Social Isolation and Psychological Well-being of U.S. Older Adults: Exploring the Moderating and Mediating Effects of Psychosocial Factors

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Social isolation has been recognized as a social problem with negative effects on psychological well-being. Using data from three waves of the Health and Retirement Study across eight years, the primary aims of this study are 1) to examine the impact of social isolation on the growth trajectories of loneliness and depressive symptoms, 2) to explore the potential moderating effects of resilience and neighborhood characteristics, and 3) to explore the mediating effect of social support on the relationships among U.S. adults aged 60 and older (N = 3,681). Social isolation index was constructed using five indicators, including not married or cohabitating with a partner, no social participation, and less than monthly contacts with children, other family members, or friends. Loneliness was measured by the UCLA loneliness scale, and depressive symptoms were measured by the Center for Epidemiological Studies-Depression scale (CES-D). The mediator of social support included positive social support and negative social support respondents received from their social relationship networks. The moderator of resilience was assessed by the simplified resilience score (SRS). The moderator of neighborhood characteristics assessed two aspects of the neighborhood environment, including physical disorder and social cohesion. The results of the latent growth curve models indicated that social isolation was associated with higher initial levels of loneliness and depressive symptoms, but it was associated with slower increasing rate of loneliness across waves. The mediation analyses indicated the significant role of positive social support as the complete mediator and the role of negative social support as the suppressor on the relationships of social isolation with loneliness

and depressive symptoms, respectively. The moderation analyses indicated that resilience significantly buffered the concurrent negative effect of social isolation on the initial level of depressive symptoms. However, neighborhood physical disorder and social cohesion had no significant moderating effect on the relationships. The findings underscore the importance of enacting strategies and interventions targeting both individual- and neighborhood-level factors to address social isolation and its negative consequences among older adults.

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1.0 Introduction

1.1 Background

Human beings are inherently social creatures, which means that social connections and social participation are crucial to an individual's well-being. The detrimental effects of social isolation on well-being have been well-acknowledged for centuries. For example, in prison or other extreme environments, solitary confinement has been employed as a punishment to trigger distressed and painful emotions by forcing individuals into isolation (Long et al., 2003; Holt-Lunstad et al., 2017). With the exponential growth of the aging population in many countries around the world, social isolation of older adults has become an increasingly pressing concern in recent years.

Social isolation has been recognized as a significant public health problem. The World Health Organization lists social isolation as one of the major targeted health problems for older adults (Wilkinson & Marmot, 2003). The AARP Foundation also identifies social isolation as an important social and public health issue and has initiated the AARP Foundation Isolation Framework Project to promote a comprehensive understanding of this issue (Elder & Retrum, 2012). Furthermore, the American Academy of Social Work and Social Welfare has identified social isolation as one of the grand challenges for social work, among eleven other critical social issues that call for immediate attention and social work interventions (Lubben et al., 2015).

During the global COVID-19 pandemic, quarantine strategies had been demonstrated to be one of the most effective methods to slow the spread of the virus. Most countries around the world adopted strategies such as lockdowns, social distancing, group meeting restrictions, and

cancellation of public events (Usher et al., 2020). Although these strategies successfully prevented the transmission of this contagious disease, most people were deeply affected by social isolation, which had negative impacts on their physical and psychological well-being (Clair et al., 2021; Ettman et al., 2020). Particularly for vulnerable populations, such as children, older adults, minorities, low-income individuals, and those with preexisting physical and mental health issues, social isolation had even more severe negative consequences (Perrin et al., 2009; Usher et al., 2020). Given the existing situation, the problem of social isolation has become increasingly serious and affected more people than ever before, which not only calls for a more explicit understanding of the nature and consequences of social isolation but also requires increased resources and interventions in response to this public health priority.

1.2 Statement of Problem

1.2.1 Social Isolation of Older Adults

Affected by the COVID-19 pandemic, social isolation had become an increasingly widespread issue for older adults. Although social distancing and quarantine proved to be effective in containing the spread of the virus during the pandemic (Usher et al., 2020), older adults had been disproportionately impacted by social isolation due to the interrupted social interactions and social participation and difficulty in maintaining their existing social contacts (Armitage & Nellums, 2020; Berg-Weger & Morley, 2020; Brooke & Jackson, 2020; Usher et al., 2020).

Even before the pandemic, researchers argued that there was a growing trend of social isolation in the United States. Americans' social network, particularly non-kin network within organizations and neighborhoods, have become dramatically smaller and people are more likely to be socially isolated over the past few decades (Holt-Lunstad, 2017; Machielse, 2015; McPherson et al., 2006). A national report estimated that in 2009, 6.7 million older adults in the United States were living in isolation, comprising 17% of all U.S. seniors (Ortiz, 2011). This number increased dramatically, with a report provided by the Pew Research Center showing that 16.7 million older Americans lived alone, accounting for 23% of the whole aging population (Livingston, 2019). According to the AARP Foundation, nearly 20% of older Americans aged 65 and older experience some degree of social isolation (Frank, 2018). Using data from a nationally representative study of Medicare beneficiaries, a recent study estimated that 24% of older adults aged 65 and older reported being socially isolated, with 4% characterized as severely socially isolated (Cudjoe et al., 2020). Moreover, another recent meta-analysis research reported that the pooled period prevalence of social isolation during Covid-19 increased to 31.2% among older adults aged 65 and older (Su et al., 2022). It is noted that the actual number of socially isolated older adults may be higher than the reported prevalence, due to factors such as inaccurate self-report results associated with the stigma of social isolation, challenges in identifying, accessing, and recruiting socially isolated older adults into studies, and inconsistent measures of social isolation used in studies (Holt-Lunstad, 2017; Victor et al., 2000).

Examining social isolation among older adults is particularly important (Cornwell & Waite, 2009). Despite that people of all ages may face the issue of social isolation, older adults are more vulnerable not only because they are at greater risk of social isolation, but also because they are more susceptible to its negative consequences than younger individuals (Kaye & Singer,

2018). First, older adults have increased likelihood of experiencing social isolation, probably due to life transitions and disruptive life events associated with old age, such as bereavement and retirement (Ferguson, 2012). Evidence indicates that the prevalence of social isolation increases with age, rising from 24.4% among adults aged 60 to 74 to 33.1% among those aged 74 and older (Wu & Sheng, 2020). Second, social isolation in later life can be exacerbated by impaired physical conditions and cognitive functioning, which often accompany the aging process (Elder & Retrum, 2012; Kaye & Singer, 2018; Victor et al., 2000). As a result, older adults may have limitations in mobility and ability to perform activities of daily living (ADLs), which prevents them from having regular social interactions and social engagement. One study found that 30% of Chinese older adults with strokes in rural areas reported social isolation, which was higher than the prevalence of social isolation among the general aging population in rural China (Zhang et al., 2016).

Lastly, the reciprocal relationship between social isolation and health suggests that socially isolated older adults are at a particularly high risk for negative health consequences. A considerable body of previous studies has demonstrated that social isolation has wide-ranging adverse consequences for older adults, including inflammation, obesity, cardiovascular disease, coronary heart disease, stroke, hypertension, and cognitive impairment (Coyle, 2014; Hakulinen et al., 2018; Pinquart & Duberstein, 2010; Robins et al., 2018; Valtorta et al., 2016; Xia & Li, 2018; Yang et al., 2016; Zhou et al., 2019; Fratiglioni et al., 2000; Read et al., 2020; Shankar et al., 2013), as well as decreased physical functional status, overall health status and health-related quality of life (Hawton et al., 2011; Shankar et al., 2017). The results of a meta-analysis study show that overall social isolation and living alone increase the likelihood of mortality by 29% and 32%, respectively (Holt-Lunstad, 2017; Holt-Lunstad et al., 2015). The detrimental effects

of social isolation on mortality and physical health are shown to be comparable to, or even greater than, those of other well-recognized risk factors such as smoking and drinking (Holt-lunstad et al., 2010), obesity, high blood pressure (Holt-Lunstad, 2017; Pantell et al., 2013), and diabetes (Yang et al., 2016). Moreover, research indicates that the impact of social isolation on health is shown to be continuous in a dose-response manner: a higher level of social isolation is associated with an increased magnitude of the effect on health (Yang et al., 2016). This continuing effects suggests that older adults with multiple indicators of social isolation may face increased risk for mortality (Holt-Lunstad, 2017).

