Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): a longitudinal mediation analysis

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Summary

Background Research indicates that social isolation and loneliness increase the risk of mental disorders, but less is known about the distinct contributions of different aspects of isolation. We aimed to distinguish the pathways through which social disconnectedness (eg, small social network, infrequent social interaction) and perceptions of social isolation (eg, loneliness, perceived lack of support) contribute to anxiety and depression symptom severity in community-residing older adults aged 57–85 years at baseline.

Methods We did a longitudinal mediation analysis with data from the National Social Life, Health, and Aging Project (NSHAP). The study included individuals from the USA born between 1920 and 1947. Validated measures on social disconnectedness, perceived isolation, and depression and anxiety symptoms were used. Structural equation modelling was used to construct complete longitudinal path models.

Findings Using data from 3005 adults aged 57–85 years, we identified two significant longitudinal mediation patterns with symptoms of depression, and two with anxiety symptoms. Overall, social disconnectedness predicted higher subsequent perceived isolation (β=0·09; p<0·0001), which in turn predicted higher depression symptoms (β=0·12; p<0·0001) and anxiety symptoms (β=0·12; p<0·0001). The reverse pathways were statistically supported as well, suggesting bi-directional influences.

Interpretation Social network structure and function are strongly intertwined with anxiety and depression symptoms in the general population of older adults. Public health initiatives could reduce perceived isolation by facilitating social network integration and participation in community activities, thereby protecting against the development of affective disorders.

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Introduction

By 2050, the number of people aged 60 years or older will increase by 1·25 billion, accounting for 22% of the global population.[1] Late-life depression and anxiety disorders are major public health issues for this population because of their high prevalence and poor outcomes.[2] It has been reported that Americans with major mental disorders (such as major depressive disorders and bipolar disorders among others) die 14–32 years younger (depending on US region or state) than those without mental disorders.[3] Further, affective problems have been found to significantly accelerate brain ageing.[4] It is therefore imperative to develop sustainable strategies to prevent late-life affective problems in the general population.

The importance of social connectedness and, conversely, social isolation in the aetiology of affective and mental health problems has been documented extensively in the scientific literature. Previous work has linked social network ties, network structure, and participation in social activities with better mental health.[5] But mental health can also be impacted by the quality and meaning of individuals' social relationships. According to theories of perceived isolation, the need for social connectedness is a deeply ingrained human characteristic that has evolved hand in hand with neural, hormonal, and genetic mechanisms directly associated with bonding, companionship, and herd behaviour as a crucial means for ensuring survival and reproduction.[6] As a consequence, overwhelming feelings of isolation or the loss of social relations has been shown to have implications for the decline in cognition, mood, and sensitivity to threat,[6] alongside a buildup of cortisol concentrations, worsening immune functioning, sleep disruption, and increased bodyweight.[7] In line with these findings, it has been shown that individuals who feel lonely or isolated, those who report low social support, and those who experience strain in their relationships are more likely to develop depression symptoms.[8] Although these aspects of social connectedness have been separately linked to mental health, previous work has not disentangled the unique contributions of objective aspects of social disconnectedness from those of more subjective

Research in context

Evidence before this study
Many studies show that larger social networks and social support are associated with improved mental health among older adults. Generally, studies report linear A to B associations between single measures of social connectedness or support and mental health outcomes. Few studies have considered how multiple aspects of social connectedness or isolation are inter-related and the mediating pathways through which they contribute to affective problems in later life.

We searched PubMed and PsycINFO for articles published in English from database inception up until Feb 15, 2019, with the terms "social networks", "social support", "loneliness", AND "mediation" OR "mediate" OR "mediating" OR "path analysis", AND "mental health" OR "mental disorder" OR "depression" OR "anxiety". We found three studies that specifically investigated mediating pathways between social network variables and mental health outcomes among older adults. Overall, previous studies have been limited by analysing only a single or few measures of social isolation; assessing associations cross-sectionally or with insufficient longitudinal data for a robust mediation analysis; assessing longitudinal associations but without assessing bi-directionality; and using small samples that are not nationally representative.

Added value of this study
Our study uncovers and disentangles pathways between social disconnectedness, perceived isolation, and symptoms of affective disorders. The novelty of our study pertains to the use of comprehensive and validated scales for social relationships, and the application of a complex longitudinal design on a nationally representative American dataset.

