see Cacioppo et al., 2010; Domènech-Abella et al., 2021). There is ample reason to believe that rates of friend engagement could predict later depressive symptoms and depressive symptoms could affect later rates of friend engagement. For studies that did investigate bi-directional effects, many utilized the cross-lagged panel model (CLPM), which conflates between-person differences (i.e. people have differences in their average rate of friend engagement and their average depressive symptom severity) and within-person differences (i.e.

people have fluctuations in rates of friend engagement or depressive symptoms that vary around their personal means; Mulder & Hamaker, 2021). The cross-lagged panel model assumes that each person varies over time around the same grand mean for the central variables and that there are no trait-like differences that exist over time (Hamaker et al., 2015). An alternative model, the random intercept cross-lagged panel model (RI-CLPM), can model the between- and within-person associations separately (Hamaker et al., 2015). In other words, it can examine whether average levels of depression, social functioning, and friend engagement are associated across people (between-person) and it can examine whether fluctuations in these variables, around those individual averages, are also associated (within-person). Few studies on social factors and depression have implemented the RI-CLPM (e.g. Kiely et al., 2021).

[FIGURE 1]

The present study has some similarities in design to the Kiely et al., (2021) study, but it uses a United States sample, all of whom are over aged 50, and includes both frequency of friend social interactions and perceptions of social functioning. It was hypothesized that all three variables (depressive symptoms, friend engagement frequency, and social functioning) would be associated with each other at the between-person level, and at the within-person level for both concurrent and cross-lagged associations. The social functioning-depression and friend engagement-depression relations would be negative, while the social functioning-friend engagement relations would be positive. For exploratory analyses, models for each gender were run to examine any potential gender differences in the relevant associations.

Methods

Participants

The data for this study were from the Wisconsin Longitudinal Study, which collected data from a random sample of those who graduated from Wisconsin high schools in 1957. Data from three waves in 1992-1993, 2003-2005 and 2011 included the relevant variables for this analysis. The original sample was 10,317 individuals, of which, 85.74% completed at least one interview or mail survey, 74.59% completing two, and 56.58% completing three. By the 2011 wave, 2,049 (19.86%) of the graduates were known to be deceased (Wisconsin Longitudinal Study, n.d.). For our purposes, we excluded participants who died before 2011 and those who only participated in the study before the 1992-1994 surveys, as they did not provide any data on the central variables. This resulted in a preliminary sample size of 6,895 participants, which would later decrease to 5,890 due to missing data on covariates. The sample is largely White (with race not being a publicly available variable) and only includes individuals that graduated from high school. See Herd, Carr, & Roan (2014) for a published cohort profile and Table 1 for some participant characteristics. The de-identified data is publicly available (https://researchers.wls.wisc.edu). In an ethics review, the Institutional Review Board (IRB) at [institution] indicated that the data received for this project did not require IRB oversight due to it not being human subjects research. The participants originally consented to having their data be used for research.

[TABLE 1]

Procedure

A survey was originally administered to all high school seniors in Wisconsin public schools in 1957. A random sample of 1/3 of the high school graduates was administered a telephone survey in 1975. At each of the three relevant waves of data collection for this study (Wave 1: 1992-1993; Wave 2: 2003-2005; Wave 3: 2011), a mail and telephone survey were

administered to the participants. This study used the publicly available dataset to conduct the analysis (see https://www.ssc.wisc.edu/wlsresearch/).

Measures

Depressive Symptoms.

At each wave the participants completed a modified version of the twenty-item Center for Epidemiological Studies – Depression scale (CES-D; Radloff, 1977). Participants were asked on how many days of the week they were experiencing various depression symptoms (e.g. "did you think your life had been a failure?" and "did you feel everything you did was an effort?"). While the original CES-D has response values of "less than 1 day," "1-2 days," "3-4 days," and "5-7 days", the version in this study had a separate response for each day separately, including "0 days." The composite score could range from 0 to 140, with a higher value representing a greater frequency of depressive symptoms. The CES-D has been determined to be an effective screener for depression in the general population (Vilagut et al., 2016). Cross-sectional internal reliability for the scale was .87 at wave 1, .85 at wave 2, and .85 at wave 3. Reliability from the multilevel perspective found that the overall composite reliability was .80, while the between-person reliability (ability to reliably detect differences across people) was .55, and the within-person reliability (ability to reliably detect differences over time for each person) was .84 (Lai, 2021).