Disadvantaged older adults are more vulnerable to social isolation. Evidence indicates that social isolation is more prevalent among racial and ethnic minority groups (e.g., African American and Hispanic population) (Alcaraz et al., 2019; Miyawaki, 2015) and older adults with lower socioeconomic status (e.g., lower education attainment and wealth or income) (Cudjoe et al., 2020; Elder & Retrum, 2012; McPherson et al., 2006; Teo et al., 2013). These older adults may face considerable challenges related to health disparities, lack of social support and social resources, and difficulties accessing social services, all of which contribute to the occurrence of social isolation. Immigrants, especially minority immigrants who migrated later in life, often encounter additional challenges during the adjustment process due to language barriers and cultural differences (Jang et al., 2021; Weng, 2019). Additionally, older adults of the LGBTQ community are at increased risk for social isolation, which may be attributed to factors such as living alone and being childless (Fredriksen-Goldsen, 2011). Stigma and discrimination toward these marginalized older populations can intensify social isolation by restricting them from social interaction and social participation (Elder & Retrum, 2012; Fredriksen-Goldsen, 2011; Kaye & Singer, 2018).

Taken together, social isolation is a deleterious problem particularly relevant to older adults, as they are not only at greater risk of social isolation but also more vulnerable to its negative consequences than younger adults. Thus, it is critical to focus on the aging population when examining social isolation and its associated negative outcomes in order to have a better understanding of its impact on the psychological well-being of older adults.

1.2.2 Social Isolation as a Risk Factor for Loneliness and Depression

Social isolation and loneliness are two interrelated yet distinct concepts that require to be examined separately (Das et al., 2021; Malcolm et al., 2019; Menec et al., 2019). Social isolation is an objective status measuring the size of one's social network and the frequency of contact, whereas loneliness is a subjective feeling of being isolated that can be developed even without the presence of social isolation (McHugh et al., 2017). Previous studies have reported mixed findings regarding the relationship between social isolation and loneliness. A number of studies have found that social isolation is significantly associated with loneliness in older adults (Cohen-Mansfield et al., 2016; Santini et al., 2020; Taylor, 2020). Compared to those who are not socially isolated, older adults with mild social isolation are 60% more likely to experience loneliness and those with severe social isolation are two times more likely to perceive loneliness (Shankar et al., 2011). In contrast, several studies indicate a weak to moderate correlation between social isolation and loneliness (Cornwell & Waite, 2009; Coyle & Dugan, 2012). Moreover, studies suggest that social isolation is not a significant predictor of loneliness (Cacioppo et al., 2010; Dahlberg et al., 2018; Domènech-Abella et al., 2019).

Late-life depression is a significant public health problem associated with increased all-cause and cardiovascular mortality (Schulz et al., 2000; Wei et al., 2019), morbidities (Agustini

et al., 2020), and cognitive impairment (Gatchel et al., 2019; Shimada et al., 2014). The issue of depression has been further exacerbated by the Covid-19 pandemic. Using data from two nationally representative surveys, a study showed that the prevalence of depression among U.S. adults increased from 8.5% before Covid-19 to 27.98% during the pandemic (Ettman et al., 2020). Data from the 2019 Behavioral Risk Factor Surveillance System (BFRSS) indicates that 14.7% of U.S. adults aged 65 and older reported being diagnosed with depressive disorder by a health professional (America's Health Rankings, 2020). Although depression is less prevalent among older adults compared to younger people, more than half of older adults with depression experience its onset after the age of 60, and the late-life depression have more severe negative health outcomes due to its interaction with age-related chronic conditions (Fiske et al., 2009). A considerable number of studies have established the significant relationship between social isolation and depression (Domènech-Abella et al., 2019; Luo et al., 2021; Noguchi et al., 2021; Santini et al., 2015); however, several studies reported no significant relationship between these two variables (Domènech-Abella et al., 2017; Santini et al., 2020), probably due to inconsistent measures of social isolation used in different studies.

To sum up, the complex relationships of social isolation with loneliness and depression are informed by the conflicting findings from previous literature, which requires further examination of these relationships, particularly in a nationally representative sample of older adults using a global measure of social isolation. Additionally, although previous research has examined the negative consequences of social isolation, there is limited understanding on the long-term impact of social isolation on the growth trajectories of loneliness and depressive symptoms among older adults.

1.3 Research Aims and Significance

Using three waves of the Health and Retirement Study (HRS) across eight years, the primary aims of this study are 1) to examine the long-term impact of social isolation on the growth trajectories (intercepts and slopes) of loneliness and depressive symptoms among older adults, 2) to explore the potential mediating effect of positive social support and negative social support on these relationships, and 3) to investigate the potential moderating effects of resilience and neighborhood characteristics, that is, physical disorder and social cohesion, on the relationships of social isolation with loneliness and depressive symptoms, respectively.

This study has significant implications. First, this study is critical in that it improves the understanding of how social isolation impacts the growth trajectories of loneliness and depressive symptoms among older adults. Second, this study disentangles the relationships by exploring the mediating and moderating effects of various psychosocial factors, which provides empirical evidence that can guide the development of effective and targeted interventions aimed to minimize the negative consequences of social isolation.

2.0 Literature Review

This chapter reviews the definition and measures of social isolation, theoretical frameworks, and existing literature on the relationship between social isolation, loneliness, and depression. The literature on the potential mediating and moderating roles of the psychological factors is also reviewed.

2.1 Definition and Measures of Social Isolation

Social isolation is an objective status reflecting the structural features such as solo-living, the lack of social interaction and social participation (Cornwell & Waite, 2009; Hawton et al., 2011; Santini et al., 2020; Steptoe et al., 2013; Teo et al., 2013). For example, social isolation is described as "the lack of contact or of sustained interaction with individuals or institutions that represent mainstream society" (Wilson, 1987, p60) and "a lack of personal relationships with family, friends, and acquaintances on which people can fall back in case of need" (Machielse, 2015, p339). Previous studies have also used the term "social disconnectedness" to refer to the objective status of social isolation (Cornwell & Waite, 2009; Santini et al., 2020).

Due to diverse attributes of social isolation, a wide variety of definitions has been used to describe social isolation (Nicholson, 2009), which result in a lack of consensus on a universally accepted operationalization. Previous studies have used a myriad of indicators and indices to assess the objective components of social isolation. The first group of studies examines social isolation using a single indicator or a combination of indicators regarding marital status (not

married), living arrangement (living alone), number of social network ties (limited number), frequency of social contact (infrequent), membership in social organizations or religious groups (no membership), and frequency of social participation (infrequent) (Hawton et al., 2011; Taylor et al., 2018; Teo et al., 2013). The frequencies of social contact and social participation are usually rated on a five- or seven-point scale, so researchers determine the cut-off points to assess the presence and severity of social isolation. For example, Victor et al. (2003) and Hawton et al. (2011) categorized people with less than weekly social contact with family, friends, or neighbors into the group of "social isolation" and those with less than monthly contact into the group of "severe social isolation".

Another group of studies measures social isolation by adopting the measurement scales primarily designed to assess the structural aspects of social network and social participation (Donovan & Blazer, 2020). The most commonly used scale is the Berkman-Syme Social Network Index (SNI) (Berkman & Syme, 1979), which is a systemic composite of four dichotomous variables assessing social network and social participation: 1) being married or living with a partner, 2) having children, close friends or relative, 3) membership in voluntary group or club, and 4) attending church services at least twice a month (Cacioppo et al., 2010; Domènech-Abella et al., 2019; Ford et al., 2006; McCrory et al., 2016; Pantell et al., 2013). The scale ranges from 0 to 4, with lower scores indicating a higher level of social isolation. Although the SNI has been widely used, no study to date has examined its psychometric properties.

Another commonly used instrument is an abbreviated version of the Lubben Social Network Scale (LSNS-6), which was designed to assess social isolation in older adults (Donovan & Blazer, 2020; Jang et al., 2021; Lubben et al., 2006; Merchant et al., 2020). The LSNS-6 consists of six equally weighted questions, with three questions assessing family relationships

and three comparable questions evaluating contacts with friends. Respondents report the number of people they "see or hear from at least once a month," "feel close to such that you could call on them for help", and "feel at ease with that you can talk about private matters" on a five-point Likert scale (Lubben et al., 2006). The total score of this scale ranges from 0 to 30, with a score below 12 indicating social isolation (Lubben et al., 2006). This scale has been tested among individuals in different countries and showed good psychometric properties (Cronbach's alpha= 0.83) (Lubben et al., 2006). In addition, this scale is a simple tool that can be easily utilized by researchers and practitioners for data collection and intervention. However, this scale only measures the quantity of social ties while neglects social participation, which potentially restricts a comprehensive examination of social isolation among older adults.

Researchers have also made efforts in generating indices using variables available in the secondary datasets to capture the construct of social isolation. For example, using the NSHAP study, researchers construct the social disconnectedness scale to examine the objective characteristics of social isolation (Cornwell et al., 2009; Cornwell & Waite, 2009; Santini et al., 2020). This scale comprises eight items assessing social network characteristics and social participation, including 1) social network size, 2) social network range, 3) proportion of each type of social network living in the household, 4) the frequency of social interaction, 5) the number of friends, 6) the frequency of attending meetings, 7) the frequency of socializing with friends and relatives, and 8) the frequency of volunteering (Cornwell et al., 2009). Although the social disconnectedness scale has acceptable internal consistency (Cronbach's alpha = 0.73) and moderate to strong item-rest correlations (Cornwell et al., 2009), it is not a validated instrument used to screen social isolation in other studies (Elder & Retrum, 2012).

