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Age-Related Differences of Rumination on the Loneliness–Depression Relationship: Evidence From a Population-Representative Cohort

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Abstract

Background and Objectives: This study examined the association of loneliness with depressive symptoms across various age groups. Loneliness is a significant risk factor for precipitating depressive symptoms. Rumination, a mechanism that underpins depression, can become intense when a person feels lonely. In addition, age is a major factor associated with changes in mental and physical health. Thus, the importance of rumination and age in moderating the loneliness–depression link were investigated.
Research Design and Methods: This cross-sectional study was conducted during the acute phase of the coronavirus disease 2019 pandemic in Hong Kong (February 27 to March 17, 2020). A population-representative sample of 1,972 people (1,107 females; 18–92 years of age) was recruited and interviewed via telephone through random digit dialing. This sample included 394 younger adults (18–30 years), 1,106 middle-aged adults (31–64 years), and 472 older adults (65 years or above). Respondents reported depressive symptoms, subjective loneliness, state rumination, and sociodemographic factors.
Results: Loneliness and rumination were positively associated with depressive symptoms, and they significantly interacted in predicting cognitive-affective symptoms. Further analysis of age showed that the interaction was significant only in middle-aged adults and older adults. Both rumination and age interacted with loneliness, respectively, in predicting cognitive-affective symptoms.
Discussion and Implications: These findings indicate that the strength of the association between loneliness and the cognitive-affective symptoms of depression depends on rumination levels and age. An intervention to regulate rumination offers a feasible direction for health care and social care aimed at improving older adults' mental health.

> **Translational Significance:** Rumination, a mechanism that underpins depression, can become intense when a person feels lonely, and this study's results indicate that rumination and age interact in altering the positive association between subjective loneliness and the cognitive-affective symptoms of depression. Professionals of geriatric mental health should be aware of the importance of addressing both negative rumination and the established negative effects of aging when assessing and intervening subjective loneliness and depressed moods among older adults.

Loneliness, a subjective perception and negative emotional state, is defined as distress under the influence of disparate ideal and perceived interpersonal relationships (Hawkley & Cacioppo, 2009). This discrepancy between one's ideal and one's perceived social connectedness may be related to a higher risk of depression (Cacioppo et al., 2006; Gualano et al., 2020; Ozamiz-Etxebarria et al., 2020), and it might be a main risk factor for significant symptoms of depression and anxiety symptoms after controlling for demographics and health-related factors (Palgi et al., 2020). In particular, significant perceived loneliness has been associated with high levels of depression-related somatic symptoms, particularly fatigue (Jaremka et al., 2013) and reduced sleep efficiency (Fässberg et al., 2012). In other studies, loneliness was related not only to higher somatic symptoms, but also to increased cognitive-affective symptoms of depression (e.g., Hwang et al., 2020) and a higher likelihood of suicidal ideation (Muyan & Chang, 2015).

Researchers have reported mixed findings concerning the association between age and depressive symptoms, especially when considering cultural differences. This association has been shown to be U-shaped regardless of the type of symptoms, meaning that younger and older adults tend to experience more severe symptoms than do middle-aged adults (Kessler et al., 1992). The U-shaped association was also found among older adults in Japan, with an overall increase from age 65 to 85 (Shimada et al., 2014). In contrast, Tomitaka et al. (2020) reported an inverted U-shaped association between age and depressive symptoms in a U.S. sample with an increase from age 18 to 59 and a decrease after age 60. Nonetheless, Schaakxs et al. (2017) showed that, in a European sample, the association between age and both aspects of depressive symptoms was linear and positive.

Similarly inconsistent results also appear in the research on age and loneliness. Matthews et al. (2016) showed that loneliness was robustly associated with depression in younger adults, and they were more likely to engage in negative stress coping strategies and risky behaviors (Matthews et al., 2019). Feeling lonely might also be positively related to perceived stress, anxiety, and depression during the pandemic among younger adults worldwide (Varma et al., 2021). Beam and Kim (2020) further extended the notion that loneliness in younger adults is more dynamic and unpredictable than in older adults. Older adults across cultures experience similar significant transitions in role (Campbell & Yang, 2011; Segel-Karpas et al., 2018) and health (Wenger et al., 1996), which might be linked to heightened feelings of loneliness. Specifically, loneliness might stem from their social interactions' poor subjective quality and reduced frequency (Hawkley & Kocherginsky, 2018; Santini et al., 2020). Previous research

on Eastern older adults has shown that loneliness is associated with increased severity of depression (Wang et al., 2017) and mortality rate (Luo & Waite, 2014). Donovan et al. (2017) further suggested a vicious cycle between loneliness and physical and mental health among older adults. The compromised health associated with loneliness could further limit and reduce the quality and quantity of older people's social connections, further reinforcing their sense of loneliness.