Implications of all the available evidence
Developed countries are increasingly seeing negative trends in mental health, a problem that is intensified with population ageing and severe budget constraints on mental health care. It is imperative to identify mental health promoting factors in communities as well as in clinics, particularly factors that do not demand excessive funding. Our findings point to perceived isolation as a lynchpin through which social disconnectedness leads to affective disorders, and through which depression and anxiety precipitate social withdrawal. Clinicians, care providers, or social and gerontological workers might screen older adults for unmet needs for companionship and support. Efforts to address social disconnectedness and perceived isolation could aid in the prevention of affective disorders. Care providers should also be aware that affective problems in late life can precipitate social withdrawal; older adults with depression and anxiety symptoms might need intervention or tools to assist in the formation and maintenance of social relationships.

experiences of relationship quality, meaning, and social support.

In this study, we build on work by York Cornwell and Waite[9] to distinguish the role of two forms of social isolation: social disconnectedness and perceived isolation. Social disconnectedness can be characterised as a scarcity of contact with others. This form of social isolation is indicated by situational factors such as network structure (eg, small network, infrequent interaction) and lack of participation in social activities and groups. Perceived isolation, by contrast, reflects the subjective experience of a shortfall in one's network functioning and social resources. This perception could involve feelings of loneliness, of absence of support or a perceived inadequacy of intimacy in one's interpersonal relationships.

Examining both social disconnectedness and perceived isolation is important because perceptions of isolation can be entirely unrelated to an individuals' objective network structures and the time that they spend alone or with others. Consistent with this theory, previous work has shown that loneliness is only weakly correlated with social network size and frequency of interaction with network members.[10] Both social disconnectedness and perceived isolation can increase the risk of mental health problems such as depression and anxiety. Having few social ties or infrequent social activities and feeling lonely or lacking support can heighten reactions to stress exposure and reduce individuals' coping abilities.[11]

An alternative possibility is that being socially disconnected can contribute to the development of perceived isolation, which could in turn have deleterious effects on health and wellbeing. Individuals who have smaller or less dense networks tend to have less access to social support and companionship.[12] Older adults (generally aged 50 years and older) are particularly likely to experience changes such as retirement and bereavement. Profound losses such as widowhood are naturally associated with increased loneliness.[13] Aspects of perceived social support have been found to be more important than indicators of network structure, such as network size, for mental health outcomes.[14] Loneliness in late life is a key predictor of depression.[15] Other research focusing on aspects of perceived isolation found that loneliness mediates the association between a lack of social support and poor mental health.[8]

The aim of this study was to examine the pathways through which social disconnectedness and perceived isolation affect mental health among community-dwelling older adults. To pursue this aim, we used 10-year follow-up data from the National Social Life, Health, and Aging Project (NSHAP), a nationally representative community-based survey of the American older population. We

hypothesise that both social disconnectedness and perceived isolation will separately contribute to higher amounts of depression and anxiety symptoms. Given the mediating pathways reported in previous studies,[9,16,17] we also hypothesise that perceived isolation mediates the association between social disconnectedness and symptoms of depression and anxiety. Disentangling the roles of social disconnectedness and perceived isolation in the aetiology of depression and anxiety is essential for informing public health interventions aimed at preventing mental disorders within the growing population of community-residing older adults in the USA.

Methods

Study design and participants
We did a longitudinal mediation analysis with data from NSHAP. The database includes demographic characteristics; social networks and social network change; social and cultural activity; physical and mental health, including cognition; well-being; illness; health-care use and medications; and history of sexual and intimate partnerships. NSHAP also collects important health information via biomeasures. Participants were born between 1920 and 1947 (aged 57–85 years at baseline), and the survey included an oversampling of black people, Hispanic people, and the oldest old (aged 75–85 years). NSHAP uses a complex, multistage area probability sampling design, which is reported elsewhere.[18] The overall response rate for the baseline survey was 75·5%. Wave 1 data were obtained from 2005–06 (T1), wave 2 from 2010–11 (T2), and wave 3 from 2015–16 (T3). The study sample is shown in the appendix (p 1). As part of the main interview at each timepoint, participants were asked to complete a network roster, in which they provided information about up to five confidants. Institutional review board approval was granted from the Social and Behavioral Sciences institutional review board at the University of Chicago and The National Opinion Research Center institutional review board.

