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Empirical Article

Temporal associations of emotional and social loneliness and psychosocial functioning in emerging adulthood

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Emerging adulthood is an important developmental phase often accompanied by peaks in loneliness, social anxiety, and depression. However, knowledge is lacking on how the relationships between emotional loneliness, social loneliness, social isolation, social anxiety and depression evolve over time. Gaining insight in these temporal relations is crucial for our understanding of how these problems arise and maintain each other across time. Young adults from a university sample (N = 1,357; M = 23.60 years, SD = 6.30) filled out questionnaires on emotional and social loneliness, social isolation, depressive and social anxiety symptoms at three time points within a 3-year period. Random intercept cross-lagged panel models were used to disentangle reciprocal and prospective associations of loneliness subtypes, social isolation, depressive and social anxiety symptoms across time. Results showed that on the within-person level, increases in emotional and social loneliness as well as social isolation predicted higher depression levels on later timepoints. Increases in depressive symptoms also predicted increases in subsequent social loneliness, but not in emotional loneliness. Finally, increases in depressive symptoms predicted increases in social isolation. There were no significant temporal relations between loneliness and social isolation on the one hand and social anxiety symptoms on the other hand. Social distancing imposed by COVID-19 related government restrictions may have impacted the current results. The findings suggest that emotional and social loneliness precede development of depressive symptoms, which in turn precedes development of social loneliness and social isolation, indicating a potential vicious cycle of social loneliness, social isolation and depressive symptoms in emerging adulthood. Social anxiety did not precede nor follow loneliness, depressive symptoms, or social isolation. The current study sheds more light on the temporal order of loneliness and psychopathological symptoms and hereby assists in identifying times where prevention and intervention efforts may be especially helpful to counter development of depression and loneliness.

Key words: Emotional loneliness, social loneliness, social isolation, social anxiety, depression, longitudinal.

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INTRODUCTION

Loneliness is the subjective negative experience of a discrepancy of either quality or quantity in an individual's social network (Perlman & Peplau, 1981). The prevalence of loneliness peaks during emerging adulthood (18–25 years of age), a phase accompanied by many changes such as increases in autonomy, self-exploration, and identity-formation (Victor & Yang, 2012), and obtaining an education or a first job (Arnett, 2000; Asghar & Iqbal, 2019; Auerbach, Mortier, Bruffaerts *et al.*, 2018). Difficulties with these changes are associated with higher chances of feeling lonely (Heinrich & Gullone, 2006). Feeling alone (loneliness) and being alone (social isolation) have been associated with other negative outcomes such as depression and social anxiety (Abdellaoui, Nivard, Hottenga *et al.*, 2018; Cacioppo, Grippo, London, Goossens & Cacioppo, 2015; Cacioppo, Hughes, Waite, Hawkley & Thisted, 2006; Heinrich & Gullone, 2006). To date, however, it remains unclear whether loneliness precedes the development of psychopathological symptoms such as social anxiety and depression or whether loneliness and social isolation are a consequence of (symptoms of) social anxiety and depression (Hawkley & Cacioppo, 2010; Orben, Tomova & Jayne-Blakemore, 2020; Teo, Lerrigo & Rogers, 2013). These temporal relations need to be clarified to determine the starting point and content for interventions aimed at reducing loneliness, social isolation, social anxiety and depressive symptoms, and thus to be able to effectively counteract their far-reaching consequences.

When investigating loneliness and its association with social isolation and mental health symptoms, it is important to make a clear distinction between these constructs. First, although they each describe separate experiences, loneliness and social isolation are often interchangeably used in the literature (Valtorta *et al.*, 2016). Whereas loneliness is defined by the subjective experience of an individual's mismatch in the quality or quantity of their social network, social isolation refers to the objective absence of social connections. Indeed, studies have shown that social

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isolation and loneliness only have a moderate, positive association (e.g., Coyle & Dugan, 2012). Importantly, they have each been related to different mental health outcomes with studies showing that social isolation has been associated with increased mortality rates, psychotic symptoms, and a higher risk of dementia (Holt-Lunstad *et al*., 2010; Ma *et al*., 2020; Pantell *et al*., 2013). On the other hand, loneliness has been associated with depression and general cognitive decline (Cacioppo & Cacioppo, 2018; Ma *et al*., 2020; Wolters, Mobach, Wuthrich *et al*., 2023).

Second, research on loneliness has led to the conclusion that it is a bidimensional rather than a unidimensional construct (Shaver & Rubenstein, 1980; Vincenzi & Grabosky, 1989; Wittenberg, 1986). Whereas *emotional* loneliness can be defined as the perceived absence of intimate or close interpersonal connections, *social* loneliness is defined as the perceived lack of an available and satisfying social network (Weiss, 1973). This division has received wide support in the literature, including among youth (Juntilla & Vauras, 2009; Qualter & Munn, 2002). Experiences of emotional and social loneliness do not necessarily overlap. For example, a young adult may lack a close friend (i.e., experiencing emotional loneliness), but may still have a large social network (i.e., not experiencing social loneliness; Maes *et al*., 2017). In line with the above, emotional and social loneliness appear to be related to different social needs (Dahlberg & McKee, 2014; DiTommaso & Spinner, 1997; Dykstra & Fokkema, 2007) with emotional loneliness being related to closeness with social ties (quality) and social loneliness being related to satisfaction with social contacts (quality) and social isolation (quantity; Green, Richardson, Lago & Schatten-Jones, 2001). Also, some studies have shown that emotional loneliness is related more strongly to depression and social anxiety than social loneliness (e.g., Dahlberg & McKee, 2014; Diehl, Jansen, Ishchanova & Hilger-Kolb, 2018; Green *et al*., 2001; Hyland, Shevlin, Cloitre *et al*., 2019). These findings indicate that the relationships between these loneliness dimensions with social isolation and mental health symptoms may differ, calling for longitudinal studies that include loneliness dimensions and social isolation as separate constructs and study their interrelations across time.

A large body of research has investigated relations between (some of) these constructs and in general has shown consistent and positive relations among loneliness, social isolation, and depressive symptoms, with stronger associations between depressive symptoms and loneliness compared to social isolation (Ge, Yap, Ong & Heng, 2017; Matthews, Danese, Wertz *et al*., 2016). Also, longitudinal designs have shown that loneliness and social isolation increase the chance of developing depression across the lifespan (Domenech-Abella, Mundó, Haro & Rubio-Valera, 2019; Goosby, Bellatorre, Walsemann & Cheadle, 2013; Richardson, Elliott, Roberts & Jansen, 2016; Wei, Russel & Zakalik, 2005). This is in line with theories on loneliness (Cacioppo *et al*. 2006a, 2006b; Hawkley & Cacioppo, 2010) and the need to belong (Baumeister & Leary, 1995; Deci & Ryan, 2000) indicating that feelings of loneliness may lead to several negative emotional, behavioral, and cognitive responses which may lead to more negative interactions and behaviors. This may increase the risk for depressive symptoms (Cacioppo & Hawkley, 2009; Qualter, Vanhalst, Harris *et al*., 2015). There are also studies that indicate, however, that these relationships are reciprocal (van Halst, Klimstra, Luyckx, Scholte, Engels & Goossens, 2012; Cacioppo *et al*., 2006; Domenech-Abella *et al*., 2019). For example, van Halst and colleagues (2012) found that loneliness and depressive symptoms positively predicted each other across a period of 5 years in mid- to late-adolescence, whereas a previous longitudinal study by the same group (van Halst *et al*., 2012) in college students showed that loneliness predicted subsequent depression, whereas the reverse relation was significant, but less strong and consistent.