Friend engagement.

At each wave the participant was asked "How many times, if at all, during the past four weeks have you gotten together with friends?" In the first and second waves, but not the third wave, that question was followed by "We mean like going out together or visiting in each other's homes." Participants could write any number, resulting in some extreme values (i.e. 300 times in the past four weeks).

Social functioning

Social functioning was assessed with three items related to Ryff's (1989) concept of positive relations, which is often used as a subscale of the global psychological well-being construct (Ryff & Keyes, 1995). These three items tapped into the participant's sense of connection to others and their ability to contribute to relationships (e.g. "To what extent do you agree that it seems to you that most other people have more friends than you do?"). They were, measured on a 6-point Likert scale, and were summed to create a composite variable (range: 3 to 18) assessing social functioning. The cross-sectional Chronbach's alpha internal reliability coefficients were .65 for wave 1, .69 for wave 2, and .64 for wave 3. The multilevel composite reliability was .75, while the between-person reliability was .69, and the within-person reliability was .52. Supplementary analyses demonstrated metric invariance of these three items across waves.

Covariates.

To control for potential issues with confounding variables as predictors of depression and the social variables, level of education, wave 1 household income, wave 1 self-rated health (reverse scored such that "excellent" = 5 and "poor" = 1), and wave 1 marital status included as covariates.

Data Analysis

All analyses were carried out in R (R Core Team, 2021) and RStudio software (RStudio Team, 2021). Particularly important packages included *tidyverse* (Wickham et al., 2019) and *lavaan* (Rosseel, 2012), with others listed in the supplemental material. Random intercept cross-lagged panel models were used to assess the associations between depression, friend engagement, and social functioning following Mulder & Hamaker (2021; See figure 1).

In an effort towards increasing model parsimony (Kline, 2010) and for the ease of interpretability (Mulder & Hamaker, 2021), the within-person concurrent, autocorrelated lagged, cross-lagged, and residual values were constrained to equality. For example, the within-wave association between depression and friend engagement would be equal at each wave. Scaled Chi-Square difference tests were used to assess for decreases in model fit (Satorra & Bentler, 2001). When model fit was worse, some of the constraints were relaxed until non-significant chi-square difference tests were non-significant. The decision of which constraints to relax was based on a review of the relevant sets of coefficients in the unconstrained model, where those coefficients that appeared to have the greatest variation had their constraints removed.

As mentioned, there were some extreme values for some of the variables (friend engagement, income, depression). To aid in convergence of the models, these extreme values were standardized and Winsorized, such that values over the 99.5^{th} percentile were changed to be equal to the 99.5^{th} percentile value. This resulted in between 13 and 34 values being changed per variable. For a sensitivity analysis, the models were also run on the non-Winsorized data with output available in the supplemental materials. The patterns of associations were very similar across datasets. The script for processing the raw data and running all of the models, as well as the output files are available here: https://osf.io/wbkam/?view_only=5643f099a7e04037a5eb2537e858536f.

[TABLE 2]

Maximum likelihood estimation was implemented to help address missing values for the main three variables. Because some participants did not have responses for the control variables, they were excluded from the main analyses reported here. However, analyses excluding those covariates and including all participants revealed similar results, albeit with some more

significant associations in the model without the covariates. Maximum likelihood estimation with robust standard errors was used in the model to account for deviations from non-normality in the variables of interest. A traditional cross-lagged panel model for comparison is also discussed below and available in supplementary materials. Summary statistics are available in table 1 and model fit indices are available in table 2.