Procedures
Depression symptomatology was assessed using the Center for Epidemiological Studies-Depression Minus Loneliness (CES-D-ML) scale.[15] Responses to the CES-D-ML are summed for a total score ranging from 0–30, with higher scores indicating more depression symptoms. The seven-item anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) was used to assess feelings of anxiety.[19] Participants report feelings of anxious mood, thoughts, and restlessness over the past week on a four-point scale from 0–3. Responses are summed for a total score ranging from 0–21, with higher scores indicating more anxiety symptoms. Information about α coefficients, longitudinal measurement invariance, and anchor points for the individual CES-D-ML and HADS-A items are shown in the appendix (pp 2–4).

Constructed scales for social disconnectedness and perceived social isolation have been validated using the NSHAP data. Satisfactory internal consistency and construct validity for both scales are reported elsewhere.[9] The scales use a range of indicators of structural or functional isolation (listed below), with indicators being standardised by converting each of them to Z scores, and subsequently averaging all metrics belonging to each scale. Specific details about how the social disconnectedness and perceived isolation scales were coded, descriptives, and measurement invariance testing over time are shown in the appendix (pp 5–14).

The social disconnectedness scale[9] incorporates social network size, social network range, frequency of interaction with network members, proportion of network members in the home, number of friends, attendance at group meetings, socialising with friends and family, and volunteering. Social disconnectedness scores more than zero are indicative of greater-than-average disconnectedness, whereas scores less than zero suggest lower-than-average disconnectedness.

The perceived isolation scale[9] comprises emotional and instrumental support from family members, friends, and spouse or partner; lack of companionship; feeling left out; and feeling isolated. Perceived isolation scores more than zero are indicative of greater-than-average perceived isolation, whereas scores less than zero suggest lower-than-average perceived isolation.

All covariates are based on baseline data (unless otherwise specified). Sociodemographic characteristics included gender (male, female), age (57–85 years at T1, continuous), ethnic group (white, black, Hispanic, other), education (no high school qualification, high school, college, bachelors or higher), employment status (currently working, retired, disabled, unemployed, homemaker, other), and annual household income (less than US$25 000, $25 000–49 999, $50 000–99 999, $100 000 or more). Variables were also included to account for changes in marital status or bereavement, moving away, and disability at T2 and T3. Further covariates included chronic medical conditions, difficulties with activities of daily living, alcohol consumption, and frequency of physical activity. Information about selected covariates and reasons for inclusion are shown in the appendix (pp 15–16).

Statistical analysis
Little's χ^2 test indicated that data were not missing completely at random (appendix pp 15–16). Frequencies showed that more missing data occurred at T2 and T3 than at baseline. To maximise statistical power while minimising bias, full information maximum likelihood imputation within Mplus was done. This imputation is termed a principled missing data method in that it does not replace a missing value directly, rather it uses available information to estimate population parameters without bias,[20] and it is deemed appropriate for imputing missing longitudinal data such as that analysed here.

	Participants
T1, Wave 1, 2005–06	
Unweighted total number of participants	3005
Age, years	69·3 (7·9)
Sex	
Female	1551 (51·6%)
Male	1454 (48·4%)
Ethnic group	
White	2110 (70·5%)
Black	509 (17·0%)
Hispanic	304 (10·2%)
Other	70 (2·3%)
Education	
No high school qualification	699 (23·3%)
High school	793 (26·4%)
College	657 (21·9%)
Bachelors or higher	413 (28·8%)
Annual household income, US$	
<25 000	762 (27·2%)
25 000–49 999	1062 (38·0%)
50 000–99 999	662 (23·7%)
100 000 or more	312 (11·2%)
Employment status	
Currently working	681 (22·7%)
Retired	1621 (54·0%)
Disabled	293 (9·8%)
Unemployed	28 (0·9%)
Homemaker	356 (11·9%)
Other	24 (0·8%)
Marital status	
Married	1518 (50·5%)
Partner	55 (1·8%)
Separated	49 (1·6%)
Divorced	317 (10·5%)
Widowed	658 (21·9%)
Never married	111 (3·7%)
Change in marital status at later time	297 (9·9%)
Mobility	
No change	2580 (85·9%)
Moved away at later time	425 (14·1%)
Chronic conditions	2·21 (1·5)
Limitations in activities of daily living	
No limitations	1390 (46·4%)
Any limitations	1004 (33·5%)
Limited at later time	604 (20·2%)
Alcohol consumption frequency	2·4 (2·5)
Physical activity frequency	3·3 (1·2)
Depression symptoms*	4·6 (4·4)
Anxiety symptoms†	3·5 (3·3)
Social disconnectedness	0·007 (0·5)
Perceived isolation	0·01 (0·6)
(Table 1 continues on next page)	