Only two studies have investigated loneliness, social anxiety symptoms, and depression symptoms in one sample (Danneel, Nelemans, Spithoven *et al*., 2019; Lim, Rodebaugh, Zyphur & Gleeson, 2016). Danneel *et al*. (2019) investigated the relations between these constructs over a three-year period in three adolescent samples and found a bidirectional relation between loneliness and social anxiety across time. Also, depression predicted higher loneliness across time. Interestingly, social anxiety mediated the relationship between loneliness and depression (Danneel *et al*., 2019). However, the indirect effects were small and inconsistent across the three samples. The second study by Lim *et al*. (2016) investigated the temporal associations between loneliness, social anxiety, and depression in a general adult sample (18–87 years old). Using a cross-lagged panel model with random intercept, they found that loneliness predicted more severe social anxiety and depression over 6 months. Depressive symptoms predicted future social anxiety, and social anxiety led to an increase in loneliness. Both studies suggest a bidirectional relationship between loneliness and social anxiety over time.

Taken together, most studies indicate positive relations between all constructs over time. However, the results on temporal directionality are inconsistent across studies and difficult to interpret as none of the studies above included all above-mentioned constructs in one study. This precludes comprehensive conclusions on how these constructs relate to each other over time. Specifically, the majority of these studies did not include social isolation, which raises questions about the extent to which the associations with loneliness might be based on real deficits in social connections. Second, neither study investigated separate relationships for emotional and social dimensions of loneliness. Even though all constructs have shown to be positively related to each other across time, there is some evidence that emotional and social loneliness as well as social isolation predict unique variance in their relationships with depression and social anxiety (e.g., Diehl *et al*., 2018; Hyland *et al*., 2019). Investigating all factors simultaneously, while controlling for each other will give more insight in these unique relationships over time.

The current study aimed to address these issues by including a comprehensive longitudinal design in which reciprocal and prospective associations between emotional and social loneliness, social isolation, social anxiety symptoms and depressive symptoms were assessed in young adults over a 3-year time period. It was hypothesized that increases in loneliness would predict higher depressive and social anxiety symptoms within persons over time and that these relations are bidirectional (e.g., van Halst *et al*., 2012). Specifically, it was expected that emotional and social loneliness would be differentially related to

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the development of depressive and social anxiety symptoms (e.g., Ma *et al*., 2020; Wolters *et al*., 2023). The lack of studies on how loneliness subtypes relate to different mental health outcomes, however, precludes a specific hypothesis on the direction of these effects. Finally, it was hypothesized that higher levels of depression and social anxiety were associated with higher levels of social isolation within persons over time, and that this relationship too would be bidirectional.

METHODS

Participants and procedure

The recruitment and data collection of the current study was part of a larger randomized controlled trial (RCT) consisting of an annual screening procedure to identify and prevent common mental health complaints in emerging adulthood taking place at a university in the Netherlands (Klein, Bol, Wolters et al., 2021). For the purposes of the current study, three consecutive waves of screening data were used. All university students and PhD students (N = 64,915) of the University of Amsterdam, the Netherlands, were invited to take part. In the first wave, 7,085 students (11%) participated. The second and third waves of data collection resulted in 3,029 and 5,223 participants, respectively. Part of the drop-out can be explained by students who were in their final year of university in Wave 1 or 2.[1] Also, participants who were included in the RCT (described below) after wave 1 were not invited for the consecutive wave(s) to avoid confounding effects. There were no missing values at the item-level and participants were included if ≥75% of their questionnaires were completed (three out of four questionnaires). The final analytical sample comprised participants who provided data on at least two out of three time points (N = 1,357). This resulted in the following sample sizes per time point: N_{wave1} = 1,167, N_{wave2} = 1,017, and N_{wave3} = 788. See Table 1 for the demographics.

Students who were included in the RCT, were not invited to fill in the screening questionnaire in the consecutive waves. All other participants received an email with a personalized link to the surveys for wave 2 and 3. Participants gave written informed consent before completing the questionnaires. Data collection ran from January 2019 until February 2021. Hence, the data collection started before the COVID-19 pandemic and continued, and ended, during the pandemic. The first wave (T1) was collected between January 28, 2019 and January 19, 2020, before COVID-19. The second wave (T2) was collected between January 21, 2020 andJuly 9, 2020. The final wave (T3) was collected between September 24, 2020 and January 29, 2021, depending on when participants entered the study. The time interval between measurements varied for each participant (T1-T2: M_{months} = 6.97, SD_{months} = 3.26; T2-T3: M_{months} = 6.84, SD_{months} = 1.50) due to being dependent on university faculties sending out the questionnaires. During the second and third waves, COVID-19 restrictions in the Netherlands included social distancing and prohibition of most social gatherings. During the second wave, the universities were closed, and education was continued online for the remaining data collection. The study was approved by the Ethics Review Board of the University of Amsterdam (2019-DP-11170).

Table 1. *Descriptive statistics at Time 1, Time 2, and Time 3*

	Time 1		Time 2		Time 3	
n	1,167		1,017		788	
Variable	*M*/*n*	*SD*/%	*M*/*n*	*SD*/%	*M*/*n*	*SD*/%
Age[a]	23.6	6.3	24.7	6.6	24.9	6.5
Gender						
Female	810	69.4	695	68.3	543	68.9
Male	349	29.9	315	31.0	242	30.7
Other	8	0.7	7	0.7	3	0.4
Emotional loneliness	2.3	2.0	2.7	2.0	2.7	2.0
α	0.79		0.87		0.76	
Social loneliness	1.5	1.7	1.5	1.8	1.4	1.7
α	0.80		0.83		0.82	
Social isolation	11.8	5.1	12.3	5.1	12.3	5.2
α	0.81		0.81		0.83	
Social anxiety	4.4	4.5	4.7	4.6	4.6	4.5
α	0.84		0.85		0.84	
Depression	16.5	10.5	17.4	11.2	17.5	11.1
α	0.91		0.92		0.92	

Note: M = mean; n = frequency; SD = Standard Deviation; α = Cronbach's Alpha.