Results

Whole group models

The base RI-CLPM fit the data well ($\chi^2(3) = 31.44$, $p < .001$; Comparative Fit Index [CFI] = 1.00; Standardized Root Mean Square Residual [SRMR] = .01; Root Mean Square Error of Approximation [RMSEA] = .04, 95% CI (0.03, 0.05)). Implementing the model constraints negatively impacted model fit, ($\Delta X^2(18) = 459.28$, $p < .001$). The autocorrelated lagged associations (fluctuations in depression at wave 1 predicting depression at wave 2), residual variances, and two of the concurrent within-person variances were allowed to vary over time, resulting in an appropriately fitting model relative to baseline ($\Delta X^2(10) = 16.17$, $p = .09$).

The main model results with standardized coefficients and confidence intervals are listed in Table 3, while the whole output is available as supplementary material. At the between-person level, average levels of friend engagement and social functioning were positively correlated, while each of those variables was negatively correlated with depression. This means that those who engaged more frequently with friends and had higher social functioning on average, had less depression on average. At the within-person level, concurrent (within-wave) associations were found for each pair of variables at each wave, in the expected directions. This can be interpreted to mean that fluctuations in social functioning and friend engagement around one's average level of social functioning and engagement, were negatively associated with same-wave depression.

The cross-lagged associations indicated that friend engagement predicted later social functioning and social functioning predicted later depression.

[TABLE 3]

Gender models

The unconstrained multiple group RI-CLPM model fit the data well ($\chi^2(6) = 33.86$, $p < .001$; CFI = 1.00; SRMR = .01; RMSEA = .04, 95% CI (0.03, 0.05)). Adding the constraints did result in a significant decrease in fit ($\Delta X^2(36) = 467.09$, $p < .001$), which was ameliorated by allowing the autocorrelated lagged associations, residual variances for friend engagement, and the friend engagement-social functioning concurrent associations to freely vary over time for the female model, resulting in a non-significant decrease in fit relative to baseline ($\Delta X^2(26) = 32.30$, $p = .18$).

At the between-person level, average levels of friend engagement and social functioning were positively associated for both groups, while average levels of social functioning was negatively associated with depression for both groups. Average rates of friend engagement were only significantly negatively associated with depression for females. Negative, within-person, concurrent associations between social functioning and depression were found for both genders. Positive within-wave associations were also found between friend engagement and social functioning for both genders. A negative within-wave association between friend engagement and depression was only found for the males. Friend engagement predicted later social functioning in both groups. However, social functioning negatively predicted later depression only in women, while friend engagement negatively predicted later depression only in men.

Discussion

The present study investigated the longitudinal associations between depressive symptoms, friend engagement, and social functioning in a large sample of adults in the United States. The use of the random intercept cross-lagged panel model was an important feature as it provided the ability to meaningfully distinguish between within- and between-person variance and associations. Relative to the Cross Lagged Panel Model (CLPM), the Random Intercept Cross-Lagged Panel Model (RI-CLPM) often results in lagged and cross-lagged parameter estimates that are "closer to zero and with larger standard errors" (Mulder & Hamaker, 2021, p. 641). A supplementary CLPM analysis demonstrated that phenomena, where there were more significant associations and associations of a higher magnitude. While the cross-lagged effects from RI-CLPMs may be less prevalent or of smaller size, when they are found, they can be more meaningful because they often better represent the relations researchers are usually intending to examine.

Across a period of about 30 years, average levels of friend engagement, social functioning, and depression were associated with each other, such that individuals who reported more frequent engagement with friends on average and especially those who reported better social functioning on average, also reported fewer depressive symptoms. The between-person level cannot speak to direction of association, but it is clear that the correlational associations found in previous research are substantiated by the longitudinal, between-person findings in these models. This aligns with Cruwyz's and colleagues (2014) argument about depression's status as a social disorder "with reduced social connectedness implicated as a cause, symptom,

and target for treatment of depression."[1] The present associations are likely more meaningful than other cross-sectional examinations of these behaviors because they are based on trait-like levels of the variables over time, as fluctuations in the variables are relegated to the within-person components of the model. Further, the associations of the two aspects of social life with depressive symptoms were present, even while controlling for the other. Lastly, the friend engagement and social functioning variables were also positively associated, indicating that those with more engagement with friends tended to rate themselves higher in social functioning.