Loneliness is a significant risk factor for engaging in ruminative behaviors. Thus, it predisposes a person to symptoms of depression. Rumination, defined as an uncontrollable and recurrent focus on negative thoughts, is a significant factor underpinning depression (Hamilton et al., 2015; Lyubomirsky et al., 2015; Michl et al., 2013; Zhang et al., 2020) by perpetuating negative thoughts and pessimistic and fatalistic thinking. In particular, brooding, the negative component of rumination, was suggested as a maladaptive coping mechanism associated with depression both cross-sectionally and prospectively (Treynor et al., 2003). Vanhalst et al. (2012) proposed the mediating and moderating role of rumination in intensifying the loneliness–depression relationship. However, the age-related differences of rumination on the loneliness–depression relationship are unclear.

The coronavirus disease 2019 (COVID-19) pandemic offers a special temporal context for understanding the distinct relationship between loneliness and depression, as well as the differential effect of rumination on such a relationship among various age groups. A dilemma illustrated by Chu et al. (2020) suggests that, although physically isolating older adults could reduce the chance of infection, socially isolating them could lead to depression and despair. However, recent studies worldwide showed that younger adults were more stressed, depressed, and lonely during the pandemic than were other age groups (Jha et al., 2020; Jung et al., 2020; Ustun, 2021). The evidence above suggests that the adverse effects of loneliness on mood have been amplified during the COVID-19 pandemic. The rapidly growing body of literature has demonstrated a positive association between COVID-19 lockdown measures (e.g., social distancing) and loneliness (Hoffart et al., 2020). In particular, Lee et al. (2020) showed that loneliness levels increased in a U.S. sample from January to May, 2020 (i.e., when the pandemic first struck the United States). Groarke et al. (2020) also showed that the rate of loneliness during the pandemic was as high as 27% in a sample of 1,964 UK adults. The Hong Kong government's goal to put the pandemic under control might have further contributed to its more stringent health measures, increasing its citizens' mental health burden compared to people in Western countries

(Bavel et al., 2020; Gelfand et al., 2011). For instance, although wearing face coverings in all indoor and outdoor public places has been mandatory since July 2020 in Hong Kong, it is optional in some states in the United States. We expected that loneliness and rumination would be positively related to depressive symptoms, particularly cognitive-affective symptoms. Furthermore, we speculated that rumination would moderate the association between loneliness and depressive symptoms such that the associations would be stronger at higher levels of rumination. We also expected that the moderating effect of rumination in the loneliness–depression relationship would be stronger in older adults compared to younger adults.

Method

Respondents

After obtaining study approval from the ethics committee of the Education University of Hong Kong, the Hong Kong Public Opinion Research Institute recruited and conducted telephone interviews with the respondents between February 27 and March 17, 2020. General COVID-19 restrictions on Hong Kong residents during this time included school closures and the provision of limited services by companies and government agencies. A computer-assisted telephone interview system and random digit dialing were used to recruit a population-representative sample of Hong Kong residents. In addition, a dual-frame approach to sampling employing landline and mobile phone numbers (50% each) was used. Telephone numbers were extracted randomly from databases of telephone numbers released by the Hong Kong Communication Authority. The inclusion criteria of the respondents were as follows: (a) Hong Kong Chinese citizen, (b) 15 years of age or older, and (c) Cantonese speaking. For landline calls, if multiple household members were eligible after successful contact, the one with the birthday closest to the interview date was selected. Five attempts were made to dial numbers that were classified as "no answer," "busy," or "eligible unavailable" (i.e., willing to participate but unavailable at the time of the call). No further attempts were made after two refusals. The voluntariness of participation without incentives was emphasized. In addition, oral informed consent was obtained at the onset of the interview. Among the total 28,837 telephone numbers attempted, 2,024 (7.0%) were ineligible for interviewing (i.e., invalid, nonresident/business telephone, fax number, no eligible respondent), 24,582 (85.3%) were unconfirmed, and 2,231 were eligible (7.7%). Among the eligible numbers, interviews were completed for 2,018 (90.5%), whereas seven (0.003%) respondents indicated refusal, and 80 (0.04%) eligible respondents did not complete the interviews (Supplementary Figure 1). An effective response rate of 70% was recorded. The sampling error was within ±2.2% at a 95% confidence level.