Materials

The De Jong-Gierveld loneliness scale (DJGLS-11; De Jong-Gierveld & Kamphuis, 1985) was used to assess emotional and social loneliness. Six negatively phrased items form the emotional loneliness subscale and five positively phrased items form the social loneliness subscale. The following items are examples for the emotional and social loneliness subscales respectively: "I miss having a really close friend" and "There are plenty of people I can lean on when I have problems." All 11 items were rated using the following answer options: "yes!" "yes," "more or less," "no," "no!" Following the scale manual, neutral and positive answers on the emotional loneliness items were scored as 1, and negative answers as 0. For the social loneliness items, neutral and negative answers were scored as 1, and positive answers as 0. This resulted in a total emotional loneliness score between 0 and 6, and a total social loneliness score between 0 and 5. A higher score indicated more severe loneliness. The DJGLS has shown good internal consistency for both subscales (emotional loneliness [EL]: α = 0.90; social loneliness [SL]: α = 0.88; De Jong Gierveld & van Tilburg, 2010). Internal consistency was good in the current study for both subscales (T1: EL: α = 0.79, SL: α = 0.80; T2: EL: α = 0.79, SL: α = 0.83; T3: EL: α = 0.76, SL: α = 0.82).

The Lubben social network scale (LSNS-6; Lubben, 1998) was used to measure social isolation. The first three items form the subscale social support received from family members. The second three items form the subscale measuring social support received from friends. For example, participants were asked to quantify "How many relatives/friends do you see or hear from at least once a month?" All six items were scored on a six-point scale ranging from 0 (none friends/relatives) to 5 (≥9 friends/relatives). All items were reverse scored for clarity, so that a higher score on the LSNS-6 scale indicated more social isolation. Total score was the summation of the two subscales and ranged between 0 and 30. The LSNS-6 was initially developed for older adults, but the scale was recently validated in younger adults (Nandi, Hazra, Sarkar, Mondal & Ghosal, 2012; Rice, O'Bree, Wilson *et al*., 2020; Watabe, Kato, Teo *et al*., 2015). Internal consistency was good in the current study (T1: α = 0.81; T2: α = 0.81; T3: α = 0.83).

The social interaction anxiety scale – six items (SIAS-6; Peters, Sunderland, Andrews, Rapee & Mattick, 2012) was used to assess social anxiety. An example item is: "I feel tense if I am alone with just one person." All six items were scored on a five-point Likert scale ranged from 0 (not at all characteristic of me) to 4 (extremely characteristic of me). Total score ranged between 0 and 24. A higher total score indicated more severe social anxiety. The SIAS-6 showed good reliability and sensitivity (de Beurs, Tielen & Wollmann, 2014; Peters *et al*., 2012). Internal consistency was good in the current study (T1: α = 0.84; T2: α = 0.85; T3: α = 0.84).

The Center for Epidemiological Studies depression scale (CES-D-20; Radloff, 1977) was used to measure depression. Participants were asked to indicate how often they felt a certain way during the past week on items such as "I was bothered by things that usually don't bother me." All 20 items were scored on a four-point Likert scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time). Following Cacioppo, Hawkley & Thisted (2010), item 14 "I felt lonely" was excluded to avoid

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confounding effects. Total score ranged between 0 and 57. A higher score indicated more severe depression. The CES-D-20 demonstrated good sensitivity and reliability (Jiang, Wang, Zhang *et al.*, 2019; Miller, Anton & Townson, 2008; Vilagut, Forero, Barbaglia & Alonso, 2015). Internal consistency was good in the current study (T1: $\alpha = 0.92$; T2: $\alpha = 0.93$; T3: $\alpha = 0.93$).

Statistical analysis

Descriptive statistics and response rates were calculated using SPSS version 25. The temporal relationships between loneliness subtypes, social isolation, social anxiety and depressive symptoms were examined with dynamic structural equation modeling (D-SEM) using a random intercept cross-lagged panel model (RI-CLPM) in Mplus Version 8.4 (Muthén & Muthén, 1998–2017). The advantages of the RI-CLPM over the general CLPM is that it has been shown to fit empirical data better (Mulder & Hamaker, 2020) and it accounts for structural between-subject differences, allowing clearer conclusions about within-person change over time (Hamaker, Kuiper & Grasman, 2015). The RI-CLPM divides observed variables into two components: (1) between subject variance: a trait-like component that is stable over time (time-invariant) captured through random intercepts (RI); and (2) within-subject variance: a state-like component that captures the time-varying part of the variable through autoregressive (AR) and cross-lagged (CL) effects (Hamaker *et al.*, 2015). The time-invariant component of the model is captured by creating random intercepts for each variable as a latent variable of the repeated measurements (e.g., loneliness at Time 1, 2, and 3), with factor loadings fixed to 1. Therefore, it controls for structural differences within persons.

The within-subject components of the RI-CLPM model, the AR and CL paths, reflect the fluctuations around a subject's own expected score and hence represent dynamics of symptom development across time at the within-person level (Mulder & Hamaker, 2020). The AR paths represent within-person carry-over effects or stability of a construct over time on the within person-level and indicate to what extent levels of loneliness, social isolation, social anxiety and depressive symptoms on the previous timepoint (t_{-1}) predict measurements of the same construct at a later time point (Mulder & Hamaker, 2020; Usami, 2020). The CL paths indicate the extent to which variables impact each other over time and thus assess temporality and causality (Hamaker *et al.*, 2015). The CL paths can be interpreted as to whether deviations in a person's expected score on one variable influence deviations in the same person's expected score on another variable. A simplified RI-CLPM as tested is illustrated in Fig. 1.

Missing data were handled as a default in Mplus using the full-information maximum likelihood (FIML) estimator (Muthén & Muthén, 1998–2017). The percentages of missing data were 14.0%, 25.1%, and 41.9% across the time points. Robust maximum likelihood estimation (MLR) was used because of its robustness to handle non-normality. We tested two RI-CLPM models, one for emotional, and one for social loneliness, including the self-report measures of social isolation, social anxiety, and depression. Model fit was tested by the comparative fit index (CFI; Bentler, 1990), the Tucker–Lewis incremental fit index (TLI; Tucker & Lewis, 1973), the root mean square error of approximation (RMSEA; Steiger & Lind, 1980), and the standardized root mean square residual (SRMR; Bentler, 1995; Jöreskog & Sörbom, 1981). A model is assumed to fit the data well when CFI and TLI are between 0.95 and 1.00, the RMSEA is below 0.08, and the SRMS is below 0.08 (Hu & Bentler, 1999). We decided to constrain both the AR and CL paths if the fit of the constrained and unconstrained model were to be similar (as judged by the model fit) as we assume constancy of effects between timepoints based on previous studies which enabled us to compare the results more easily to those of previous studies, such as Cacioppo