The central findings from the study focus on the within-person level, or how variations around average levels of the variables were associated. If someone had higher than their average social functioning during a given wave, they tended to also have lower depressive symptoms at that same wave with a moderate effect size. Further, variations in social functioning also predicted later depressive symptoms, controlling for covariates and previous levels of depression. Impressively, these associations, albeit small in magnitude, spanned an 8-10 year gap between waves of data collection. These findings align with the U.S. Surgeon General's recent call to improve social connection (Office of the U.S. Surgeon General, 2023), along with the work of other global foundations and organizations aiming to do the same (e.g. Badcock et al.,

[1] Despite the findings that friend engagement and functioning are associated with depression, it should also be noted that control variables such as income, education, gender and health were all predictive of depression (see supplemental materials). As such, social determinants of health, some of which may be only partially related to social connectedness, should also be considered as important factors (Cross-Denny & Robinson, 2017). Nonetheless, as a factor that is to some degree modifiable, social connectedness seems highly important.

2022; The Foundation for Social Connection, n.d.). Of the various modifiable lifestyle or behavioral factors that relate to depression, social connection may really be one of the most important. A recent 100,000+ person longitudinal Mendelian randomization study, which as an approach, can approximate an experimental design, found that confiding in others was one of the very few variables that strongly and consistently predicted later depression (Choi et al., 2020). And beyond mental health, social life strongly predicts physical health and mortality as well (Park et al., 2020; Rico-Uribe, 2018). The findings from the present study add to this literature using an analysis that assesses relationships at both between- and within-person levels, while also examining potential bidirectional effects. Improving social connections emerges as a pivotal treatment target, bolstered by robust evidence derived from this and other longitudinal studies, in conjunction with some randomized trials (e.g. Cruwys et al., 2022).

The within-wave, within-person associations between social functioning and depression cannot speak to causation or direction, but bi-directional effects may be at play. Decreased energy or pleasure as symptoms of depression may temporarily hamper one's ability to maintain relationships, and negative cognitions, often associated with depression (LeMoult & Gotlib, 2019), may lead someone to simply rate their social functioning as worse. And in the other direction, failing socially is theorized to harm one's mental health while successfully resolving social dilemmas can improve it (Lipsitz & Markowitz, 2013). A recent randomized control trial comparing a loneliness-oriented intervention to cognitive behavioral therapy for treating loneliness and depressive symptoms found that they were equally efficacious (Cruwys et al., 2022), potentially highlighting the idea that directly targeting one side of the bidirectional relationship (either social functioning or depression), may bring about improvement in the other.

Associations between frequency of friend engagement with depressive symptoms were also found at the within-person level, although the associations tended to be smaller than for social functioning and depressive symptoms. If participants had higher than their average rates of friend engagement in a given wave, they also reported less depression. In the multi-group models, this finding did not remain in the women-only model, while a new finding of friend engagement predicting *later* depression was found in the men-only model, although the effect was quite small. Despite the small differences in effect sizes across men and women, fluctuations in rates of friend engagement may not be as impactful for the mental health of women as men. One explanation for the differences could be that women may develop larger, more active social networks (Okun & Keith, 1998). Thus, with more resilient social networks and with a higher frequency of engagement overall, fluctuations in friend engagement for women may not impact depressive symptoms to the degree that similarly sized fluctuations would for men. In this sample, women did engage with friends more regularly at each time point, although only about once more per month. It is also possible that the women's social networks were more dynamic considering their higher rates of telephone and social media engagement as has been shown in previous research (Kimbrough et al., 2013), which was not measured in this study.