The participation and nonparticipation rates were acceptable and comparable with the population-representative samples in previous studies conducted in Hong Kong (Galea & Tracy, 2007; Hou et al., 2015; Lai et al., 2020; Leung et al., 2005).

Measures

Depression

Depressive symptoms during the previous 2 weeks were assessed using the Chinese version of the nine-item Patient Health Questionnaire (PHQ-9; Yu et al., 2012). Respondents were asked to review whether some behaviors and feelings bothered them and gave rise to the cognitive-affective symptoms assessed (e.g., presence of suicidal thoughts or lack of interest in doing things) and somatic symptoms (e.g., fatigue or trouble in falling/staying asleep) over the past 2 weeks on a 4-point Likert scale (0 = not at all, 1 = on several days, 2 = on more than half of the days, 3 = nearly every day). Higher scores indicated higher depressive symptoms. The full scale showed acceptable reliability ($\alpha = 0.83$) in the current study. Apart from using the total sum scores as a single indicator of symptom severity, we analyzed cognitive-affective and somatic symptoms separately (Krause et al., 2008). The two-factor model has been found to yield a better fit for data compared with the single-factor model (Elhai et al., 2012). Cronbach's alpha for the cognitive-affective subscale and the somatic subscale was 0.77 and 0.67, respectively.

Loneliness

Subjective loneliness was assessed using a short Chinese version of the Revised University of California Los Angeles Loneliness Scale (Liu et al., 2020; Russell et al., 1980), which comprised the three items with the highest loading on the loneliness factor from the original scale (Hughes et al., 2004). Respondents were asked to indicate the frequency with which they felt a lack of companionship, left out, and isolated from others using a 4-point Likert scale (1 = never, 2 = seldom, 3 = sometimes, 4 = often). These items were reliable in the current study sample ($\alpha = 0.73$).

Rumination

Respondents' ruminative thoughts were assessed using the Chinese five-item subscale of the Ruminative Response Scale (Sin et al., 2018; Treynor et al., 2003). Respondents were asked to rate the frequency of the repetitive and judgmental evaluation of their depressed mood within the past 2 weeks using a 4-point Likert scale (1 = never, 2 = sometimes, 3 = often, 4 = nearly all of the time). The scale's reliability in the current study was 0.77.

Sociodemographics

Standardized questions were asked to record respondents' age, gender, marital status, education level, employment status, and monthly household income.

Analytic Plan

Only data from participants aged 18 or above were included in the current investigation. Missing data in the original data set (<1%) were replaced with multiple imputations using SPSS (version 24). A confirmatory factor analysis with the maximum likelihood method was performed on the whole sample fitting a single- and two-factor model of depression (Krause et al., 2008) with the lavaan package on the R platform (Rosseel, 2012). Analysis of variance was then used to compare the two models' differences. The procedure was repeated on the sample with three separate groups input into the multiple group function in the package: younger adults (aged 18–30), middle-aged adults (aged 31–64), and older adults (aged 65 or above). A model fit with the comparative fit index (CFI) and the Tucker-Lewis index (TLI) ≥ 0.95, as well as root mean square error of approximation (RMSEA) and the standardized root mean squared residual (SRMR) ≤ 0.08 were considered acceptable (Hu & Bentler, 1999).

Moderation analyses were performed using PROCESS (version 3.5.3, model 3; Hayes, 2013) implemented on SPSS (version 24). Loneliness was the predictor variable, rumination and age were the moderating variables, and cognitive-affective symptoms and somatic symptoms were the outcome variables. Age was input as a continuous variable. Zero-order correlation and Mann–Whitney U tests were used to identify potential confounding sociodemographic variables. Significant variables were then included in the final model. Employment and marital status were recorded in two groups (i.e., employed vs dependent/unemployed and married vs unmarried/divorced/widowed). The scores for loneliness and rumination, as well as those for age, were centered to create the interaction terms. The moderation effect of rumination and age were deemed significant if the interaction term had a p value of ≤.05 and if the 95% confidence interval (CI) did not include zero. Further conditional effects on effects of interests were then performed on significant interactions using the pick-a-point approach (Aiken & West, 1991).