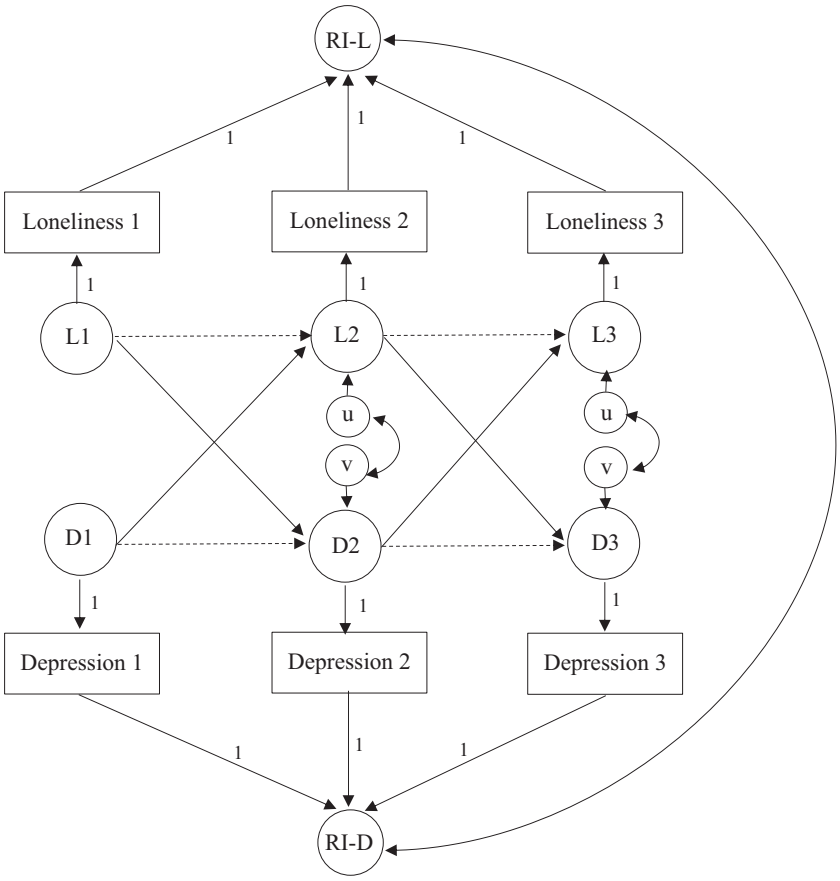

Fig. 1. A simplified representation of RI-CLPM model with two variables over three time points.*Note*: The auto-regressive paths are the dotted lines and the cross-lagged paths the solid lines. The squares represent observed scores, and the ovals represent latent variables of the observed scores. The *u* and *v* represent the residuals of the latent variables. RI-L and RI-D represent the random intercepts of loneliness and depression, respectively.

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et al. (2010), Domenech-Abella, Mundó, Switsers, van Tilburg, Fernandez & Aznar-Lou (2021), and Lim *et al*. (2016). Also, the aim of the paper was to investigate the longitudinal relationships over time, rather than the temporal changes between specific time points. Hence, the predictions of loneliness at T2 and T3 by loneliness at T1 and T2, respectively, were set to be equal (as for all other AR paths in the model). Additionally, the predictions of loneliness at Time 2 and Time 3 by depressive symptoms at Time 1 and Time 2, respectively, were constrained (as for all other CL paths in the model).

RESULTS

Model fit

First, unconstrained RI-CLPM models for emotional and social loneliness were estimated to determine whether the assumptions for constrained models were met, and the constrained AR and CL paths were justified. The model fits of all four models were excellent (see Table 2). The SRMR and CFI fits were slightly better for the unconstrained models, and the RMSEA a little better for the constrained model with emotional loneliness. Taken together, we chose the use of the constrained model because of an equally excellent fit and to facilitate comparison of our results to previous studies (e.g., Lim *et al*., 2016).[2]

Emotional loneliness

The first model assessed how emotional loneliness, social isolation, social anxiety, and depressive symptoms related to each other across the three time points. Standardized parameters for the auto-regressive and cross-lagged paths are presented in Table 3. The random intercepts of all variables were positively and strongly related (Table 3). The significant auto-regressive and cross-lagged paths are depicted in Fig. 2. Although the estimates were constrained over time, the standardized parameters were still able to vary between time points (Mulder & Hamaker, 2020). The cross-lagged paths showed that higher-than-expected scores on emotional loneliness predicted higher-than-expected scores on depressive symptoms within persons over time (T1-T2: $\beta = 0.121$, $SE = 0.061$, $p = 0.047$; T2-T3: $\beta = 0.130$, $SE = 0.65$, $p = 0.045$). However, depressive symptoms did not significantly predict emotional loneliness on the within-person level (T1-T2: $\beta = 0.098$, $SE = 0.068$, $p = 0.149$; T2-T3: $\beta = 0.120$, $SE = 0.83$, $p = 0.148$). Further, a reciprocal relationship was found between social isolation and depressive symptoms, with higher-than-expected social isolation scores predicting higher-than-expected depression scores on the within-person level over time (T1-T2: $\beta = 0.177$, $SE = 0.072$, $p = 0.014$; T2-T3: $\beta = 0.179$, $SE = 0.073$, $p = 0.014$) and vice versa (T1-T2: $\beta = 0.275$, $SE = 0.083$, $p = 0.001$; T2-T3: $\beta = 0.277$, $SE = 0.077$, $p < 0.001$). Unexpectedly, emotional loneliness was not significantly related to social anxiety on the within-person level at subsequent timepoints (T1-T2: $\beta = 0.087$, $SE = 0.063$, $p = 0.167$; T2-T3: $\beta = 0.090$, $SE = 0.064$, $P = 0.163$) or vice versa (T1-T2: $\beta = -0.025$, $SE = 0.077$, $p = 0.744$; T2-T3: $\beta = -0.028$, $SE = 0.087$, $p = 0.744$). Nor was social isolation related to social anxiety within persons across time (T1-T2: $\beta = 0.013$, $SE = 0.075$, $p = 0.861$; T2-T3: $\beta = 0.013$, $SE = 0.073$, $p = 0.861$) and vice versa (T1-T2: $\beta = 0.018$, $SE = 0.099$, $p = 0.858$; T2-T3: $\beta = 0.016$, $SE = 0.092$, $p = 0.858$).

Together, these results indicate that young adults who have higher-than-average scores on emotional loneliness report more depressive symptoms, but not more social anxiety symptoms across a period of 3 years on the within-person level, whereas depressive symptoms and social anxiety symptoms do not reinforce emotional loneliness in a similar way. Additionally, young adults with higher-than-average scores on social isolation report more depressive symptoms, but not more social anxiety symptoms across a period of 3 years on the within-person level and higher-than-average scores on depressive symptoms, but not social anxiety symptoms, similarly reinforce social isolation across this time period.