Interestingly, depressive symptoms did not predict later social functioning or friend engagement. One evolutionary perspective argues that depression-related behaviors may have been selected over time as signals to others that the depressed person needs support for their survival (Gilbert, 2001). On its face, this would lead to the expectation of depression predicting later social factors, likely because depressed individuals would attract the support of their attentive friends. However, Allen and Badcock (2003) make the argument that because of advances in modern technology, obtaining necessary resources for survival (i.e. shelter and

food), has become "somewhat decoupled from the need to form and maintain social relationships." They argue that the once adaptive features of depressive symptoms may no longer be effective because depression-related signaling behaviors "…are no longer perceived in the social ecology and therefore do not effectively bring about change to signals of social value or social burden" (p. 907). Further, they argue that the potential social facilitation of depression may not be the same across all levels of severity – where mild depression may effectively signal for support, severe depression on the other hand may simply exacerbate the person's social situation. Thus, the lack of longitudinal associations of depression predicting later social functioning may be due to changes in the modern social environment and the heterogeneity of how depressive symptoms function across levels of severity. Another consideration is that fluctuations in depressive symptoms may be managed over the long term with other forms of coping such as increased physical activity, religious participation, therapy, or medication (Chambers et al., 2015). Changes in social factors may have a more lasting impact on long-term functioning than changes in depressive symptoms do because symptoms can be managed in various ways, while there may not be as many ways to address the impact of reductions in social functioning and engagement.

While not of central interest to this project, greater than average friend engagement positively predicted later social functioning. Same-wave fluctuations in each variable were also positively associated. It may be that those who are functioning well in social life will be better able to manage and maintain social relationships, while engaging in more social interactions may help provide the learning experiences that help individuals improve their social functioning over time.

There are some limitations to be noted for this study. More extensive measurement of the friend engagement variables would likely be helpful. The nature of spending time with friends can vary greatly in terms of activities and levels of emotional and physical support being provided and received. Having dinner with fulsome conversation might have different outcomes than less engaging interactions like watching TV together. Investigating the frequency of friend interaction could be supplemented by including characteristics of the friend interactions such as provision of support, engagement in healthy lifestyle behaviors, quality of conversation, and satisfaction. Also of interest would be the gender of the participant and their friend, as the characteristics of friend interactions (e.g. communal vs dominant) differs by gender (Suh et al., 2004). In fact, previous research on this sample indicates that women are more likely to exchange emotional support than men (Liebler & Sandefur, 2002) – and outside of this sample, they tend to provide more emotional support via social networking sites (Tifferet, 2020) highlighting important characteristics to investigate.

Having measurement periods separated by 10 years raises some questions about the ability to adequately assess potential longitudinal associations. Further, there is some evidence of changes in network size for older women (Schwartz & Litwin, 2018) and changes in the functions of relationships over time (Lockenhoff & Carstensen, 2004), raising questions about the stability of the associations over time. While the RI-CLPM can ask interesting questions at the between- and within-person levels, it does not easily capture individual differences in linear/curvilinear trends over time. Future research may apply the General Cross-lagged Model which can account for those trends (Zypher et al., 2020).

The sample itself was racially and geographically homogenous and everyone had at least a high school education. As such, this study can say little about the important cross-cultural

differences in friend engagement and mental health. Future research will need to account for and/or investigate potential differences by applying additional multiple group RI-CLPM's in diverse samples. Lastly, some components of reliability for the depressive symptoms and social functioning scales were somewhat low, indicating the ability to detect variation between people or over time might have been hampered.

Some scholars have made strong arguments about the social nature of depressive symptoms. To more rigorously investigate the empirical validity of claims about the centrality of social life in depressive symptoms, high-quality longitudinal studies are needed. Most previous studies investigating cross-lagged associations between social engagement and depressive symptoms were hampered by conflation of between- and within-person variance. This study circumvented the problems of traditional cross-lagged panel models by using RI-CLPMs to examine how depressive symptoms and social factors are related across people, within given time points, and over time. Associations between friend engagement, social functioning and depression were found in the expected directions at the between-person level, and within-waves at the within-person level, and longitudinally across waves. These findings add further support to the need to attend to social life as a predictor of depression in older adults.