Results

Sample Characteristics

The 1,972 respondents, 1,107 of whom were female, ranged in age from 18 to 92 years (mean age = 49.31, standard deviation [SD] = 17.96). A total of 242 respondents reported no formal or primary education (U.S. equivalent of elementary school), 862 reported secondary education (U.S. equivalent of high school), and 868 reported tertiary education or above (U.S. equivalent of college and university or above). In addition, 779 respondents were unmarried, and 111 were unemployed. A total of 394 respondents (210 females) reported ages between 18 and 30 years ($M = 24.31$, $SD = 3.80$), whereas 1,106 respondents (618 females) were aged 31–64 ($M = 48.25$, $SD = 9.73$), and 472 respondents (33 females) were between 65 and 92 years ($M = 72.66$, $SD = 6.60$). The sample characteristics, which are illustrated in Table 1, resembled the population in terms of age groups, gender, and education (Census and Statistics Department, 2020).

Factor Structure of PHQ-9

Cognitive-affective symptoms and somatic symptoms were moderately correlated with each other ($r = 0.65$, $p < .001$). The two-factor model demonstrated an acceptable data–model fit ($\chi^2(26) = 281.31$, $p < .001$, CFI = 0.95, TLI = 0.93, RMSEA = 0.07, SRMR = 0.04), with the fit indices being slightly better than those of the single-factor model ($\chi^2(27) = 352.91$, $p < .001$, CFI = 0.94, TLI = 0.91, RMSEA = 0.08, SRMR = 0.04), $\Delta\chi^2 = 71.60$, $p < .001$. Furthermore, the two-factor model ($\chi^2(78) = 411.03$, $p < .001$, CFI = 0.93, TLI = 0.91, RMSEA = 0.08, SRMR = 0.04) fitted significantly better on the three individual age groups than the single-factor model ($\chi^2(81) = 489.71$, $p < .001$, CFI = 0.92, TLI = 0.89, RMSEA = 0.09, SRMR = 0.04), $\Delta\chi^2 = 78.68$, $p < .001$. A comparison of the fit statistics between the two models on the whole sample and separated age groups are illustrated in Supplementary Tables 1a and 1b. The factor loadings of the nine items for the whole sample and separated groups are illustrated in Supplementary Table 1c.

Moderation Analyses

Descriptive statistics and the correlations of the study variables are presented in Table 2. Marital status was significantly different in terms of both cognitive-affective ($z = –6.23$, $p < .001$) and somatic symptoms of depression ($z = –6.86$, $p < .001$), whereas only household income was significantly correlated with somatic symptoms ($r = –0.06$, $p = .014$). Therefore, these variables were included in the final moderation models. The overall model on both cognitive-affective ($F(8,1963) = 84.29$, $p < .001$) and somatic ($F(8,1963) = 52.06$, $p < .001$) symptoms were significant (Table 3). Higher loneliness ($\beta = 0.35$, $p < .001$, 95% CI [0.29, 0.41]) and rumination ($\beta = 0.33$, $p < .001$, 95% CI [0.28, 0.38]) levels were significantly associated with higher levels of the cognitive-affective symptoms of depression. Loneliness ($\beta = 0.22$, $p < .001$, 95% CI [0.17, 0.27]) and rumination ($\beta = 0.21$, $p < .001$, 95% CI [0.17, 0.25]) were also positively associated with somatic symptoms. Rumination significantly moderated the relationship between loneliness and cognitive-affective ($\beta = 0.43$, $p < .001$, 95% CI [0.02, 0.06]) but not somatic symptoms ($\beta = 0.01$, $p = .357$), indicating that the association was stronger between loneliness and cognitive-affective symptoms when the rumination levels were high compared to when they were low. Further analyses were performed to investigate the conditional effect of the interaction on cognitive-affective