	Participants
(Continued from previous page)	
T2, Wave 2, 2010–11	
Unweighted N	2249
Depression symptoms*	4·6 (4·4)
Anxiety symptoms†	4·7 (3·7)
Social disconnectedness	0·002 (0·4)
Perceived isolation	0·005 (0·6)
T3, Wave 3, 2015–16	
Unweighted N	1538
Depression symptoms*	4·7 (4·5)
Anxiety symptoms†	4·5 (3·4)
Social disconnectedness	–0·004 (0·4)
Perceived isolation	0·01 (0·6)

Data are mean (SD), or unweighted n (%) unless otherwise specified. Sampling weights were used for the calculation of proportions and means (SD). *Based on the Center for Epidemiological Studies-Depression Minus Loneliness scale. †Based on the 7-item anxiety subscale of the Hospital Anxiety and Depression Scale.

Table 1: **Baseline characteristics**

Structural equation modelling with observed variables was done to assess associations and statistical mediations among social disconnectedness, perceived isolation, and depression symptoms (model 1) and anxiety symptoms (model 2) at all timepoints. Thus, in both cases, we constructed complete mediation structural equation models[21] (appendix p 17) in which all six possible unique longitudinal mediations were examined. As recommended by Hoyle and Panter,[22] several fit indices were used including the root mean square error of approximation (RMSEA), the standardised root mean square residual (sRMR), and the comparative fit index (CFI). Values greater than 0·95 for the CFI were considered to reflect good model fit. RMSEA and sRMR values of 0·06 or less were considered to indicate a good fit, although values up to 0·08 were considered acceptable. All mediations were tested with 5000 bootstrapped iterations.

The following variables were entered into the models as continuous: social disconnectedness, perceived isolation, depression symptoms, anxiety symptoms, number of chronic conditions, frequency of alcohol consumption, frequency of physical activity, and age, whereas the remaining variables were entered as categorical. In all analyses, estimates are adjusted for stratification and clustering in the T1 sample, and weighted using the NSHAP-provided person-level weight. This weight is based on differential probabilities of selection into the sample with post-stratification adjustments for non-response and drop outs at later timepoints. Weights were used to attenuate selection bias due to non-response.

Role of the funding source
The funder of the study had no role in study design, data collection, data analysis, data interpretation, or the writing

	Social disconnectedness			Perceived isolation			Depression symptoms			Anxiety symptoms		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Social disconnectedness												
T1	..	0·63	0·58	0·32	0·28	0·31	0·21	0·19	0·18	0·11	0·09	0·06*
T2	..	..	0·69	0·31	0·32	0·33	0·22	0·23	0·21	0·11	0·10	0·08
T3	..	..	..	0·31	0·33	0·42	0·29	0·31	0·32	0·13	0·15	0·15
Perceived isolation												
T1	..	..	..	..	0·49	0·53	0·34	0·34	0·32	0·26	0·30	0·24
T2	..	..	..	..	..	0·61	0·31	0·37	0·33	0·23	0·30	0·25
T3	..	..	..	..	..	..	0·36	0·40	0·43	0·26	0·31	0·34
Depression symptoms												
T1	..	..	..	..	..	..	..	0·60	0·61	0·64	0·40	0·43
T2	..	..	..	..	..	..	..	..	0·65	0·45	0·50	0·45
T3	..	..	..	..	..	..	..	..	..	0·47	0·46	0·53
Anxiety symptoms												
T1	..	..	..	..	..	..	..	..	..	..	0·50	0·53
T2	..	..	..	..	..	..	..	..	..	..	..	0·59
T3	..	..	..	..	..	..	..	..	..	..	..	..
Mean	0·01	0·07	0·14	0·02	0·05	0·08	4·65	4·47	4·91	3·60	4·90	4·71
SD	0·46	0·42	0·38	0·59	0·53	0·50	4·07	3·59	3·34	3·39	3·06	2·55

N=3005. T1=wave 1, 2005–06. T2=wave 2, 2010–11. T3=wave 3, 2015–16. *p<0·01, all other correlations p<0·0001.