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Table 1

Summary Statistics

Variable	Percentage reporting	Number of respondents
Sex (Female)	54.14%	(n = 6,895)
Married (1993/1994)	84.14%	(n = 6,648)
Education		(n = 6,649)
High school graduate	56.38%	
Some college	15.96%	
Bachelor's degree	13.63%	
Master's degree	10.20%	
Doctoral degree	3.83%	
	Mean (SD)	
Age (2011)	72.14 (0.50)	(n = 6,895)
Household income	$63,112 ($56,508)	(n = 6,648)
Self-rated health (1993/1994)	4.19 (0.64)	(n = 5,893)
CES-D w1	16.00 (14.70)	(n = 5,857)
CES-D w2	13.25 (13.05)	(n = 6,078)
CES-D w3	15.25 (13.98)	(n = 5,019)
Friend engagement /month w1	3.93 (3.85)	(n = 5,883)
Friend engagement /month w2	3.64 (3.56)	(n = 5,999)
Friend engagement /month w3	3.70 (3.79)	(n = 4,764)
Social functioning w1	14.31 (2.97)	(n = 5,764)
Social functioning w2	14.35 (2.93)	(n = 6,035)
Social functioning w3	14.31 (2.94)	(n = 4,923)

Note. CES-D, Center for Epidemiological Studies Depression scale

Table 2

Fit Indices (Robust Versions)

Model	X^2 (DF); scaling factor	CFI	RMSEA [95% CI]	SRMR
Whole sample baseline	31.44 (3); 1.04	1.00	0.04 [0.03, 0.05]	0.01
Whole sample full constraints	502.50 (21); 1.41	0.96	0.07 [0.07, 0.08]	0.06
Whole sample partial constraints	47.01 (13); 1.06	1.00	0.02 [0.02, 0.03]	0.01
Multigroup baseline	33.86 (6); 1.04	1.00	0.04 [0.03, 0.05]	0.01
Multigroup full constraint	512.52 (42); 1.41	0.95	0.07 [0.07, 0.08]	0.06
Multigroup partial constraints	62.74 (32); 1.19	1.00	0.02 [0.01, 0.03]	0.01

Note. DF = Degrees of freedom; CFI = Comparative fit index; RMSEA = Root mean square error of approximation; SRMR = Standardized root mean squared residual.