Table 1. Demographic Variables and Sample Characteristics

Variable	Whole sample (N = 1,972) N (%)	Younger adults (n = 394) n (%)	Middle-aged adults (n = 1,106) n (%)	Older adults (n = 473) n (%)
Age, years (*M*, *SD*)	49.31 (17.96)	24.31 (3.80)	48.25 (9.73)	72.66 (6.60)
Sex				
Female	1,107 (56.1)	210 (53.3)	618 (55.9)	279 (59.1)
Male	865 (43.9)	184 (46.7)	488 (44.1)	193 (40.9)
Education level				
No formal education received	50 (2.5)	0 (0)	9 (0.8)	41 (8.7)
Primary school	192 (9.7)	0 (0)	75 (6.8)	117 (24.8)
Junior high school	269 (13.7)	10 (2.5)	172 (15.6)	87 (18.4)
Senior high school	593 (30.1)	72 (18.3)	387 (35)	134 (28.4)
College (nondegree)	205 (10.4)	70 (17.8)	103 (9.3)	32 (6.8)
College or above (degree)	663 (33.6)	242 (61.4)	360 (32.5)	61 (12.9)
Marital status				
Married	1,193 (60.5)	54 (13.7)	832 (75.2)	307 (65.0)
Single	539 (27.3)	336 (85.2)	171 (15.5)	32 (6.8)
Divorced	113 (5.7)	3 (0.8)	75 (6.8)	35 (7.4)
Widowed	127 (6.5)	1 (0.3)	28 (2.5)	98 (20.8)
Employment				
Employed	1,025 (52.0)	233 (59.2)	722 (65.3)	70 (14.8)
Unemployed	111 (5.6)	23 (5.8)	82 (7.4)	6 (1.3)
Retired	436 (22.1)	3 (0.8)	119 (10.8)	314 (66.5)
Housewife	274 (13.9)	10 (2.5)	183 (16.5)	81 (17.2)
Student	126 (6.4)	125 (31.7)	0 (0)	1 (0.2)
Monthly household income (HK$)				
$9,999 or below	329 (16.7)	24 (6.1)	125 (11.3)	180 (38.1)
$10,000–$19,999	280 (14.2)	41 (10.4)	155 (14.0)	84 (17.8)
$20,000–$29,999	333 (16.9)	79 (20.1)	192 (17.4)	62 (13.1)
$30,000–$39,999	279 (14.1)	75 (19.0)	163 (14.7)	41 (8.7)
$40,000–$49,999	189 (9.6)	51 (12.9)	115 (10.4)	23 (4.9)
$50,000–$59,999	157 (8.0)	29 (7.4)	97 (9.8)	31 (6.6)
$60,000–$79,999	148 (7.5)	44 (11.2)	86 (7.8)	18 (3.8)
$80,000 or above	257 (13.0)	51 (12.9)	173 (15.6)	33 (7.0)

Note: SD = standard deviation.

symptoms at different age points (Figure 1). Higher and lower rumination levels were indicated by scores at 1 *SD* above or below the mean, and medium levels were indicated by scores within 1 *SD* of the mean. The results showed the interactions were only significant in middle-aged adults (represented by mean age; i.e., 49.31 years old), estimate = 0.04, $F(1,1963) = 15.87$, $p < .001$, and older adults (represented by 1.5 *SD* above the mean age; i.e., 76.24 years old), estimate = 0.05, $F(1,1963) = 6.23$, $p = .0127$, but not in younger adults (represented by 1.5 *SD* below the mean age; i.e., 22.37 years old), estimate = 0.03, $F(1,1963) = 2.98$, $p = .0842$. In addition, age interacted significantly with loneliness in predicting cognitive-affective symptoms ($\beta = 0.004$, $p = .0292$, 95% CI [0.0004, 0.01]), but not somatic symptoms ($\beta = 0.002$, $p = .11$), indicating a stronger relationship between loneliness and cognitive-affective symptoms in older people. No other significant effects were found.

Discussion

This study examined the moderating role of rumination and age in the loneliness–depression relationship through a population-representative sample in Hong Kong. Our findings clearly indicate that loneliness and rumination are associated with higher symptom levels, controlling for the sociodemographic effects (i.e., marital status and income) related to depressive symptoms. The results of the moderation analyses indicate that the rumination significantly moderated the relationship between loneliness and the cognitive-affective symptoms only for middle-aged and older adults.

Loneliness stemming from social isolation is a major threat to mental health (Hossain et al., 2020). Our study's respondents showed a difference in level of loneliness (Liu et al., 2020) and rumination (Zhang et al., 2020) compared with recent data in Hong Kong obtained before the COVID-19 pandemic. Nonetheless, our data showed a nonsignificant association between any specific policy or measure imposed

Table 2. Descriptive Statistics, Correlation, and One-Way Analysis of Variance (ANOVA) of the Study Variables on the Whole Sample and by Groups