Lastly, the Steptoe Social Isolation Index is another widely accepted scale, which is generated using five variables from the English Longitudinal Study of Ageing (ELSA) (Read et al., 2020; Shankar et al., 2011, 2017; Steptoe et al., 2013). The scale items are 1) not married or not cohabitating with a partner, 2) less than monthly contact with children, 3) less than monthly contact with friends, 4) less than monthly contact with other family members, and 5) no participation in any organizations, religious groups, or committees. The total score ranges from 0 to 5, with a higher score indicating a greater degree of social isolation.

2.2 Theoretical Framework

2.2.1 Social Isolation Hypothesis and Identity Accumulation Hypothesis

The hypothesis proposed in this study that social isolation has a long-term impact on loneliness and depressive symptoms across waves (H1) can be supported by the social isolation hypothesis. The social isolation hypothesis is first introduced by Faris (1934), linking social isolation to the mental disorder of schizophrenia. According to this hypothesis, social isolation acts as an external force that poses individuals to a great tendency towards the onset of schizophrenia (Jaco, 1954). As a precipitating factor, social isolation is an external condition in the social environment, which requires the investigation at the community level (Jaco, 1954). The researcher further validates the proposed hypothesis by providing empirical evidence: compared to those with lower rate of schizophrenia, communities with a high rate of schizophrenia have greater social isolation (Jaco, 1954). However, other researchers have raised concerns about the methodological limitations of the social isolation hypothesis, as the

underlying assumptions are not explicitly presented, and the hypothesis fails to address key questions such as how the different types of social isolation, the situational contexts, or the timing of experiencing social isolation might have different health outcomes (Clausen & Kohn, 1954; Thoits, 1983).

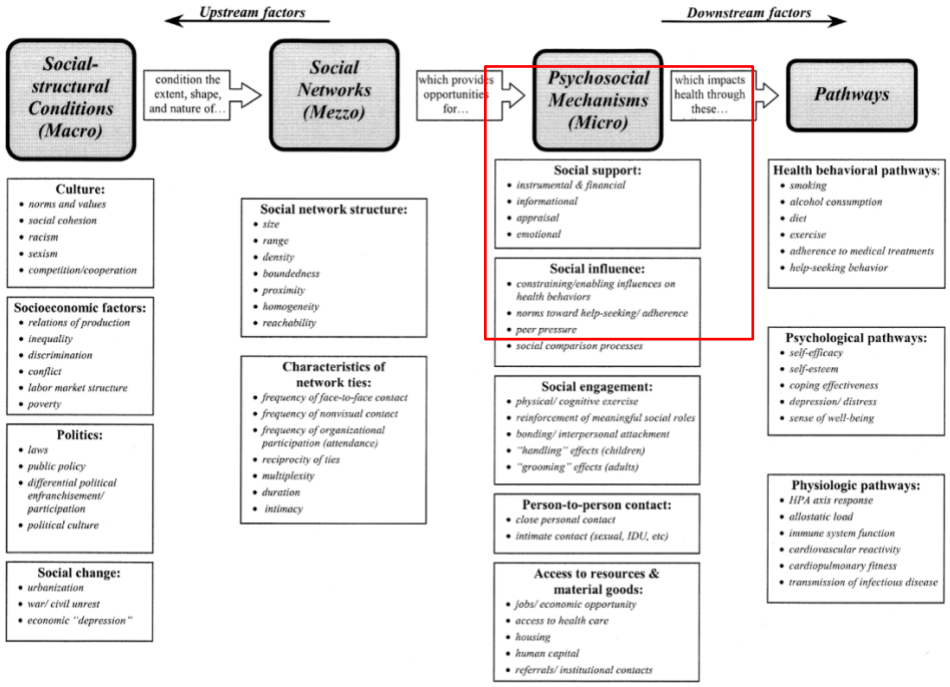
Building on the symbolic interactionist theory, Thoits (1983) reformulates the social isolation hypothesis and proposes the identity accumulation hypothesis, positing that the effects of role gain and role loss on psychological well-being could be conditional upon the degree of social isolation and the number of social identities early in life. Thoits first emphasizes the importance of social identities for psychological well-being, which is consistent with role theory (Thoits, 1983). That is, when individuals possess multiple social identities granted by employment status, and family and social relationships, such as being an employee, parents, spouse, caregiver, or friend, they can acquire self-realization, social identification, and meaning for existence, which are essential components of psychological well-being (Thoits, 1983; Thoits, 1985; Vesnaver & Keller, 2011). As people assume multiple social roles, they develop a stronger sense of the life value (Thoits, 1983). On the contrary, people with fewer social identities are at increased risk for psychological distress (Thoits, 1983).

Thoits (1983) further defines social isolation as "the possession of few social identities" and refers to individuals with limited or no social identities as "isolates". Empirical evidence indicates that identity loss is associated with increased psychological distress (Thoits, 1983). Social isolation in later life is often accompanied with the sudden loss of previously important roles, potentially leading to ambiguity about expected behaviors and the meaning of existence, and subsequently escalated psychological distress among older adults.

The social isolation hypothesis and the identity accumulation hypothesis provide theoretical support for the significant relationship between social isolation and psychological distress. In addition, the identity accumulation hypothesis indicates the long-term impact of social isolation on psychological well-being, thus pointing to the importance of examining the longitudinal relationships of social isolation with loneliness and depressive symptoms among older adults.

2.2.2 Berkman's Framework

The hypothesis that social isolation impacts psychological well-being through the psychological pathways (H2) is supported by Berkman's conceptual model of the impacts of social network on health (highlighted in the figure).



Source: Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine*, 51(6), 843–857.

Figure 1 Berkman's Conceptual Model of Social Network and Health

After reviewing classical theories and empirical research, Berkman and colleagues (2000) developed a conceptual framework to examine social network. The framework focuses on two sets of upstream factors (social-structural conditions and social network) and two sets of downstream factors (psychosocial mechanisms and pathways) (Berkman et al., 2000). To be specific, this conceptual framework is designed to understand how social and cultural conditions shape the structure of social network and how social network subsequently impacts individual health through various pathways.

The model proposes that social network affects health through several psychosocial mechanisms, including social support, social influence, social engagement, person-to-person contact, and access to resources and material goods (Berkman et al., 2000). Berkman and colleagues identify social support (including instrumental/financial support, informal support, appraisal support, and emotional support) as the most important mechanism through which social network influences health. Social influence, encompassing constraining/enabling influences, social norms, peer pressure, and social comparison processes, is the second micro mechanism identified by the study through which social network impacts health. The model further presents social engagement as another micro mechanism through which social network benefits health, particularly psychological well-being. Social engagement not only provides individuals with a sense of value and belonging by helping them develop and maintain meaningful roles within family, community, and society, but also satisfies individual needs for companionship and sociability. The fourth micro mechanism is the access to material resources, suggesting that a broader social network may provide people with opportunities to access a variety of resources and material goods. In addition to the positive effects, Berkman also points out that social network can have negative health consequences. For example, a larger social network size is

associated with the higher frequency of face-to-face interactions, which might increase the risk of exposure to infectious diseases, particularly through close personal and intimate contact.

In addition, Berkman lists three pathways through which these micro-level psychosocial mechanisms influence health: health behavioral pathways, psychological pathways, and physiological pathways. The health behavioral pathways primarily refer to health-related behaviors that can be strengthened or prohibited by social support and social influence, including smoking, alcohol consumption, diet, exercise, adherence to medical treatments, and help-seeking behaviors. Moreover, social network influences an individual's health through various psychological pathways. Social support, social engagement, and social integration are positively associated with self-efficacy, self-esteem, coping effectiveness, sense of well-being, and negatively associated with depression and distress. Based on the results of several studies examining the effects of early life maternal separation on rat's health status in later life (Meaney et al., 1985, 1988), Berkman hypothesizes that social isolation at the early life stages has an impact on physiologic functions throughout a human's life course. The experience of social isolation could potentially accelerate the aging process, impair cognitive functioning, and compromise an individual's adaptive mechanism to respond to and recover from stressful stimuli. Furthermore, the lack of social support and social network in adulthood has negative effects on cardiovascular reactivity and immune systems.

With the focus on social network, Berkman's conceptual framework provides a comprehensive theoretical framework for the analysis of social isolation. This framework explains how adequate social network impacts health through different pathways, implying that social isolation (the lack of social network) directly and indirectly impacts health through several psychosocial mechanisms. According to this framework, social isolation restricts people from

accessing social support, social influence, social engagement, and resources and material goods. Without social network, those who are socially isolated may have great difficulty in maintaining health-benefiting behaviors and be at increased risk of experiencing the negative health consequences of social isolation.