Table 3

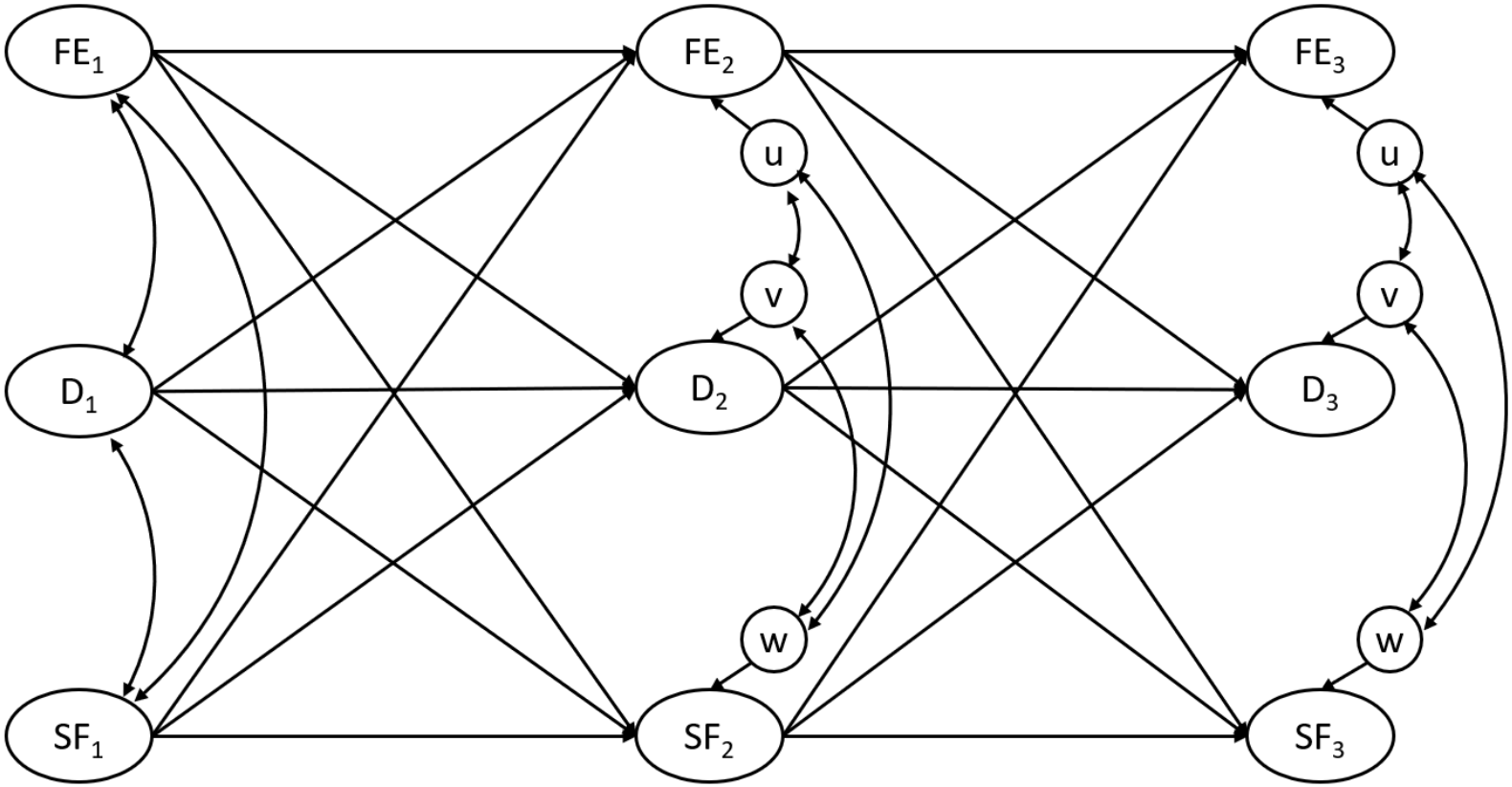
Model Coefficients

	Combined model β (95% CI)	Male group β (95% CI)	Female group β (95% CI)
Between-person			
Dep – F. Eng Covariance	**-0.19 (-0.27, -0.12)**	-0.07 (-0.17, 0.04)	**-0.07 (-0.10, -0.05)**
Dep – S. Func Covariance	**-0.55 (-0.60, -0.51)**	**-0.55 (-0.62, -0.48)**	**-0.25 (-0.28, -0.21)**
F. Eng – S. Func Covariance	**0.34 (0.28, 0.41)**	**0.34 (0.24, 0.44)**	**0.11 (0.08, 0.14)**
Within-person concurrent			
Dep – F. Eng Covariance			
Wave1	**-0.05 (-0.07, -0.02)**	**-0.09 (-0.13, -0.05)**	-0.02 (-0.05, 0.01)
Wave2	**-0.04 (-0.07, -0.02)**	**-0.08 (-0.12, -0.05)**	-0.02 (-0.05, 0.01)
Wave3	**-0.07 (-0.10, -0.03)**	**-0.12 (-0.17, -0.07)**	-0.03 (-0.08, 0.02)
Dep – S. Func Covariance			
Wave1	**-0.30 (-0.34, -0.25)**	**-0.26 (-0.32, -0.20)**	**-0.27 (-0.32, -0.22)**
Wave2	**-0.24 (-0.28, -0.19)**	**-0.25 (-0.30, -0.20)**	**-0.27 (-0.32, -0.23)**
Wave3	**-0.24 (-0.29, -0.20)**	**-0.25 (-0.30, -0.20)**	**-0.27 (-0.32, -0.23)**
F. Eng – S. Func Covariance			
Wave 1	**0.20 (0.17, 0.23)**	**0.14 (0.10, 0.18)**	**0.22 (0.17, 0.27)**
Wave 2	**0.18 (0.15, 0.22)**	**0.13 (0.09, 0.17)**	**0.20 (0.15, 0.25)**
Wave 3	**0.13 (0.08, 0.17)**	**0.19 (0.14, 0.25)**	**0.10 (0.05, 0.16)**
Within-person autocorrelations			
$Dep_1 \rightarrow Dep_2$	0.07 (-0.01, 0.15)	**0.12 (0.01, 0.23)**	0.03 (-0.07, 0.13)
$Dep_2 \rightarrow Dep_3$	**0.18 (0.10, 0.25)**	**0.27 (0.18, 0.37)**	**0.12 (0.02, 0.22)**
F. $Eng_1 \rightarrow$ F. Eng_2	**0.20 (0.15, 0.25)**	**0.15 (0.07, 0.23)**	**0.24 (0.17, 0.30)**
F. $Eng_2 \rightarrow$ F. Eng_3	**0.21 (0.14, 0.28)**	**0.11 (0.001, 0.23)**	**0.26 (0.18, 0.35)**
S. $Func_1 \rightarrow$ S. $Func_2$	**0.15 (0.08, 0.22)**	**0.16 (0.07, 0.26)**	0.09 (0.01, 0.18)
S. $Func_2 \rightarrow$ S. $Func_3$	**0.28 (0.22, 0.34)**	**0.30 (0.22, 0.37)**	**0.26 (0.19, 0.33)**
Within-person cross-lagged			
$Dep_1 \rightarrow$ F. Eng_2	-0.01 (-0.03, 0.02)	-0.04 (-0.08, 0.01)	-0.01 (-0.03, 0.04)