Variable	R-UCLA	RRS	Cognitive-affective symptoms (PHQ-9)	Somatic symptoms (PHQ-9)
Whole sample (N = 1,972)				
Cronbach's alpha	0.73	0.77	0.77	0.67
Range	3–12	5–18	0–18	0–9
Mean (*SD*)	4.60 (2.03)	8.44 (2.51)	2.01 (2.76)	1.76 (2.04)
Kurtosis	0.99	0.24	3.54	0.62
Skewness	1.27	0.67	1.81	1.41
Correlation				
1	—			
2	0.45*	—		
3	0.42*	0.43*	—	
4	0.36*	0.37*	0.65*	—
Younger adults (n = 394)				
Cronbach's alpha	0.73	0.74	0.75	0.70
Range	3–12	5–17	0–18	0–9
Mean (*SD*)	5.03 (2.00)	9.79 (2.47)	2.49 (2.73)	2.33 (2.15)
Kurtosis	0.18	–0.11	3.06	–0.17
Skewness	0.83	0.21	1.48	0.76
Correlation				
1	—			
2	0.44*	—		
3	0.33*	0.44*	—	
4	0.28*	0.38*	0.65*	—
Middle-aged adults (n = 1,106)				
Cronbach's alpha	0.74	0.76	0.78	0.67
Range	3–12	5–18	0–17	0–9
Mean (*SD*)	4.61 (2.06)	8.46 (2.45)	1.97 (2.75)	1.66 (1.96)
Kurtosis	0.95	2.55	3.39	0.60
Skewness	1.28	1.25	1.81	1.15
Correlation				
1	—			
2	0.47*	—		
3	0.47*	0.45*	—	
4	0.39*	0.37*	0.66*	—
Older adults (n = 472)				
Cronbach's alpha	0.67	0.67	0.75	0.62
Range	3–12	5–18	0–15	0–9
Mean (*SD*)	4.21 (1.91)	7.28 (2.08)	1.70 (2.77)	1.52 (2.06)
Kurtosis	2.76	2.55	5.03	1.80
Skewness	1.78	1.25	2.18	1.51
Correlation				
1	—			
2	0.31*	—		
3	0.34*	0.32*	—	
4	0.32*	0.28*	0.63*	—
ANOVA				
$F_{(2,1969)}$	17.76*	120.14*	9.25*	20.09*

Notes: PHQ-9 = nine-item Patient Health Questionnaire; RRS = Ruminative Response Scale; R-UCLA = Revised University of Los Angeles Loneliness Scale; *SD* = standard deviation.

*Correlation or ANOVA result is significant at the .001 level.

to slow the spread of COVID-19 (e.g., self-isolation) and the mental health among the respondents. Moreover, our findings concurred with Hossain et al.'s (2020) observation

that loneliness was positively associated with the intensity of depressive symptoms. In particular, our findings showed that loneliness was more strongly associated with more
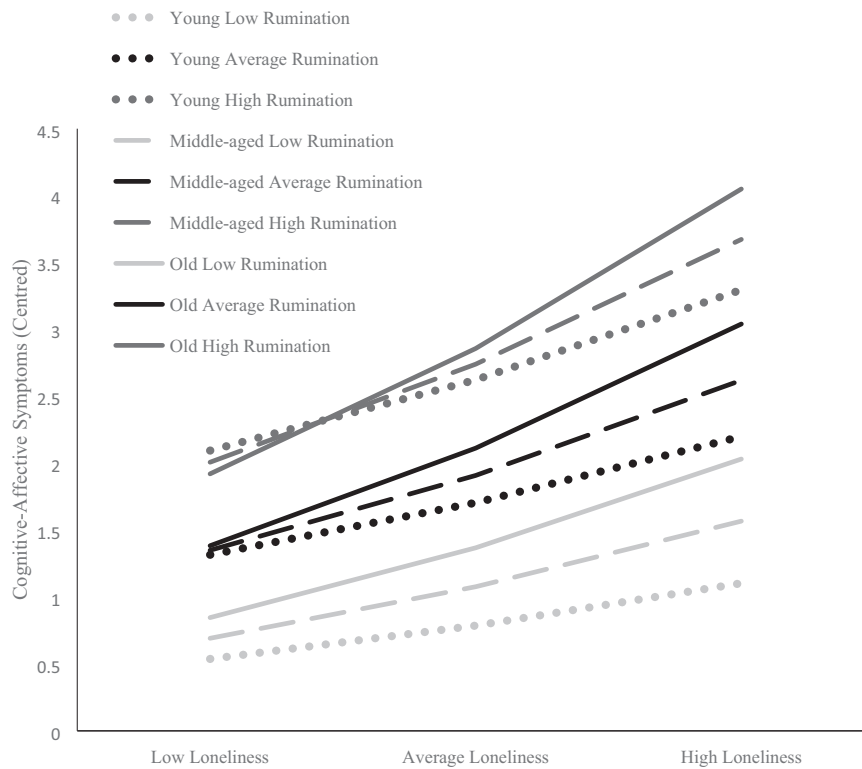
Figure 1. The three-way interaction plot illustrating simple slopes of loneliness on cognitive-affective depressive symptoms at different age points and rumination levels.

severe cognitive-affective symptoms than with somatic symptoms. This observation aligns with previous evidence that loneliness resulting from self-quarantine is closely related to the observed cognitive-affective symptoms, such as irritability and poor concentration (Brooks et al., 2020). The finding is also consistent with prior evidence that loneliness is more strongly related to higher affective symptoms than to somatic symptoms (Lyyra et al., 2018).