Social loneliness

The second model investigated how social loneliness, social isolation, social anxiety, and depressive symptoms were associated with each other across the three time points. Standardized parameters for the auto-regressive and cross-lagged paths are presented in Table 4. All within-person correlations between the constructs can be found in Table 5. The significant auto-regressive and cross-lagged paths are depicted in Fig. 3. The random intercepts of all variables were positively and strongly related (Table 4). The cross-lagged paths showed a bidirectional relationship between social loneliness and depressive symptoms within persons across the three timepoints. Thus, higher-than-expected scores on social loneliness positively predicted higher-than-expected scores on depressive symptoms (T1-T2: $\beta = 0.130$, $SE = 0.064$, $p = 0.042$; T2-T3: $\beta = 0.146$, $SE = 0.071$, $p = 0.039$), and vice versa (T1-T2: $\beta = 0.164$, $SE = 0.070$, $p = 0.020$; T2-T3: $\beta = 0.198$, $SE = 0.082$, $p = 0.015$). Similar to the first model, social isolation and depressive symptoms showed a significant, positive bidirectional relationship on the within-person level across time, indicating that

Table 2. *Model fit indices of unconstrained and constrained models including emotional loneliness or social loneliness*

	Model	χ^2 (df), *P* value	TLI	RMSEA	CFI	SRMR
Unconstrained RI-CLPM	EL	7.154 (6), $P = 0.307$	0.998	0.012	1.000	0.009
	SL	5.532 (6), $P = 0.478$	1.00	0.000	1.00	0.008
Constrained RI-CLPM	EL	24.885 (22), $P = 0.303$	0.998	0.010	0.999	0.017
	SL	13.385 (22), $P = 0.922$	1.00	0.000	1.00	0.012

Note: RI-CLPM = random intercepts cross-lagged panel model; TLI = Tucker–Lewis incremental fit index; RMSEA = root mean square error of approximation; CFI = comparative fit index; SRMR = standardized root mean square residual.

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Table 3. *Summary of the standardized random intercepts, auto-regressive and cross-lagged estimates of the RI-CLPM including emotional loneliness*

Random intercepts	Est.	*SE*	*P*
Emotional loneliness – social isolation	**0.673**	**0.036**	**0.000**
Emotional loneliness – social anxiety	**0.532**	**0.048**	**0.000**
Emotional loneliness – depression	**0.643**	**0.041**	**0.000**
Social isolation – social anxiety	**0.484**	**0.042**	**0.000**
Social isolation – depression	**0.485**	**0.041**	**0.000**
Social anxiety – depression	**0.557**	**0.052**	**0.000**

	Time 1 – Time 2			Time 2 – Time 3		
	β	*SE*	*P*	*β*	*SE*	*P*
Auto-regressive parameters						
Emotional loneliness	**0.179**	**0.076**	**0.019**	**0.195**	**0.083**	**0.018**
Social isolation	0.034	0.097	0.727	0.029	0.083	0.731
Social anxiety	**0.296**	**0.121**	**0.014**	**0.318**	**0.136**	**0.020**
Depression	**0.188**	**0.093**	**0.043**	**0.226**	**0.113**	**0.045**
Cross-lagged parameters						
Social isolation – emotional loneliness	−0.012	0.063	0.854	−0.012	0.065	0.854
Social anxiety – emotional loneliness	−0.025	0.077	0.744	−0.028	0.087	0.744
Depression – emotional loneliness	0.098	0.068	0.149	0.120	0.083	0.148
Emotional loneliness – social isolation	−0.001	0.071	0.987	−0.001	0.063	0.987
Social anxiety – social isolation	0.018	0.099	0.858	0.016	0.092	0.858
Depression – social isolation	**0.275**	**0.083**	**0.001**	**0.277**	**0.077**	**0.000**
Emotional loneliness – social anxiety	0.087	0.063	0.167	0.090	0.064	0.163
Social isolation – social anxiety	0.013	0.075	0.861	0.013	0.073	0.861
Depression – social anxiety	0.113	0.075	0.132	0.131	0.086	0.128
Emotional loneliness – depression	**0.121**	**0.061**	**0.047**	**0.130**	**0.065**	**.045**
Social isolation – depression	**0.177**	**0.072**	**0.014**	**0.179**	**0.073**	**0.014**
Social anxiety – depression	0.031	0.084	0.715	0.034	0.094	0.715

Note: Significant estimates are presented in bold ($p < 0.05$). *β* = standardized estimates, *SE* = standard error.

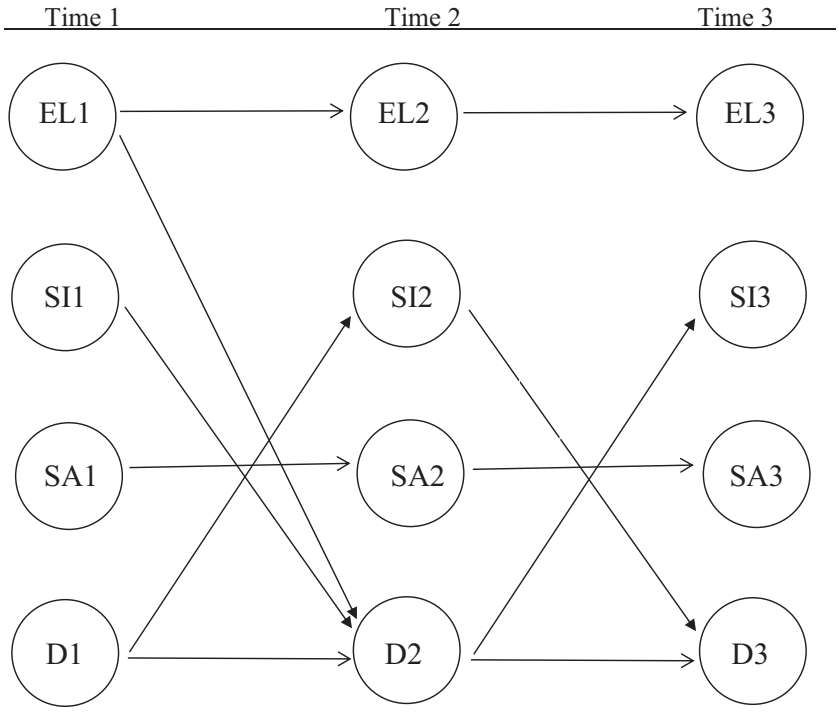

Fig. 2. Significant standardized auto-regressive and cross-lagged paths for the RI-CLPM including emotional loneliness, social isolation, social anxiety, and depression at three time points.*Notes*: EL = emotional loneliness; SI = social isolation; SA = social anxiety; D = depression. The three time points are indicted above the model and by the numbers after EL, SI, SA, and D; e.g., EL1 = emotional loneliness at Time 1.