$Dep_1 \rightarrow$ S. $Func_2$	-0.01 (-0.05, 0.04)	0.00 (-0.06, 0.07)	-0.03 (-0.08, 0.03)
$Dep_2 \rightarrow$ F. Eng_3	-0.01 (-0.05, 0.03)	-0.06 (-0.13, 0.01)	-0.01 (-0.04, 0.06)
$Dep_2 \rightarrow$ S. $Func_3$	-0.01 (-0.05, 0.04)	0.00 (-0.06, 0.07)	-0.03 (-0.08, 0.02)
F. $Eng_1 \rightarrow Dep_2$	-0.01 (-0.04, 0.02)	**-0.05 (-0.09, -0.003)**	0.01 (-0.03, 0.05)
F. $Eng_2 \rightarrow$ Dep3	-0.01 (-0.05, 0.02)	**-0.05 (-0.09, -0.002)**	0.02 (-0.03, 0.06)
F. $Eng_1 \rightarrow$ S. $Func_2$	**0.08 (0.05, 0.11)**	**0.06 (0.02, 0.10)**	**0.09 (0.05, 0.13)**
F. $Eng_2 \rightarrow$ S. $Func_3$	**0.09 (0.06, 0.12)**	**0.06 (0.02, 0.11)**	**0.10 (0.06, 0.15)**
S. $Func_1 \rightarrow Dep_2$	**-0.06 (-0.10, -0.01)**	-0.05 (-0.11, 0.02)	**-0.07 (-0.13, -0.01)**
S. $Func_2 \rightarrow Dep_3$	**-0.06 (-0.10, -0.01)**	-0.05 (-0.11, 0.02)	**-0.07 (-0.14, -0.01)**
S. $Func_1 \rightarrow$ F. Eng_2	0.03 (0.00, 0.06)	0.00 (-0.05, 0.05)	0.03 (-0.01, 0.07)
S. $Func_1 \rightarrow$ F. Eng_2	0.04 (-0.01, 0.09)	0.01 (-0.07, 0.08)	0.05 (-0.01, 0.11)

Note. All values are standardized with 95% Confidence Intervals. Dep = Depression; S. Func = Social Functioning; F. Eng = Friend engagement. These are the coefficients from the final, partially constrained models. Note that the constraints on coefficients are based on the unstandardized values, leading to some variation in the standardized values despite constraints (see Mulder & Hamaker, 2021). Bolded coefficients are statistically significant.

Figure 1

RI-CLPM model



Note. Only the within-person associations are displayed here, as space constraints made the display of the between-person components impractical. Refer to Mulder & Hamaker (2021), for example figures based on two variables.

FE, Friend engagement; D, Depressive symptoms; SF, Social functioning ; u, residual variance for friend engagement; v, residual variance for depressive symptoms; w, residual variance for social functioning.