2.2.3 Ecological Theory

The ecological theory proposed by Bronfenbrenner (1977, 1979) guides the examination of how psychosocial factors moderate the effect of social isolation on psychological well-being (H3). This theory posits that individuals are embedded within different systems, including the microsystems, mesosystem, exosystem, macrosystem, and chronosystem (Bronfenbrenner 1977, 1979). People's behaviors are profoundly influenced by their surrounding environment at different levels of the system, which can only be fully understood when considering the influences of each level (Grauerholz, 2000).

The ecological model provides a comprehensive framework for the investigation of multiple determinants of health behavior across different levels, thereby promotes the development of multilevel interventions to optimize outcomes (Bauman et al., 2012; Holt-Lunstad et al., 2017). Researchers emphasize the importance of incorporating the ecological model to understand and address social isolation (Holt-Lunstad et al., 2017). According to the model, the microsystem is the setting for interpersonal interaction with the most immediate relationship, with family context being the most important microsystem. Socially isolated older adults often have limited access to social support and companionship offered by their spouse and children in the family context, which may contribute to psychological distress such as loneliness and depressive symptoms. The mesosystem extends to the broader context involving the

interactions with non-immediate social relationships such as friends and neighbors. Socially isolated older adults have limited interaction with friends and other social relationships, which also restricts them from receiving adequate social support. Moreover, low social participation among socially isolated older adults limits the opportunity to engage with their neighborhood and establish new social relationships, which in turn aggravates psychological distress.

The exosystem includes settings that impact individuals indirectly, such as neighborhood environment. Neighborhood characteristics, such as social cohesion and physical disorder, can significantly influence the psychological well-being of socially isolated older adults. Social interaction and social participation foster perception of safety, feelings of acceptance, inclusiveness, social cohesion, and a sense of belonging to the community (Finlay & Kobayashi, 2018; Zavaleta et al., 2014). Conversely, living in a neighborhood with a high level of physical disorder may discourage older adults from social participation due to the safety concerns, which aggravates social isolation and associated psychological distress. The macrosystem and chronosystem include societal values, cultural context, and historical components. The macro-level factors, including socioeconomic development, social dynamics, social policy, cultural perceptions, beliefs and values, and public health crisis, may have a significant influence on social isolation (Elder & Retrum, 2012). The COVID-19 pandemic is an explicit demonstration of the impact of macrosystem factors on the development of social isolation among older adults.

Ecological theory helps to explain how the impact of social isolation on psychological well-being can be simultaneously determined by various factors. These factors range from individual level to the broader cultural contexts and socioeconomic conditions of a society. Utilizing the ecological theory allows a holistic examination of the factors across multiple levels,

which can foster a comprehensive understanding of how social isolation affects psychological well-being of older adults.

2.3 The Relationship between Social Isolation, Loneliness and Depression

2.3.1 Social Isolation and Loneliness

Social isolation and loneliness are closely related, but they are distinct constructs that describe different life experiences, and either can exist independently of the other (Coyle & Dugan, 2012; Das et al., 2021; Hughes et al., 2004; Matthews et al., 2016; Xiang et al., 2021). Different from social isolation which represents an objective status, loneliness is described as a subjective status that reflects an individual's distressing feeling of isolation, disconnectedness, and lack of belonging, as well as dissatisfaction with the quantity and quality of current social relationships (Coyle & Dugan, 2012; Holt-Lunstad et al., 2015; Hughes et al., 2004).

The discrepancy model of loneliness proposed by Peplau & Perlman (1982) defines loneliness as the perceived discrepancy between the social contacts individuals desired to have versus social contacts they actually have (Holt-Lunstad et al., 2015; Peplau & Perlman, 1982; Steptoe et al., 2013; Victor et al., 2000). Individuals may perceive loneliness when their actual social relationships are below their expectations regarding the quantity or quality of these relationships (Russell et al., 2012). This model implies that loneliness might not always coexist with social isolation, since it is jointly determined by expected and actual social interaction. Based on the discrepancy model of loneliness, researchers have categorized people into four

groups: 1) socially isolated and lonely, 2) neither isolated nor lonely, 3) socially isolated but not lonely, 4) lonely but not isolated (Newall & Menec, 2019; Victor et al., 2008).

Previous studies have reported mixed results on the relationship between social isolation and loneliness. Social isolation and loneliness seem to coexist due to shared characteristics such as the lack of social network and being alone. A number of cross-sectional studies have provided empirical evidence on the significant relationship between social isolation and loneliness (Cohen-Mansfield et al., 2016; Domènech-Abella et al., 2017; Taylor, 2020). A systematic review identifies several key indicators of social isolation as significant correlates of loneliness, including living alone, having a small social network, infrequent contact with others, being unmarried or widowed, and lack of social participation (Cohen-Mansfield et al., 2016). In a study of a nationally-representative sample of adults aged 50 and older in Spain, researchers found that a larger social network was associated with a lower probability of perceiving loneliness (Domènech-Abella et al., 2017). Another study, using a sample of 6,962 older adults from the Health and Retirement Study (HRS), examined the individual and overall effect of seven indicators of social isolation (e.g., living alone, frequency of contact with children, family, and friend, and social participation), and found that overall social isolation and nearly all single indicators were associated with increased loneliness, except for contact with adult children (Taylor, 2020).

Furthermore, social isolation has been identified as a significant predictor contributing to the development of loneliness in later years. A longitudinal study used three waves of data from NSHAP over ten years to examine the relationships between social disconnectedness (measured by the size and range of social network, frequency of contact and social participation), perceived isolation (measured by loneliness and perceived social support) and depression (Santini et al.,

2020). The findings indicated that baseline social disconnectedness was significantly associated with greater perceived isolation in subsequent waves (Santini et al., 2020).

However, despite the evidence supporting the significant effect of social isolation on loneliness, some studies suggest that social isolation and loneliness are only weakly to moderately correlated, and both constructs had independent relationships with physical and mental health problems among older adults (Cornwell & Waite, 2009; Coyle & Dugan, 2012; Dahlberg et al., 2015; Drageset, 2004; Holt-Lunstad, 2017; Hughes et al., 2004; Shankar et al., 2013; Tomaka et al., 2006). A cross-sectional study found that the indicators of social isolation, such as frequency of contact, were not significantly associated with loneliness (Domènech-Abella et al., 2017). Moreover, some longitudinal studies also suggest that social isolation is not an antecedent risk factor for loneliness. For example, using two waves of a nationally representative study in Ireland, a study indicated that loneliness at baseline predicted changes in social isolation in the later waves, whereas social isolation was not a significant predictor for loneliness (Domènech-Abella et al., 2019). Another study involving 229 adults aged 50 and older found that social isolation was significantly associated with loneliness at the baseline wave; however, the results of cross-lagged analyses indicated that social isolation did not predict loneliness in subsequent waves (Cacioppo et al., 2010). Similarly, a study across 20 years found that a low level of social contact had a short-term, but not long-term, relationship with loneliness (Dahlberg et al., 2018). Taken together, these findings suggest that social isolation may have an immediate and transient effects on loneliness, but the effects tend to diminish over time.

Possible explanations are provided to understand the distinction between social isolation and loneliness. The objective status of social isolation does not necessarily correlate with loneliness, in that the degree of embeddedness and satisfaction towards current social

relationships can be more influential on the perception of loneliness than the frequency and quantity of social network (de Jong Gierveld et al., 2006; Hughes et al., 2004). A population-based study of older adults found that the actual frequency of social contact with children and friends was not associated with loneliness, but rather the expectations and satisfaction with these social contacts significant predicted feelings of loneliness (Routasalo et al., 2006). Another longitudinal study using a nationally representative survey in England also found that perceived closeness with a spouse or partner had a profound effect on mitigating loneliness over time, whereas changes in marital status or the size of social network had no significant effect on loneliness (Yang, 2018). Personal choice of lifestyles may also help explain the discrepancy between social isolation and loneliness. For example, older adults who are socially isolated do not necessarily perceive loneliness, as they may enjoy a solitary lifestyle and intentionally remain isolated to focus on the most intimate relationships and to avoid unwanted and unpleasant ones (Cornwell & Waite, 2009; Coyle, 2014; de Jong Gierveld et al., 2006; Finlay & Kobayashi, 2018).