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Table 4. *Summary of the standardized random intercepts, auto-regressive and cross-lagged estimates of the RI-CLPM including social loneliness*

Random intercepts	Est.	*SE*	*P*
Social loneliness – social isolation	**0.770**	**0.028**	**0.000**
Social loneliness – social anxiety	**0.459**	**0.042**	**0.000**
Social loneliness – depression	**0.489**	**0.043**	**0.000**
Social isolation – social anxiety	**0.497**	**0.039**	**0.000**
Social isolation – depression	**0.491**	**0.038**	**0.000**
Social anxiety – depression	**0.570**	**0.047**	**0.000**

	Time 1 – Time 2			Time 2 – Time 3		
	β	*SE*	*P*	*β*	*SE*	*P*
Auto-regressive parameters						
Social loneliness	0.040	0.083	0.628	0.045	0.095	0.630
Social isolation	0.060	0.093	0.516	0.053	0.083	0.524
Social anxiety	**0.248**	**0.121**	**0.041**	0.266	0.138	0.055
Depression – depression	**0.194**	**0.094**	**0.040**	**0.233**	**0.116**	**0.044**
Cross-lagged parameters						
Social isolation – social loneliness	−0.033	0.065	0.606	−0.034	0.065	0.605
Social anxiety – social loneliness	0.029	0.086	0.740	0.032	0.097	0.741
Depression – social loneliness	**0.164**	**0.070**	**0.020**	**0.198**	**0.082**	**0.015**
Social loneliness – social isolation	−0.104	0.070	0.135	−0.100	0.066	0.127
Social anxiety – social isolation	0.019	0.089	0.829	0.018	0.085	0.829
Depression – social isolation	**0.282**	**0.077**	**0.000**	**0.292**	**0.074**	**0.000**
Social loneliness – social anxiety	0.108	0.070	0.123	0.117	0.074	0.116
Social isolation – social anxiety	−0.023	0.070	0.741	−0.023	0.070	0.741
Depression – social anxiety	0.110	0.078	0.160	0.127	0.091	0.160
Social loneliness – depression	**0.130**	**0.064**	**0.042**	**0.146**	**0.071**	**0.039**
Social isolation – depression	**0.158**	**0.069**	**0.021**	**0.160**	**0.069**	**0.020**
Social anxiety – depression	−0.008	0.086	0.925	−0.009	0.096	0.925

Note: Significant estimates are presented in bold ($p < 0.05$). *β* = standardized estimates, SE = standard error.

Table 5. *Within-person correlations for the model including emotional loneliness and social loneliness*

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Social/emotional loneliness T1	–	0.669	0.664	0.588	0.528	0.558	0.420	0.379	0.350	0.411	0.370	0.317
2. Social/emotional loneliness T2	0.645	–	0.675	0.531	0.615	0.537	0.332	0.407	0.378	0.367	0.459	0.390
3. Social/emotional loneliness T3	0.578	0.624	–	0.514	0.535	0.610	0.317	0.332	0.383	0.335	0.387	0.457
4. Social isolation T1	0.511	0.437	0.415	–	0.773	0.734	0.382	0.358	0.344	0.408	0.396	0.322
5. Social isolation T2	0.492	0.500	0.433	0.773	–	0.758	0.387	0.407	0.383	0.416	0.484	0.390
6. Social isolation T3	0.468	0.425	0.471	0.734	0.760	–	0.384	0.360	0.407	0.365	0.419	0.417
7. Social anxiety T1	0.447	0.326	0.343	0.381	0.387	0.384	–	0.797	0.740	0.465	0.379	0.373
8. Social anxiety T2	0.432	0.381	0.352	0.359	0.407	0.358	0.797	–	0.790	0.431	0.431	0.403
9. Social anxiety T3	0.383	0.355	0.390	0.342	0.383	0.406	0.740	0.791	–	0.424	0.451	0.498
10. Depression T1	0.534	0.425	0.394	0.408	0.416	0.366	0.464	0.431	0.424	–	0.671	0.647
11. Depression T2	0.456	0.546	0.451	0.398	0.485	0.421	0.380	0.432	0.453	0.670	–	0.738
12. Depression T3	0.409	0.461	0.542	0.321	0.392	0.418	0.372	0.402	0.497	0.647	0.736	–

Note: Correlations below the diagonal line (i.e., the lower half) represent the results from the emotional loneliness model and correlations above the diagonal line (i.e., the upper) represent the results from the social loneliness model.

individuals with higher-than-expected scores on social isolation predicted higher-than-expected scores on depressive symptoms at a later time (T1-T2: $\beta = 0.158$, $SE = 0.069$, $p = 0.021$; T2-T3: $\beta = 0.160$, $SE = 0.069$, $p = 0.020$), and vice versa (T1-T2: $\beta = 0.282$, $SE = 0.077$, $p < 0.001$; T2-T3: $\beta = 0.292$, $SE = 0.074$, $p < 0.001$). Unexpectedly, but similar to the emotional loneliness model, social loneliness was not significantly related to social anxiety on the within-person level at subsequent timepoints (T1-T2: $\beta = 0.108$, $SE = 0.070$, $p = 0.123$; T2-T3: $\beta = 0.117$, $SE = 0.074$, $p = 0.116$) or vice versa (T1-T2: $\beta = 0.029$, $SE = 0.086$, $p = 0.740$; T2-T3: $\beta = 0.032$, $SE = 0.097$, $p = 0.741$). Nor was social isolation related to social anxiety within persons across time (T1-T2: $\beta = -0.023$, $SE = 0.070$, $p = 0.741$; T2-T3: $\beta = -0.023$, $SE = 0.070$, $p = 0.741$) and vice versa (T1-T2: $\beta = 0.019$, $SE = 0.089$, $p = 0.829$; T2-T3: $\beta = 0.018$, $SE = 0.085$, $p = 0.829$).