Rumination is associated with depression (Zhang et al., 2020). The findings from our population-representative sample showed that rumination, like loneliness, has a significant association with symptoms of depression. Furthermore, rumination is more significantly associated with cognitive-affective symptoms than with somatic symptoms (Gordon et al., 2012). Consistent with the findings of Vanhalst et al. (2012), our study's results confirmed the moderating role of rumination in the loneliness–depression relationship. This moderating role of rumination was observed only in middle-aged adults and older adults, indicating a potential difference between younger and older adults in the function and association between rumination and other negative mood or stimuli (Ricarte et al., 2016).

We used the PHQ-9 to assess depressive symptoms. There has been controversy about whether the test reflects a one-factor model (e.g., Huang et al., 2006; Keum et al., 2018) or a two-factor model (e.g., Richardson & Richards, 2008). Our findings from the population-representative data clearly support the two-factor model,

with separable cognitive-affective symptoms and somatic symptoms of depression measured by the PHQ-9. Stemming from these observations and the current study's particular interest in age, overall depressive symptoms based on a combined score of somatic and cognitive-affective symptoms should be interpreted with caution among older adults because experiencing depressive somatic symptoms such as loss of appetite could also be linked to aging-related physiological changes or health conditions (Tsutsumimoto et al., 2018). Previous studies have shown that somatic depressive symptoms are more socially acceptable (Zhou et al., 2016) and more commonly reported (Dreher et al., 2017; Kleinman, 1982) than cognitive-affective symptoms within Asian sociocultural contexts. However, the frequency of reporting cognitive-affective symptoms nonetheless has been shown to be similar between Chinese and American cultures (Stewart et al., 2002; Yen et al., 2000), whereas somatic symptoms could be more commonly reported in Western cultures compared to East Asian cultures (Dere et al., 2013). Further in-depth research is encouraged to investigate the differences between cultures in experiencing cognitive-affective and somatic symptoms.

The current study's results did not support previous evidence for the positive association between age and depressive symptoms (Kessler et al., 1992; Tomitaka et al., 2020). Unlike the pattern mentioned in the introduction, results from the current study showed a negative association

Table 3. Predictors of Cognitive-Affective and Somatic Depressive Symptoms on the Sample (*N* = 1,972) Based on Regression Analysis

Variable	β	SE	*t*-value	*p*	95% CI [lower, upper]	R^2	*F*-value
Dependent variable cognitive-affective symptoms							
Predictors[a]				>.001		0.26	84.29
Loneliness	0.35	0.33	10.66	>.001	[0.29, 0.41]		
Rumination	0.33	0.26	12.86	>.001	[0.28, 0.38]		
Loneliness × Rumination	0.43	0.01	3.98	>.001	[0.02, 0.06]		
Age	0.08	0.004	2.14	.0324	[0.0006, 0.01]		
Loneliness × Age	0.004	0.002	2.18	.0292	[0.0004, 0.01]		
Rumination × Age	−0.001	0.001	−0.94	.3498	[−0.004, 0.001]		
Loneliness × Rumination × Age	0.0003	0.0006	0.49	.6258	[−0.001, 0.001]		
Dependent variable somatic symptoms							
Predictors[b]				>.001		0.19	52.06
Loneliness	0.22	0.03	8.85	>.001	[0.17, 0.27]		
Rumination	0.21	0.02	10.50	>.001	[0.17, 0.25]		
Loneliness × Rumination	0.008	0.008	0.92	.357	[−0.01, 0.02]		
Age	−0.001	0.003	−0.40	.6901	[−0.01, 0.004]		
Loneliness × Age	0.002	0.001	1.60	.1105	[−0.0005, 0.005]		
Rumination × Age	−0.001	0.001	−1.35	.1786	[−0.004, 0.0007]		
Loneliness × Rumination × Age	−0.0001	0.0005	−0.11	.9132	[−0.001, 0.0009]		

Notes: β = standardized estimate; CI = confidence interval; *SE* = standard error.
[a]The model controlled significant demographic covariate (i.e., marital status).
[b]The model controlled significant demographic covariate (i.e., marital status and household income).

between age and depressive symptoms, which could be due to the social unrest that occurred during 2019 and 2020, when younger adults were reported to be at higher risk of clinically significant symptoms of mood disorders such as posttraumatic stress disorder (Ni et al., 2020).