Taken together, previous studies have emphasized the distinction between social isolation and loneliness, which provides a compelling reason to differentiate between social isolation and loneliness and examine these two concepts separately. Several methodological limitations are noted in previous studies. First, there is considerable ambiguity regarding the relationship between social isolation and loneliness, probably due to the inconsistency in operationalizing social isolation across studies. The examination of single indicators fails to capture the holistic picture of social isolation - a multifaceted experience. Second, most of the empirical evidence on the significant relationship are provided by cross-sectional studies, which are incapable of establishing temporal or causal relationship between social isolation and loneliness. Although

several studies have used longitudinal data in the investigation of the predicting effect of baseline social isolation on loneliness at later time, it remains unexplored how the dynamic attributes of social isolation affect the change trajectories of psychological outcomes. Third, very few studies have explored the potential mechanisms or buffering effects of psychosocial factors when examining the relationship between social isolation and loneliness. It is important to disentangle social isolation from loneliness by investigating the pathways between these two distinct concepts. Therefore, future studies are in need to address these limitations to have a deeper understanding of social isolation and loneliness.

2.3.2 Social Isolation and Depression

The relationship between social isolation and depression among older adults has been widely examined in previous studies using both cross-sectional and longitudinal data. However, these studies present controversial findings, primarily due to the inconsistent measures of social isolation used across studies.

Several studies examining the relationship between social isolation and depression have adopted an overall index to measure social isolation, which is generated by combining different sets of indicators (Luo et al., 2021; Noguchi et al., 2021). In a longitudinal study using a sample of Chinese adults aged 45 and older who initially reported no depression, researchers found that social isolation (comprising five indicators) was associated with the onset of depression over four years (Luo et al., 2021). Similar findings were reported in a cross-national study of older adults in Japan and England that overall social isolation was associated with an increased risk of the onset of depression in both countries (Noguchi et al., 2021).

Measured by variables of marital status, having close friends or relatives, group membership and attendance of church, social isolation was significantly associated with depression cross-sectionally, but it did not predict depression in the following waves (Cacioppo et al., 2010). A subsequent study adopted the same social isolation index, but categorized respondents into four groups representing different degree of social isolation (Domènech-Abella et al., 2019). Compared to the most isolated individuals, those with lower levels of social isolation were less likely to have major depressive disorder in the two-year follow-up (Domènech-Abella et al., 2019). Despite using the same social isolation measure, the contrasting findings suggest that the results may be contingent on the way researchers operationalize the variable in their studies.

When investigating individual indicators of social isolation, the findings were mixed regarding the independent and differential effect of each indicator. For example, a systematic review study found that nine out of 13 studies reported a significant relationship between social network size and depression, and two out of four studies found that the frequency of social contact was a significant predictor (Santini et al., 2015). Furthermore, the relationship between the frequency of social contact and depression varies with the type of social relationship. Using the longitudinal data from HRS, the study findings indicated that after controlling for the covariates, the frequency of contact with friends significantly reduced the likelihood of developing depressive symptoms, while no significant associations were found with children or other family members (Teo et al., 2015).

Several studies argued that objective measures of social isolation had no significant relationship with depression (Teo et al., 2013). After adding the variables of loneliness or subjective social isolation (the closeness with family and friends) to the multivariate regression

models, the frequency of contact was no longer significantly associated with depressive symptoms (Domènech-Abella et al., 2017; Taylor et al., 2018). Using a global measure of social isolation, Santini et al. (2020) examined the longitudinal data across ten years and did not find any evidence on the predicting effect of social isolation on depressive symptoms in the following waves.

In conclusion, discordant findings have been reported in the relationship between social isolation and depression. Similar to the studies on loneliness, limitations are evident in the existing literature on social isolation and depression, such as the inconsistent measurement and unexplored growth trajectory. To fill the research gap and contribute to current knowledge, this study will disentangle the relationships of social isolation with loneliness and depressive symptoms through the explicit examination of the moderating effects and mediating pathways of psychosocial factors.

2.4 Moderating and Mediating Role of Psychosocial Factors

Although previous studies have provided empirical evidence on the relationships of social isolation with loneliness and depression, results from different studies are mixed, which requires further investigation into the moderating and mediating roles of psychosocial factors. From an ecological perspective, this study aims to explore three psychosocial factors, which are selected from different domines of the ecological system and are closely related to social isolation, loneliness, and depressive symptoms.

2.4.1 The Moderating Effect of Resilience

Resilience is defined by the American Psychological Association (APA) as "the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress" that "involves bouncing back from these difficult experiences and profound personal growth" (American Psychological Association, 2012; MacLeod et al., 2016). This definition highlights the key features of resilience. First, different from personality that is relatively stable across the lifetime, resilience refers to a dynamic process that allow individuals to build up capabilities over time (MacLeod et al., 2016). The results of previous studies indicate that resilience is increased with age (MacLeod et al., 2016). Compared to young people, older adults have significantly higher levels of resilience, especially in the sub-domains of emotional regulation ability and problem-solving skills (Gooding et al., 2012). Second, resilience is positive adaptation associated with optimal outcomes. The outcomes of resilience is "operationalized as either the absence of a negative outcome, the presence of a positive outcome, or the combination of both (Smith & Hayslip, 2012, p11). By examining individuals who are in the face of different types of stressful life events and physical conditions across different age groups, extensive studies have demonstrated that resilience is associated with successful aging (Jeste et al., 2013), quality of life (Musich et al., 2022), reduced risk for depression and fewer depressive symptoms (King et al., 2019; Kirby et al., 2017; Laird et al., 2019; Toukhsati et al., 2017), and lower levels of anxiety and stress (Rossi et al., 2021). Third, the process of being resilient may occur when individuals have been exposed to stressful life events that threaten their psychological well-being (Masten et al., 2009). Though resilient individuals have experienced transient distress following stressful events, they are able to maintain their psychological well-being and carry on with their lives (Bonanno et al., 2012). These characteristics imply the importance of resilience for socially

isolated older adults in that they have the ability to develop adaptive strategies to cope with the stressful situation of social isolation and the associated negative consequences.

Resilience may buffer the negative effects of social isolation on psychological well-being among older adults. According to the ecological model of resilience, resilience is a flexible adaptation process not only related to individual characteristics, but also influenced by the opportunities and support from contextual and sociocultural resources (Aldwin & Igarashi, 2012). This model indicates that how well individuals respond to stressful events can differ by individual attributes (such as human capital, personality), interpersonal relationships (such as social support), or environmental supports (such as community attachment) (Aldwin & Igarashi, 2012; Smith & Hayslip, 2012). At the individual level, resilient older adults share the characteristics of optimism and hopefulness, adaptive coping styles, positive emotional regulation skills and problem-solving ability (Aldwin & Igarashi, 2012; MacLeod et al., 2016; Manning et al., 2016), which help them rapidly adapt to social isolation and retain or regain psychological well-being. Resilience also implies the ability to mobilize and activate the resources that protect individuals from the negative outcomes of adversity (King et al., 2019). Resilient older adults, particularly those who are newly isolated due to disruptive life events, such as widowhood, can quickly activate existing social network or to cultivate new network ties to acquire quality social support (King et al., 2019). Moreover, a supportive environment with availability and accessibility of support and resources in the community can satisfy the needs of older residents, which can also buffer the negative effects of social isolation on psychological well-being (Kim, 2010; Zhang et al., 2021).

Even though the buffering effect of resilience on the negative effects of social isolation on psychological well-being is theoretically supported, there is a paucity of empirical study that

has investigated this effect. To fill this gap, it is critical to examine how the relationships of social isolation with loneliness and depression vary by levels of resilience in the older population. The findings of this study can also provide a possible explanation on the inconsistent results of existing literature.

2.4.2 The Mediating Effect of Social Support

Social support is a multidimensional concept that encompasses various domains of support that people can receive from others, including emotional support, instrumental support, and informational support (House, 1981). Moreover, social support can be further categorized into perceived social support and received social support (Santini et al., 2015). Perceived social support was a more potent predictor of mental health than the objective indicators of social network size (Brummett et al., 2001; Santini et al., 2020).

Social support has long been recognized to play a crucial role in psychological well-being (Thoits, 1982). It is particularly important during a life crisis, as social support can buffer the negative influence of stressful life events on psychological well-being, and both instrumental support and emotional support can help people get through those difficult times in life (Berkman et al., 2000). Even without the stressful events, social support was found to have a lasting effect on alleviating loneliness across 20 years (Dahlberg et al., 2018). Older adults with chronic conditions or cognitive impairment have increased needs for social support, which contribute to psychological distress when those needs are unmet.

Empirical evidence on the protective effect of social support against depression and loneliness has been provided by extensive studies (Santini et al., 2015). A study indicated that having unmet needs and the absence of tangible support from family members or neighbors were

significantly associated with more depressive symptoms (Barger et al., 2014). In a longitudinal study of a nationally representative sample of Irish older adults, Santini et al. (2016) found that support from children and friends were protective against depressive symptoms at a two-year follow-up observation. Using the cross-sectional data from the HRS, researchers found that positive social support from spouse and friends were significantly related to a lower level of loneliness (Chen & Feeley, 2014). In addition to the examination of social support from different sources, studies assessed social support as a global measure, and found that overall social support regardless of its sources was also related to decreased depressive symptoms and loneliness (Cacioppo et al., 2010; Vanderhorst & McLaren, 2005).