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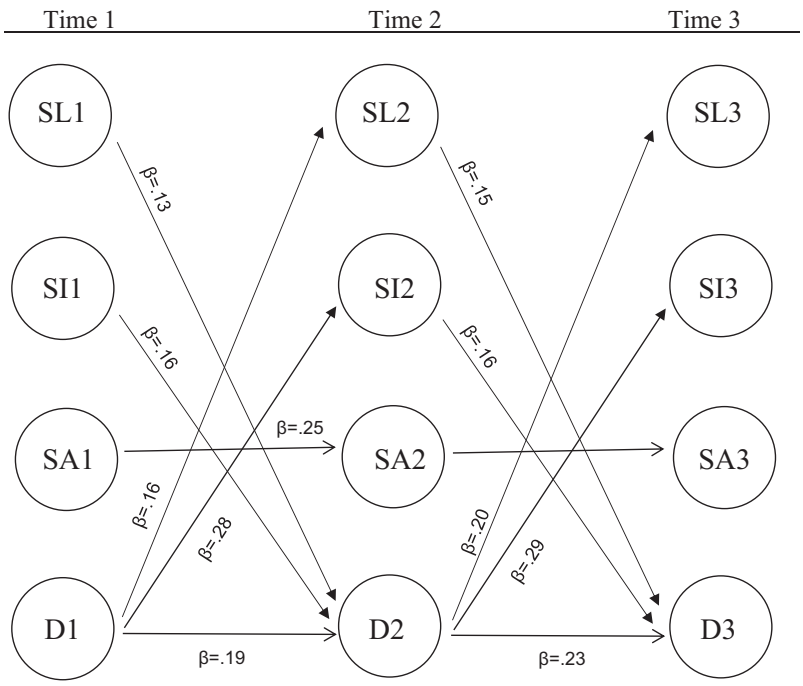

Fig. 3. Standardized significant auto-regressive and cross-lagged paths for the RI-CLPM including social loneliness, social isolation, social anxiety, and depression at three time points.*Notes*: SL = social loneliness; SI = social isolation; SA = social anxiety; D = depression. The three time points are indicted above the model and by the numbers after SL, SI, SA, and D; e.g., SL1 = social loneliness at Time 1.

Together, these results indicate that young adults who have higher-than-average scores on social loneliness report more depressive symptoms, but not more social anxiety symptoms across a period of 3 years on the within-person level. Depressive symptoms, but not social anxiety symptoms, similarly reinforce social loneliness. Additionally and similar to the previous model on emotional loneliness, young adults with higher-than-average scores on social isolation report more depressive symptoms, but not more social anxiety symptoms across a period of 3 years on the within-person level and higher-than-average scores on depressive symptoms, but not social anxiety symptoms, similarly reinforce social isolation across this time period.

DISCUSSION

The aim of this study was to build on previous studies that investigated temporal relations between loneliness, depression, and social anxiety, by further investigating reciprocal and prospective associations between emotional and social loneliness, social isolation, social anxiety symptoms and depressive symptoms using a comprehensive longitudinal design in which young adults were followed over a 3-year time period. In doing so, this study extends the knowledge base and provides important directions for prevention and intervention efforts to prevent escalation of symptoms in a vulnerable developmental phase.

In line with our first hypothesis, the findings showed that emotional and social loneliness predicted depressive symptoms at the within-person level at later timepoints. This means that young adults who were emotionally or socially lonely at baseline developed more depressive symptoms across a period of 3 years. Conversely, depressive symptoms also predicted within-person changes in social loneliness, indicating that a vicious cycle emerges where depressive symptoms and social loneliness maintain each other across young adulthood. Against expectations, the relation between emotional loneliness and depressive symptoms was not bidirectional, which indicates that young adults who are emotionally lonely, have a higher chance of developing more depressive symptoms at the within-person level across time, but that depressive symptoms do not predict more emotional loneliness within persons across time. Interestingly, emotional and social loneliness did not predict social anxiety at the within-person level across the 3 years, nor did social anxiety predict either of the loneliness subtypes. Taken together, these results suggest that while loneliness may play an important role in the development of future depression and conversely depressive symptoms may play an important role in sustaining social loneliness, social anxiety does not play a significant role in the development of depression or loneliness. Also, both a perceived lack of an emotional connection with others (emotional loneliness) and a social network that is perceived as unavailable or unsatisfying (social loneliness) can increase the risk for development of depressive symptoms in emerging adulthood. These results are in line with the substantial literature base showing the impact of loneliness on depression across the lifespan (e.g., Cacioppo *et al.*, 2006; van Halst *et al.*, 2012; Lim *et al.*, 2016; Victor & Yang, 2012), and replicates (Yang *et al.*, 2021) and extends these results by showing that this relationship applies to both emotional and social loneliness.

Additionally, with regards to our second hypothesis stating that emotional and social loneliness would be differentially related to depressive and social anxiety symptoms across time, our results showed that depressive symptoms predicted social loneliness, but not emotional loneliness. This suggests that, although they are related constructs, emotional and social loneliness have unique

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relationships with depressive symptoms in emerging adulthood. There are a few explanations to be considered in this regard. It is possible that depressed mood decreases an individual's efforts to socialize due to experienced anhedonia or reduced pleasure in such activities (APA, 2013). This in turn could result in a perceived lack of a social network (social loneliness), but not necessarily in relation to the perceived closeness with social ties (emotional loneliness). Indeed, studies have found some evidence on the interrelations between loneliness, anhedonia and reduced social functioning in young adults (Lim & Gleeson, 2014; Tan *et al*., 2020). However, studies have yet to include all these variables in a comprehensive analysis to draw stronger conclusions on these hypotheses. Another potential explanation for the lack of a significant predictive relation between depressive symptoms and emotional loneliness is that the model controlled for the trait-like nature of emotional loneliness and depressive symptoms which showed a strong relation (within-person correlations ranging from r = 0.53–0.55 across timepoints), taking away the variance otherwise explained by depressive symptoms. However, theories or experimental studies on these relationships are currently lacking and the exact mechanisms remain unclear. Furthermore, there is an ongoing discussion whether the relationship between depression and loneliness is bidirectional, with evidence for loneliness leading to depression (Cacioppo *et al*., 2010; Lim *et al*., 2016; Richardson *et al*., 2016), depression predicting loneliness (Danneel *et al*., 2019), or both (Cacioppo *et al*., 2006; Domenech-Abella *et al*., 2019; Hawkley & Cacioppo, 2010; Santini, Jose, Cornwell *et al*., 2020; van Halst *et al*., 2012). Heterogeneity in the results might be due to a variety of reasons, such as variance in measurements, but it might also be impacted by the use of general loneliness measures instead of differentiating between loneliness subtypes as substantiated by the current results.

With regards to our third hypothesis, results indicated that social isolation predicted the development of more depressive symptoms across a 3-year time period, suggesting that objectively having limited social contacts or a small network predicts increases in depressive symptoms within individuals. These results point to the importance of both objective social network characteristics (i.e., social isolation) and subjective social disconnectedness (emotional and social loneliness) in the development of depression during emerging adulthood. This is in line with previous studies in older adults (Cacioppo & Cacioppo, 2018; Cacioppo *et al*., 2010; Domenech-Abella *et al*., 2019). In addition, a recent study in university students showed that social isolation predicted depression, while controlling for loneliness (Liu, Zhang, Yang & Yu, 2020) Further, previous research in older adults showed that loneliness mediates the relationship between social isolation and depression (Domenech-Abella *et al*., 2021; Santini, Fiori, Feeney, Tyrovolas, Haro & Koyanagi, 2016). The current study, however, indicated that depressive symptoms might play an important role in the relationship between loneliness subtypes and social isolation in young adults. The exact pathways underlying loneliness subtypes, social isolation, and depression remain unclear however and need to be followed up in future studies.