Our results concur with previous findings (Cacioppo et al., 2010), indicating the positive association between loneliness and depressive symptoms. In addition, the results showed that with increased age comes a stronger association between loneliness and the cognitive-affective symptoms of depression. This resembles the patterns of findings suggesting the strong linkage between loneliness and depression in older adults (Oluanaigh et al., 2012). Furthermore, the interaction between loneliness and rumination in association with the cognitive-affective symptoms of depression was significant only for middle-aged and older adults. This might indicate different experiences of loneliness in younger and older adults. Previous evidence has suggested that increased use of social media and online communication by young adults was associated with loneliness and anxiety (Ahmad & Murad, 2020; Lisitsa et al., 2020). Although we did not measure the use of social media among various age groups, we suspect that the results are consistent with the mixed findings from studies of younger and older adults' social behaviors. Thomas et al. (2020) suggested that younger adults have a stronger desire to modify or hide their true appearance online, as well as a higher tendency to feel lonely relative to older adults. This concurred with our results showing a heightened level of loneliness in younger adults. Nevertheless, we speculate

that younger adults, compared to older adults, are usually equipped with sufficient digital literacy that enables them to adapt to the loneliness arising from social isolation, reducing in turn their depressive symptoms (Cauberghe et al., 2021; Colasante et al., 2020; Seifert, 2020). This expectation matched our data showing a weaker association between loneliness and depressive symptoms in younger adults.

Older adults in our study were less lonely, which coincided with the socioemotional selectivity theory suggesting that older adults can cope with a smaller social network without feeling lonely or isolated (Chiarelli & Batistoni, 2021). However, older adults' lower digital literacy levels (Schreurs et al., 2017) could predispose them to being socially and digitally excluded from society during pandemics (Seifert et al., 2021). The reduced social connections might subsequently contribute to a stronger association between loneliness and depressive symptoms in older adults compared to younger adults. Because they are alone, older adults are less able to inhibit the tendency to ruminate over negative information, given that inhibition can be increasingly compromised as one ages (Linville, 1996). These age-related differences in digital literacy imply that mental health care provided to younger and older adults should be different, as in recent suggestions for providing online health intervention for younger adults (Liu et al., 2020) and telephone health care for older adults (Yang et al., 2020). Furthermore, although older adults reported less loneliness and fewer depressive symptoms, the strong association between them supported a recent intervention

recommended by Zubatsky et al. (2020) to target loneliness by maintaining older adults' mental health during pandemics. The association also supported the suggestion that training and education related to social isolation and loneliness should be implemented in geriatric care training programs and health profession schools (Wu, 2020).

Limitations

Some limitations of the current study should be considered when interpreting its findings. First, the cross-sectional design precludes inferences about causal associations among the study variables. Second, the participants were assessed for general loneliness. Researchers in future studies should consider measuring other dimensions of loneliness, such as intimate, relational, and collective loneliness, as these dimensions feature vary in age-dependent experiences. For example, younger adults may be vulnerable to collective loneliness (e.g., feeling lonely in the workplace or at school). Meanwhile, older adults might experience intimate loneliness due to the loss of a loved one and due to the empty-nest phenomenon (Cacioppo et al., 2015). Furthermore, due to the time constraints of the telephone survey, the three-item loneliness scale adopted in this study might not be adequate to assess the emotional and social dimensions of loneliness separately, as outlined in the full 20-item UCLA loneliness scale (Ausín et al., 2019), even though the three-item scale has been found to validly and reliably measure overall perceived loneliness (Hughes et al., 2004; Robinson-Whelen et al., 2016). Third, although random digit dialing was used to recruit a population-representative sample of Hong Kong Chinese in the current study, older adults who are in hospitals or long-term care facilities could have limited phone access and thus might be underrepresented. The current study did not address changes in older adults' mental health over time because of time and resource constraints. Future studies should consider the long-term effects of quarantine on loneliness, rumination, and depressive symptoms.

Conclusion

The study's findings clearly illustrated the nature of associations among loneliness, rumination, age, and various aspects of depressive symptoms. It is therapeutically important to target loneliness when promoting mental health, especially among older adults. The observed significant moderating role of rumination in the loneliness–depression link affects middle-aged and older adults but not younger adults offers important insights for future research and the practice of mental health care for older adults. Although a big leap still needs to be made between the research and the clinical field in terms of interventions, our results imply that negative rumination could be a factor contributing to poor mental health.

Supplementary Material

Supplementary data are available at *Innovations in Aging* online.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

H. Tong, W. K. Hou, and T. M. C. Lee contributed equally to this article as leading authors.

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