Table 2: Correlations for all continuous variables

of the report. The corresponding author had full access to all of the data in the study and the final responsibility to submit for publication.

Results

Table 1 shows baseline characteristics of the 3005 participants that were included at T1. The mean age of respondents in the analytic sample was 69·3 (SD 7·9) years, and 1551 (51·6%) of 3005 were women. Table 2 reports the zero order correlations, means, and SDs for the key variables.

Each model was constructed to be a fully saturated model in which all variables or residuals at a given timepoint were allowed to correlate. Equality constraints were imposed for each cross-lagged parameter over time to determine whether the model could be simplified, and one path of six in each model yielded a significant χ^2 change value. The two paths were perceived isolation to depression and perceived isolation to anxiety. All other paths were constrained to be equal over time, but these two paths were allowed to freely vary. The analyses were run in both maximum likelihood as well as maximum likelihood with robust SEs, and they yielded virtually identical results. Since Mplus cannot do bootstrapping in maximum likelihood with robust SEs, we opted for maximum likelihood with bootstrapping. However, results were very similar for the estimates of the indirect effects between the two estimators with and without bootstrapping.

Using maximum likelihood estimation with 5000 bootstrapped iterations, the two resulting models yielded good model fit for depression (χ^2 to df ratio 3·07, RMSEA 0·026, 95% CI 0·017–0·037, CFI 0·99, sRMR 0·004); and anxiety (χ^2 to df ratio 2·62, RMSEA 0·023, 95% CI 0·013–0·034, CFI 0·99, sRMR 0·004).

We found that perceived isolation was positively associated with depression symptoms at T2 and T3 (β=0·12; p<0·0001). This result supports our first hypothesis, namely that feeling lonely and having a lack of social support predicts higher frequencies of depression symptoms. However, we did not find evidence that social disconnectedness (ie, having a small network or infrequent social interaction) predicted higher frequencies of depression symptoms at subsequent timepoints (β=0·003; p=0·77; data not shown).

To test our second hypothesis, we examined whether perceived isolation mediated the relationship between social disconnectedness and depression symptoms. We found support for this prediction. Social disconnectedness predicted higher amounts of perceived isolation (β=0·09; p<0·0001), and perceived isolation predicted higher amounts of depression symptoms (β=0·12; p<0·0001). To further test the longitudinal mediation, we used a 95% CI in Mplus (table 3). The predicted mediation relationship (from social disconnectedness to perceived isolation to depression symptoms) was empirically supported (indirect effect 0·007, SE 0·002; p<0·0001).

We also observed evidence of reverse influence, with depression symptoms predicting higher amounts of social disconnectedness (β=0·06; p<0·0001) and perceived isolation (β=0·13; p<0·0001) at subsequent timepoints.

	Data	Effect size
Model 1		
T1 social disconnectedness to T2 perceived isolation to T3 depression symptoms	β=0·007, SE 0·002; p<0·0001	0·32
T1 depression symptoms to T2 perceived isolation to T3 social disconnectedness	β=0·012, SE 0·002; p<0·0001	0·24
Model 2		
T1 social disconnectedness to T2 perceived isolation to T3 anxiety symptoms	β=0·007, SE 0·002; p=0·0150	0·39
T1 anxiety symptoms to T2 perceived isolation to T3 social disconnectedness	β=0·009, SE 0·002; p<0·0001	0·27

Effect size is the proportion mediated, which is calculated by dividing the indirect effect by the total effect. T1=wave 1, 2005–06. T2=wave 2, 2010–11. T3=wave 3, 2015–16.

Table 3: **Statistical results of the longitudinal mediations**
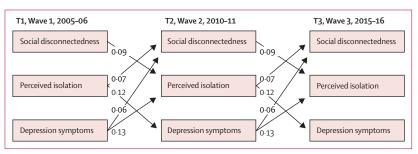
Figure 1: **Model 1 longitudinal associations between social disconnectedness, perceived isolation, and depression symptoms**
Data shown are coefficients and all associated p values were less than 0·0001.
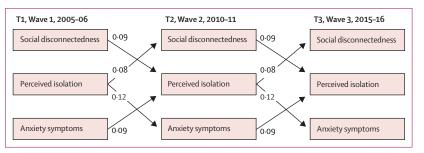
Figure 2: **Model 2 longitudinal associations between social disconnectedness, perceived isolation, and anxiety symptoms**
Data shown are coefficients and all associated p values were less than 0·0001.