Although social support is usually perceived to be beneficial and pleasant, excessive social support may serve as a risk factor for depression (Fiske et al., 2009). Among older adults who were in need of help with ADLs due to health problems, men with a high desire of independence reported more depressive symptoms when they received greater amount of social support than needed (Nagumey et al., 2004). Moreover, there are negative aspects of social support involving interpersonal conflicts and strained relationships (Chen & Feeley, 2014). Usually termed as "social strain" and "negative social exchanges", it measures the negative experience in the process of receiving social support from others, such as criticism, excessive demands, intrusion, unmet needs, insensitive behaviors, ignorance and rejection (Chen & Feeley, 2014; Newsom et al., 2005). Negative social support has a detrimental effect, which not only predicts increased negative affect and psychological distress, but also predict reduced positive affect and positive well-being (Newsom et al., 2003, 2005). Social strain from spouse significantly predicted depressive symptoms in men, and social strain from children was associated with more depressive symptoms in women (Santini et al., 2016). Another study using

cross-sectional data of HRS found that negative strain from all sources was associated with aggravated loneliness (Chen & Feeley, 2014).

According to Berkman's conceptual model (2000), social network may operate through social support to influence psychological well-being. Social network is important in people's lives in that they provide people with social support (Hurlbert et al., 2000), which is protective against psychological distress. The lack of social support among socially isolated individuals is established by the nature of social support, as it is usually provided by close social ties. Isolated older adults are characterized by living alone, being unmarried, having limited contact with social relationships, which indicate that they lack access to both emotional support and instrumental support from others (Brummett et al., 2001). Under the circumstances of the worsened physical conditions and stressful life events, older adults have higher demands on social relationships and social support (Flowers et al., 2017; Machielse, 2015). Without those needed social connections, older adults may face increased psychological distress. In addition, socially isolated older adults may have limited involvement in community activities, which restricts them from gaining positive social support from others and generating a sense of belonging (Hagerty et al., 1996). Therefore, social isolation and the lack of positive social support may jointly contribute to loneliness and depression among older adults.

Meanwhile, socially isolated older adults are less likely to be exposed to negative social support. Older adults may even deliberately choose to minimize social contacts to avoid the negative aspects of social interaction. Given that negative social support has a stronger and longer-lasting effect on psychological distress than positive social support (Newsom et al., 2003; Shiovitz-Ezra & Leitsch, 2010), we can assume that reduced negative social support may offset

the negative effect of social isolation on psychological well-being. However, there is no empirical evidence in previous studies to validate this assumption.

Altogether, previous studies have provided empirical evidence that positive social support plays a significant mediating role in the relationship between social isolation and psychological health outcomes. Although the indirect pathway of negative social support is equally important when examining the relationship, there is a paucity of knowledge about the role of negative social support. To fill this research gap, the present study takes into account both positive and negative social support from diverse sources to examine their mediating effect on loneliness and depressive symptoms among older adults.

2.4.3 The Moderating Effect of Neighborhood Physical Disorder and Social Cohesion

Neighborhoods can be an important determinant of mental health conditions among older adults (Beard et al., 2009). Subjective assessment of neighborhood physical disorder and social cohesion can be stronger indicators for mental health than objective measures of neighborhoods, such as neighborhood socioeconomic status (Wen et al., 2006). According to the collective efficacy theory (Shaw & McKay, 1969), neighborhood social resources, such as mutual trust and social cohesion, may have an impact on individual health outcomes of the residents. Social cohesion not only has a direct impact, but also contributes the health outcomes through the mechanisms of social control and positive psychosocial processes (Cagney et al., 2009). Physical disorder refers to the visible signs of neighborhood deterioration, such as inadequate light at night, poorly maintained sidewalks, and vandalism or graffiti, which deepen the fear of crime and safety issues in the neighborhood and in turn prevent residents from social participation (Cagney et al., 2009).

Previous study has documented the significant relationships of neighborhood physical disorder and social cohesion with depression and loneliness (Mair et al., 2008). Using HRS data, a study found that perceived neighborhood social cohesion was significantly associated with a reduced likelihood of depression and loneliness at the four-year follow-up (Kim et al., 2020). Another study of older adults in Spain found that low social cohesion was associated with worse mental health (Domènech-Abella et al., 2021).

Both social cohesion and neighborhood physical disorder may have moderating effects on the relationships of social isolation with loneliness and depressive symptoms. Evidence was provided by a study using a sample of 1049 adults aged 55 and older to examine the moderating effect of perceived neighborhood environment on the relationship between living alone and depressive symptoms (Stahl et al., 2017). The results of this study indicated that the relationship between living alone and depressive symptoms was conditioned by the perception of neighborhood: among respondents who were living alone, those who perceived worse neighborhood environments reported more depressive symptoms than those perceiving fewer problems (Stahl et al., 2017). However, neighborhood environment examined in this study mainly focused on the physical quality, such as built environment, accessibility of grocery stores, and neighborhood safety. The moderating effects of social cohesion and physical disorder remain unexplored. In addition, this study only examined a single indictor of living alone, thus the results may be different when examining overall social isolation, which is more likely to be affected by neighborhood environments. Despite the fact that social cohesion is widely recognized as a protective factor for psychological well-being, some argued that living in the community with high level of social cohesion may have negative impact on those isolated residents, which can be explained by the concept of relative deprivation that the relative social

isolation may be associated psychological distress (Noguchi et al., 2021; Smith et al., 2012). The examination of possible moderating roles of social cohesion and physical disorder will illustrate the characteristics of neighborhood environments whereby social isolation is related to loneliness and depression.

2.5 Summary

In conclusion, previous studies reported inconsistent findings on the relationships of social isolation with loneliness and depressive symptoms. The literature review identifies several study limitations that need to be addressed in future studies to gain a better understanding of the relationships.

First, the understanding of social isolation and psychological distress is largely based on the evidence provided by cross-sectional studies. A great amount of previous research has used cross-sectional data to examine how social isolation is associated with loneliness and depressive symptoms. These cross-sectional studies have limited ability to rule out the reciprocal causality, that is, depressive symptoms and loneliness may lead to social isolation. Furthermore, cross-sectional studies cannot examine the long-term impact of social isolation on the growth trajectory of depressive symptoms and loneliness (Crowe et al., 2021; Lam & García-Román, 2019; Shaw et al., 2017). Even though the longitudinal study also has limitations, such as attrition and missing values (Wenger & Burholt, 2004), it is a much more favorable approach to better understanding the longitudinal relationship between social isolation and psychological well-being among older adults. In comparison to the huge body of cross-sectional studies, the lack of longitudinal studies remains a significant limitation of existing literature on this topic.

Second, the mechanisms by which social isolation influences loneliness and depressive symptoms remain unclear. A limited number of studies have made efforts to improve our understanding of the relationship between social isolation and psychological distress by taking into consideration the potential mechanisms. It is critical for future studies to further investigate the mediating or moderating factors on the longitudinal relationship to understand the mechanisms and conditions through which social isolation has impacts on loneliness and depressive symptoms.

By performing the latent growth curve modeling analyses and using a sample from a nationally representative study across eight years, this study will contribute to current knowledge, and provide explicit understanding of the long-term impact of social isolation on loneliness and depressive symptoms, and the possible mediating or moderating roles of psychological factors. The findings of this study will provide empirical evidence for the development of effective interventions that target minimizing the negative effects of social isolation among older adults.

2.6 Research Questions and Hypotheses

To fill the research gaps, this study aimed to answer the following three research questions. The hypotheses for each research question were proposed based on the theoretical framework and existing literature on this topic. The conceptual framework is illustrated in figure 2.

Research question 1: What is the long-term impact of social isolation on the growth trajectories (intercepts and slopes) of loneliness and depressive symptoms among older adults?

Hypothesis 1a: Baseline social isolation is positively associated with the intercepts of loneliness and depressive symptoms, respectively.

Hypothesis 1b: Baseline social isolation predicts faster increasing rate of loneliness and depressive symptoms across waves.

Research question 2: Do positive social support and negative social support at the baseline wave mediate the relationships of social isolation with loneliness and depressive symptoms, respectively?

Hypothesis 2a: Positive social support plays a significant mediating role on the relationships of social isolation with loneliness and depressive symptoms, respectively. Baseline social isolation is associated with fewer positive social support, and fewer positive social support is in turn associated with more loneliness and depressive symptoms at the baseline wave, as well as greater increasing rates of loneliness and depressive symptoms, respectively.

Hypothesis 2b: Negative social support plays a significant mediating role on the relationships of social isolation with loneliness and depressive symptoms, respectively. Baseline social isolation is associated with fewer negative social support, and fewer negative social support is in turn associated with lower levels of loneliness and depressive symptoms at the baseline wave, as well as slower increasing rates of loneliness and depressive symptoms, respectively.