Finally, young adults with higher depressive symptom levels at baseline showed an increased risk for future social isolation on the within-person level across the three-year period. In fact, it showed the largest effect in both models. Hence, depression not only impairs an individual's perception of the quality of their social network, but it may lead to actual social isolation. This, in combination with poor help-seeking behaviors previously found in university students (Hunt & Eisenberg, 2010), warrants more attention for the early detection and prevention of low mood. One of the core characteristics associated with depression is social difficulties, such as impaired social relationships, social isolation, or reduced social support (Burcusa & Iacono, 2007). The vicious cycle of social isolation, social loneliness and low mood puts young adults at increased risk for psychosocial symptoms. These findings clearly underline the importance of addressing impaired social functioning in depression.

Contrary to our expectations and previous findings (Danneel *et al*., 2019; Lim *et al*., 2016), we did not find any significant temporal relationship for both loneliness subtypes or social isolation with social anxiety symptoms. These results suggest that there is no significant temporal relationship between social anxiety on the one hand and social isolation, emotional and social loneliness and depressive symptoms on the other hand, in emerging adulthood. Alternatively, it is possible that the relationships between loneliness, social anxiety, and depression are partly explained by interpersonal mechanisms (i.e., social withdrawal) resulting in significant associations between loneliness, social isolation, and depression only. In previous models without social isolation, social anxiety appeared to play an important role in the development of loneliness (Danneel *et al*., 2019; Lim *et al*., 2016), however it could be that this relationship is even better accounted for by including social isolation in the model. Future research is needed to replicate these findings and further untangle the relationships between loneliness subtypes, social isolation, depression and social anxiety using longitudinal designs.

Limitations

Besides the novelty of the current study providing a comprehensive overview of the temporal relationships among the most common psychopathological symptoms, depressive and social anxiety symptoms, and highly prevalent psychosocial issues including loneliness and social isolation in young adults, there are a few limitations that should be discussed. First, it should be noted that our data collection started before the COVID-19 pandemic and ended whilst the pandemic was still ongoing (including among others, social restrictions). The RI-CLPM automatically accounts for confounding occasion effects of shared events that impacts everyone in the sample (COVID-19) by subtracting the average scores for all individuals at each occasion (Zyphur, Allison, Tay *et al*., 2020). However, we cannot be completely sure that the results found in the current study were impacted by this event, as COVID-19 might have a different impact on different individuals. Second, and relatedly, although the RI-CLPM has a significant advantage over traditional cross-lagged panels by separating between-person and within-person associations, it does not include random slopes across time, which precludes drawing conclusions on differences of cross-lagged effects between individuals (Lucas *et al*., 2023).

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Third, the relatively small proportion of the total sample who provided data at more than one timepoint likely points to a selection bias and it is possible that individuals with concerns about their mental health may have a greater tendency to complete the questionnaires. Fourth, individuals who met a certain cut-off point at the first wave of the study were invited to participate in the RCT and thus may differ from individuals in the current sample who were not invited to participate leading to potential systematic differences of the relationships between the included constructs. Fifth, all measures included in the current study were self-reported which might result in a social acceptability bias in the data collection. Sixth, and relatedly, the time between waves differed across the participants. This variability in time intervals may have impacted the relations between the results which calls for replication in future studies to draw more definite conclusions. Finally, our sample consisted of university students, meaning our results cannot be generalized to all young adults in emerging adulthood.

Implications

The current findings have implications for future research and clinical practice. First, although this study shed light on the temporal relations between loneliness subtypes, social isolation, depressive and social anxiety symptoms, it was out of the scope of the current study to test specific mediators that may underlie the found associations. It would be interesting for future studies to investigate whether variations in depressive symptoms possibly mediate the relationship between loneliness subtypes and social isolation. This would be helpful in gaining an even better understanding of the underlying working mechanisms and temporal associations of depression, social isolation, and loneliness. Second, longitudinal studies including both loneliness and social isolation are scarce and it is important to increase our understanding of how loneliness, social isolation, social anxiety, and depression evolve together over time. Comprehensive analyses of all constructs can help determine the overlapping and unique associations over time, which is important for developing effective intervention for loneliness and mental health issues in emerging adulthood. Both loneliness subtypes and social isolation should be included since they often co-occur, and each seem to play a unique role in the development of mental health issues (Cacioppo & Cacioppo, 2018; Dahlberg & McKee, 2014).

Improvements to the current interventions targeting emotional and social loneliness could be made by combining existing, effective psychological treatment programs (e.g., cognitive behavioral therapy) focusing on loneliness and depression symptoms. Previous interventions alleviating general loneliness have also been effective in reducing depression (e.g., Chiang, Chu, Chang *et al.*, 2010; Lloyd-Evans, Frerichs, Stefanidou *et al.*, 2020; Zagic, Wuthrich, Rapee & Wolters, 2021; but see also Chan, Yu & Choi, 2017; Käll, Jägholm, Hesser *et al.*, 2020). Transdiagnostic interventions need further examination to find out whether they have the potential to reduce emotional and social loneliness, social isolation, and in turn depressive symptoms (and vice versa), or whether separate treatment programs are required.

CONCLUSION

The current study emphasized the impact of emotional and social loneliness as well as social isolation in the development of depressive symptoms, which in turn can accumulate into more social loneliness and social isolation, in emerging adulthood. Interestingly, emotion and social loneliness showed unique relationships with depressive symptoms. That is, depressive symptoms predicted future social loneliness, but not emotional loneliness. Surprisingly, both emotional and social loneliness as well as depressive symptoms were unrelated to future social anxiety and vice versa. Although more research is needed to substantiate these conclusions, these findings do suggest the importance of addressing both loneliness subtypes and social isolation in young adults to prevent the development of depression and the vicious cycle that maintains loneliness. Future longitudinal research and intervention studies are warranted to investigate effective prevention and intervention efforts to alleviate emotional and social loneliness as well as depression.

We would like to give thanks to the UvAcare study team for their contribution to the data collection of the current study. The data that support the findings of this study are available from the corresponding author upon reasonable request.

ENDNOTES

[1] Some of the participants only completed two waves. After wave 1 was completed, an additional batch of students was included from wave 2 onwards due to a dependence on the timing and planning of participating faculties.

[2] Results of the unconstrained model can be found in the Supplementary Materials.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Summary of the standardized random intercepts, auto-regressive and cross-lagged estimates of the RI-CLPM unconstrained including emotional loneliness.

Table S2. Summary of the standardized random intercepts, auto-regressive and cross-lagged estimates of the unconstrained RI-CLPM including social loneliness.

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