Perceived isolation also predicted higher amounts of social disconnectedness at later timepoints (β=0·07; p<0·0001). We further identified a longitudinal mediation pattern going from depression symptoms to perceived isolation to social disconnectedness (indirect effect 0·012, SE 0·002; p<0·0001). Model 1 results are shown in figure 1. Information regarding stability coefficients is shown in the appendix (p 18).

Effect sizes of the longitudinal mediations were computed using MacKinnon's formula for calculating the mediated percentage, which is the indirect effect divided by the total effect (table 3).[23] Both effect sizes fell in the medium range on the basis of Cohen's guidelines,[24]

suggesting that these mediations captured significant covariation over time.

Model 2 tested our hypotheses about the role of social disconnectedness and perceived isolation in the development of symptoms of anxiety (figure 2). We found that perceived isolation predicted higher amounts of anxiety symptoms at subsequent timepoints (β=0·12; p<0·0001), but we did not find that social disconnectedness significantly predicted higher amounts of anxiety (β=0·02; p=0·18; data not shown).

As with depression symptoms, we obtained support for our hypothesis that perceived isolation would mediate the relationship between social disconnectedness and symptoms of anxiety. Social disconnectedness predicted higher amounts of perceived isolation (β=0·09; p<0·0001), and, in turn, perceived isolation predicted higher amounts of anxiety symptoms (β=0·12; p<0·0001). Analyses using a 95% CI lent additional support for this pathway (indirect effect 0·007, SE 0·002; p<0·0001). Additionally, as shown in table 3, the pathway from social disconnectedness to perceived isolation to anxiety yielded a medium effect size of 39%.

Results from model 2 also indicated that anxiety symptoms predicted higher amounts of perceived isolation at follow-up (β=0·09; p<0·0001), but anxiety symptoms did not precipitate higher amounts of social disconnectedness in a direct fashion (β=0·01; p=0·36; data not shown). However, we did observe one additional mediation pathway involving anxiety, which suggested that anxiety predicted social disconnectedness indirectly. As shown in figure 2 and table 3, symptoms of anxiety predicted higher amounts of perceived isolation, which, in turn, predicted higher amounts of social disconnectedness (indirect effect 0·009; SE 0·002; p<0·0001). The effect size for the pathway running from anxiety symptoms to perceived isolation to social disconnectedness was 27%.

Increasingly researchers are using a random intercept cross-lag panel model to clarify between-participant and within-participant covariances over time (ie, to specifically control for time-invariant trait-like differences). We did two random intercept cross-lag panel models, one for each affective outcome, to establish whether the associations noted above with the traditional cross-lag panel model approach might have been obtained spuriously on the basis of stable third variable traits that were not covaried. The analyses confirmed that the obtained significant direct and indirect paths were as strong, and in many cases, stronger than in the original analyses (data not shown).

Discussion
We found that social disconnectedness predicted higher amounts of perceived isolation, which in turn predicted higher amounts of depression and anxiety symptoms. In the reverse direction, depression and anxiety symptoms predicted higher amounts of perceived isolation, which in turn predicted higher amounts of social disconnectedness.

The strengths of the study include the large sample size, prospective design, the use of nationally representative data, with validated scales for social disconnectedness, perceived isolation, and symptoms of depression and anxiety. Although previous research has used indicators of numerous aspects of social relationships, no single indicators have comprehensively captured the complex nature of structural or functional social isolation, which has been a limitation in most studies.[25] One of the strengths of the NSHAP data is the various measures pertaining to network structure and function, which have made it possible to develop more comprehensive scales. Some limitations should be considered when interpreting the results. First, these findings were based on self-reported data, which implies the possibility for self-report bias and issues pertaining to common-methods variance. Second, the scales for anxiety and depression symptoms were based on the self-report of symptoms. The results might also have differed if anxiety or depression symptoms had been assessed by clinical evaluation and diagnosis rather than the use of screening tools.[26]

Third, residual confounding might exist due to potential confounders that we could not include in the analysis or adjust for, such as stressful life events, family history of mental disorders, or genetic profiles. Fourth, since a sizable proportion of the data were imputed, attrition bias and the amount of missing data might have affected the results and the data imputation. That said, we used weights to account for non-response and loss to follow-up in all analyses, and we have arrived at the same results both with and without data imputation (also with weights applied in both cases). This result indicates that the patterns of associations are robust, at least as far as the available data have allowed us to establish. Finally, those participating in the baseline survey who were not followed up at subsequent timepoints were more likely to be older, unemployed, and have disability and lower education. They were also more likely to report more depression symptoms, social disconnectedness, and perceived isolation (appendix p 19). Although the NSHAP generated weights are likely to have adjusted for drop outs to some extent, we cannot rule out some degree of bias.