Research question 3: Do resilience, neighborhood physical disorder, and social cohesion at the baseline wave moderate the relationships of social isolation with loneliness and depressive symptoms, respectively?

Hypothesis 3a: Resilience significantly moderates the relationship between social isolation and both the intercepts and slopes of loneliness and depressive symptoms. Among

respondents with a higher level of resilience, baseline social isolation is associated with lower levels of loneliness and depressive symptoms at the baseline wave and slower increasing rates of loneliness and depressive symptoms, respectively.

Hypothesis 3b: Neighborhood physical disorder significantly moderates the relationships of social isolation with the intercepts and slopes of loneliness and depressive symptoms. Among respondents who report fewer neighborhood physical disorder, baseline social isolation is associated with lower levels of loneliness and depressive symptoms at the baseline wave and slower increasing rates of loneliness and depressive symptoms, respectively.

Hypothesis 3c: Social cohesion has a significant buffering effect on the relationships of social isolation with the intercepts and slopes of loneliness and depressive symptoms. Among respondents with a higher level of social cohesion, baseline social isolation is associated with lower levels of loneliness and depressive symptoms at the baseline wave and slower increasing rates of loneliness and depressive symptoms, respectively.

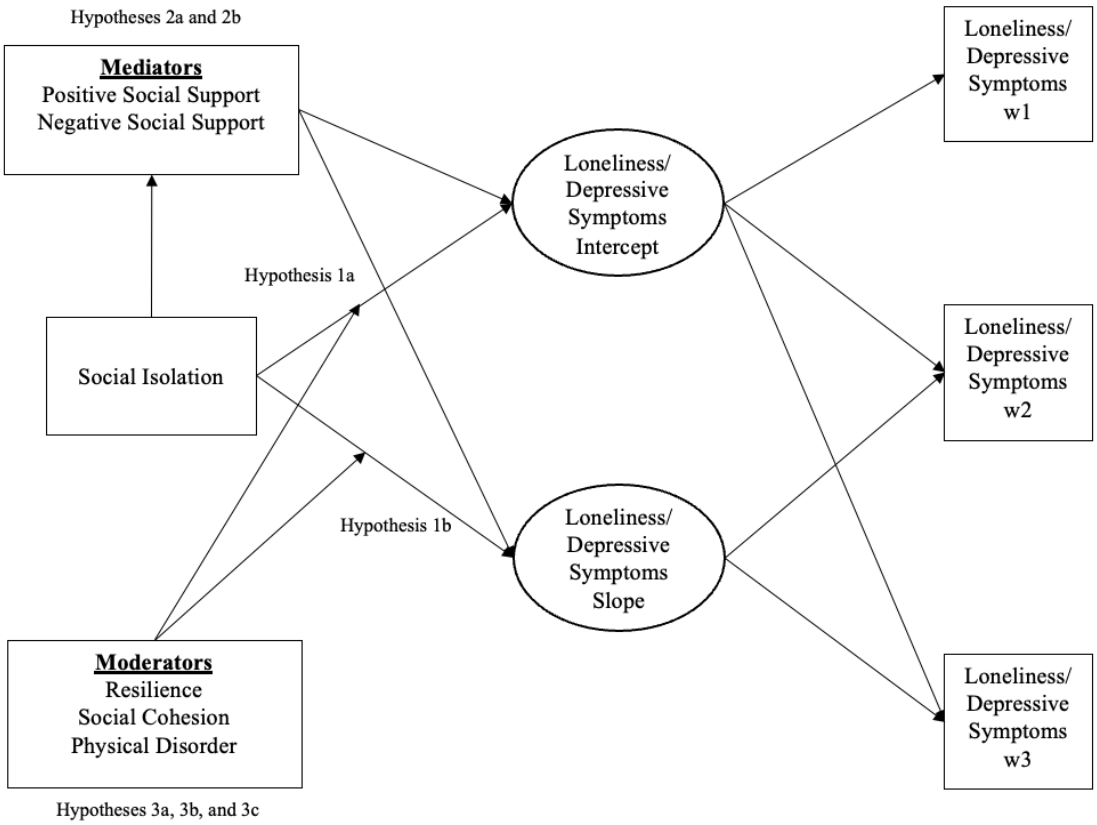


Figure 2 Conceptual Model

3.0 Methods

3.1 Dataset and Sample

To achieve the study objectives, this study utilized longitudinal data from the Health and Retirement Study (HRS), which is a nationally representative survey that investigates the economic, health, marital, and family status, as well as public and private support systems among U.S. residents aged 50 and above (HRS, 2019). The HRS (Health and Retirement Study) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. Specifically, this study used data from the 2008 to 2018 RAND HRS fat files and the RAND HRS Longitudinal file 2018. The RAND HRS fat files are developed by the RAND Center for the Study of Aging by merging all raw variables from the HRS core datasets into respondent-level datasets for each wave. The RAND HRS Longitudinal File 2018 includes cleaned and imputed data of variables from the original fourteen waves of the HRS core interviews (Bugliari et al., 2021).

Starting from 2006, the HRS study added an additional Leave-behind (LB) Questionnaire on psychosocial topics, including the key variables explored in this study, such as loneliness, social isolation, resilience, and neighborhood characteristics (HRS, 2019). One-half of the HRS respondents were randomly selected for answering the questionnaire in the study wave of 2006, with the other half of the respondents selected for the following study wave of 2008 (HRS, 2019). The study design repeated for each subsequent wave; thus, one-half of the respondents participated in waves 2008, 2012, and 2016, and the other half participated in waves 2010, 2014, and 2018. This study combined two cohorts of respondents to obtain three-wave repeated

observations of the same respondents with an interval of four years. As a result, wave 1 (baseline wave) included data from waves 2008 and 2010, wave 2 included data from waves 2012 and 2014, and wave 3 included data from waves 2016 and 2018. The response rate for the panel respondents in waves 2010 to 2014 ranged from 76.9% to 81.1% (Smith et al., 2017).

Several steps were used to select the study sample. First, the sample was restricted to adults aged 60 and older at the baseline wave (either 2008 or 2010). Second, this study only included individuals who participated in all three waves of study and completed the Leave-behind Questionnaire to acquire full information on the key variables of social isolation, loneliness, social support, resilience, and perceived neighborhood characteristics. Third, only 72 respondents reported being in the racial groups other than Hispanic, non-Hispanic White, or non-Hispanic Black. These racial groups were American Indian, Alaskan Native, Asian, Native Hawaiian, Pacific Islander, and other. These 72 respondents were excluded from the final analysis due to the small sample size. The selection procedure resulted in the final sample of 3,681 respondents, which was comprised of 1,874 respondents who participated in the waves 2008, 2012, and 2016 and 1,807 respondents who participated in the waves 2010, 2014, and 2018.

3.2 Measures

3.2.1 Outcome Variables

This study examined two outcomes regarding psychological well-being -- loneliness and depressive symptoms.

Loneliness was measured by 11 questions derived from the UCLA Loneliness Scale (Russell, 1996; Smith et al., 2017). Respondents were asked to report the frequency of experiencing the following feelings, including “lack of companionship”, “left out”, “isolated from others”, “in tune with the people around you”, “alone”, “there are people you can talk to”, “there are people you can turn to”, “there are people who really understand you”, “there are people you feel close to”, “part of a group of friends”, and “have a lot in common with the people around you”. Response for each question was reported on a 3-point scale (1= often, 2= some of the time, and 3= hardly ever or never). Four negative statements were reversely coded in accordance with other positive statements. For easier explanation, all items were rescaled to start from zero. The total score of this scale ranged from 0 to 22, with a higher score indicating a higher level of loneliness. The Cronbach’s alpha for three waves were 0.87, 0.85, and 0.87, indicating good internal reliability.

Depressive symptoms were measured using a revised eight-item version of the Center for Epidemiological Studies-Depression scale (CES-D), which has been demonstrated in previous studies to be comparable to the original CES-D scale with adequate internal consistency (Turvey, Wallace, & Herzog, 1999; Turvey, Schultz, Beglinger, & Klein, 2009). Respondents were asked whether they had the following symptoms much of the time during the past week: “felt depressed,” “felt that everything you did was an effort,” “sleep was restless,” “were happy,” “felt lonely,” “enjoyed life,” “felt sad,” and “could not get going.” Responses were provided on a dichotomized scale (1= yes, 0= no). All responses to eight items were summed up into one composite score, ranging from 0 to 8, with a higher score indicating increased depressive symptoms. The scale had good internal reliability, as indicated by the Cronbach’s alpha of 0.80, 0.81, 0.80 for three waves, respectively.