Our results suggest an especially tight connection between social disconnectedness and perceived isolation, and between perceived isolation and affective problems. The patterns point to the key role of perceived isolation, that is, older adults who perceive a shortfall in social support, are at greater risk of depression and anxiety. Further, enhanced social connectedness among older adults might prevent perceptions of isolation, which in and of itself should serve as a protective factor against the onset or maintenance of affective disorders.

On the basis of the longitudinal associations identified, depression symptoms appear to be more intertwined with social disconnectedness and perceived isolation than anxiety symptoms. It is possible that the course of depression more readily results in social withdrawal than the course of anxiety, or that social connections might be less inclined to maintain contact with a person showing depression symptoms than with a person showing anxiety symptoms. This possibility could have important implications for the treatment or prevention of depression. Further research on the influence of depression on network structure, as compared with anxiety, could shed light on the pathways through which depression shapes late-life trajectories of health and wellbeing. That said, it is important to observe that all variables were related to all other variables either directly or indirectly. This degree of interconnection means that these four constructs reinforce each other in a downward spiral unless buffered by protective factors or interrupted through interventions.

From a public health or social policy standpoint, this study has important implications for the prevention of affective disorders in the transition to older adulthood. Our findings point to perceived isolation as a lynchpin through which social disconnectedness leads to affective disorders, and through which depression and anxiety precipitate social withdrawal. From a practical perspective, social or gerontological care strategies might increase the focus on individuals' evaluations of the extent to which their social relationships meet their needs for companionship and support. Given that our results point to perceived isolation as a precursor to affective problems, it is of high importance to assess subjective evaluations as a means to detect at-risk individuals. Such assessment will also provide pointers for a course of action. For some older adults, one or two close relationships might fulfil needs for companionship and support whereas others might require more extensive networks or broader social interaction. It could be worthwhile to implement such assessment practices in standard care provision and social or gerontological work. Relevant tools designed for practitioners to screen for social disconnectedness also exist and have documented predictive validity in terms of various mental and physical health outcomes.[27,28]

From a broader perspective, strategies designed to structurally optimise opportunities for social connectedness are greatly needed. Given that our results point to social disconnectedness as being the catalyst of a downward negative spiral, leading to perceived isolation and ultimately late-life affective disorders, comprehensive strategies should give high priority to addressing, targeting, and intervening in social disconnectedness throughout society. Yet, a growing proportion of older adults are ageing independently in their long-term residential community, and communities vary in the extent to which they provide opportunities for social engagement and cohesion.

One innovative solution might lie in the Act-Belong-Commit mental health promotion campaign, also referred to as the ABCs of mental health, which is currently being deployed in different parts of the world, such as Australia, Denmark, Faroe Islands, Norway, and recently in

university settings in the USA.[29,30] The campaign encourages individuals to engage in mentally healthy behaviours, such as keeping active, maintaining contact with social ties, and getting involved in meaningful challenges or causes. The campaign simultaneously supports and encourages community organisations that offer opportunities for mentally healthy activities. Act-Belong-Commit can be tailored to all segments of a population and can also be implemented in social and gerontological practice or clinical settings.[31]

Finally, our results indicate that it might be possible to prevent the development, maintenance, or worsening of social disconnectedness among people with affective problems, and that this might be done with efforts focused on preventing or reducing perceived isolation (ie, enhancing social support and reducing loneliness). Although standard clinical treatment might involve addressing social interaction and withdrawal, alternative initiatives designed to create opportunities for social interaction and a sense of community belonging, such as prescription gardening,[32] prescription football,[33] or prescription art,[34] have been implemented in various settings with promising results. These interventions could—in addition to their associated health benefits—be essential as a means to increase social support and reduce loneliness, which in turn could foster social connectedness among older adults with affective problems.

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