3.2.2 Main Predictor

Following previous studies (Steptoe et al., 2013; Shankar, 2017; Peng & Roth, 2021), an index of social isolation was generated using five indicators at baseline: 1) not married or cohabitating with a partner; 2) less than monthly contact with children; 3) less than monthly contact with other family members; 4) less than monthly contact with friends; 5) no participation in any clubs and organizations. The total score of social isolation ranges from 0 to 5, which was calculated by summing up the number of indications of being isolated.

The first indicator of not married or cohabitating with a partner was measured by the self-reported current marital status. Respondents who reported the status of separated, divorced, widowed, or never married were coded as one, and those in married status were coded as zero (1 = not married or cohabitating with a partner, 0 = married). The second to fourth above indicators of the frequency of social contact was measured by four questions asking respondents how often they used each of the following communication methods to contact their social network, including face-to-face meetings, telephone, written/email, and social media. The same set of four questions was used for each of the three types of social network, including children, other family members, and friends. Respondents who reported no children, no other family members, or no friends were recoded as zero representing no social contact. Based on the responses, three dichotomous variables were generated to represent less than monthly contact with children, other family members, and friends via all communication methods (1 = less than monthly contact, 0 = contact that occurs monthly or more frequently). The fifth indicator was measured by the frequency of activities such as “going to a sport, social, or other club”, and “attending meetings of non-religious organizations, such as political, community, or other interest groups”. Respondents who never participated in the above clubs or organizations were coded as one,

indicating no social participation (1 = no social participation, 0 = some levels of social participation).

3.2.3 Moderators and Mediators

The mediators and moderators examined in this study included three psychosocial factors at different levels of the ecological system, which were resilience, social support (positive social support and negative social support), and neighborhood characteristics (neighborhood physical disorder and social cohesion).

Resilience. The HRS does not directly measure resilience using the standardized scale. This study used the simplified resilience score (SRS) designed by Manning et al. (2016) as the measure of resilience. Guided by the Wagnild and Young Resilience Scale (Wagnild & Young, 1993), the SRS was developed to capture the construct of resilience on the basis of 12 questions in the HRS that were most closely related to the Wagnild and Young Resilience Scale (King et al., 2019; Manning et al., 2016). These 12 questions were reported on different scales, with three questions ranging from one to six, and the remaining nine questions ranging from one to seven. To harmonize these differences, each question was recoded by dividing each individual's response by the total number of scale response items for that question (Manning et al., 2016). The total score of SRS ranged from 1.92 to 12, with a higher score indicating a higher level of resilience (Cronbach's alpha = 0.84).

Social support. The scale in the HRS measured positive and negative social support respondents received from spouse, children, family members, and friends. Positive social support was measured by three items: "How much do they really understand the way you feel about things?" "How much can you rely on them if you have a serious problem" and "How much can

you open up to them if you need to talk about your worries?" Negative social support was measured by four items, including "How often do they make too many demands on you?" "How much do they criticize you?" "How much do they let you down when you are counting on them" and "How much do they get on your nerves?". These seven questions were repeated for each type of the social relationship. The responses to all questions were reported on a 4-point scale (from 1 = a lot to 4 = not at all). All the responses were reversely coded and rescaled to start from zero for easier interpretation. The overall positive social support index was created by summing the responses of all three items assessing positive social support across four social relationships. The total score ranged from 0 to 36 (Cronbach's alpha = 0.82), with a higher score indicating greater positive social support. Similarly, the overall negative social support index was generated by summing four items across the social relationships. The total score ranged from 0 to 48 (Cronbach's alpha = 0.85), with a higher score indicating more negative social support. Respondents who had no spouse, children, family members, or friends were recoded as zero representing neither positive social support nor negative social support received from the corresponding social relationship.

Neighborhood physical disorder and social cohesion. Two aspects of the neighborhood were examined in this study, which were physical disorder and social cohesion (Cagney et al., 2009; Smith et al., 2017). In HRS, a neighborhood was identified as the local area "within a 20-minute walk or about a mile of your home" (Smith et al., 2017). Physical disorder was measured by asking respondents to rate the degree of concern about the cleanliness and safety issues in their neighborhood, which were captured by four items including "vandalism and graffiti", "afraid to walk alone after dark", "full of rubbish and litter", and "many vacant or deserted hoses or storefronts". Similarly, social cohesion was measured by asking respondents to rate four

items, which were “I feel that I don’t belong in this area”, “most people can’t be trusted”, “most people are unfriendly”, and “there is nobody who could help you”. All responses were reported on a 7-point Likert scale. The total scores of neighborhood physical disorder and social cohesion were calculated separately, which ranged from 0 to 24 (Cronbach’s alpha = 0.82 and 0.85), with higher scores representing a higher level of physical disorder or a higher level of social cohesion.

3.2.4 Covariates

Covariates examined in the study were sociodemographic and health status variables that have been demonstrated in previous studies as predictors of loneliness and depressive symptoms (Cohen-Mansfield et al., 2016; Cornwell & Waite, 2009b; Taylor, 2020). The inclusion of the covariates in the model can improve the precision of coefficient estimation.

Sociodemographic variables at the baseline wave were included in the model as the covariates. Age was self-reported by the respondents and coded as a continuous variable. Gender was a binary variable (female/male) with male set to be the reference group. Self-reported race and ethnicity were categorized into Hispanic, non-Hispanic White, and non-Hispanic Black, with non-Hispanic White being the reference group. Years of education was treated as a continuous variable ranging from zero to 17. Since the variable of total household income was highly skewed (skewness = 6.71), it was log-transformed (skewness = -0.08) before adding to the final models.

Self-rated health and functional limitations were included in the model as covariates. Self-rated health was the general health status that respondents rated on a 5-point scale (from 1= excellent to 5= poor). It was reversely coded and rescaled to start from 0 to 4, with a higher score indicating better health status. Functional limitation was measured by asking respondents

whether they had difficulty in performing the following 12 types of activities: walking several blocks, jogging one mile, walking one block, sitting for two hours, getting up from a chair, climbing stairs, climbing one flight of stairs, stooping, reaching arms, pulling/pushing large objects, lifting weights, and picking up a dime. The sum score was calculated by counting the number of reported difficulties.

3.3 Statistical Analyses

This study started with the descriptive analyses used to present the characteristics of the study sample.

To test the proposed hypotheses, this study used structural equation modeling (SEM) to perform latent growth curve models (LGCM) with mediation and moderation analyses. The LGCMs were estimated using the method of maximum likelihood with robust standard errors (MLR) to account for any nonnormality in the sample. Since the LGCMs with quadratic slopes cannot be estimated with only three timepoints, the models estimated in this study only assessed a linear slope. The factor loadings for intercept were constrained to be equal to one, and the factor loadings for slope were constrained to be zero for the baseline wave, one for the second wave, and two for the third wave.

Data analysis followed the following procedures. To examine the growth trajectories of loneliness and depressive symptoms in the study sample, the first step was to perform two unconditional LGCMs for loneliness and depressive symptoms separately to estimate the latent growth factors of intercepts and slopes. Second, to explore the impact of social isolation on the growth trajectories of loneliness and depressive symptoms (Research question 1), two

conditional LGCMs with different outcomes were estimated with covariates added to the models. Third, to investigate the mediating effect of positive social support and negative social support (Research questions 2), the mediators were added to the LGCMs, respectively, with outcomes of loneliness and depressive symptoms. The mediation analyses were estimated using the method of bootstrapping with 5,000 replications. The significance of mediating effect was determined by the p-value and bias-corrected 95% confidence intervals. Fourth, to examine the moderating effect of resilience, neighborhood physical disorder, and social cohesion (Research question 3), the interaction terms of social isolation with these three variables were added to the LGCMs, respectively.

The model fit was assessed by commonly used goodness of fit indices, including maximum likelihood ratio chi-square statistics (χ^2), the root mean square error of approximation (RMSEA), the Tucker-Lewis Index (TLI), the comparative fit index (CFI), and the standardized root mean square residual (SRMR). The likelihood ratio chi-square indicates the degree of difference between true and estimated models, and the insignificant chi-square indicates that the model is consistent with the data. The values of CFI and TLI larger than 0.90 indicate an acceptable fit and 0.95 indicate the excellent fit (Kline, 2015). The models with RMSEA values smaller than 0.05 are considered to have a good fit and values smaller than 0.08 to have an acceptable fit (Hu & Bentler, 1999). The value of SRMR less than 0.08 indicates a good model fit (Hu & Bentler, 1999). Data preparation (data cleaning and variable construction) was performed using the Stata 17 and data analyses of LCGMs were conducted using Mplus version 8.8.

4.0 Results

4.1 Descriptive Statistics

The descriptive statistics of sample characteristics at the baseline wave and outcome variables of loneliness and depressive symptoms across three waves are presented in Table 1. Among the final sample of 3,681 respondents, the average age was 70.23 years (*SD* = 6.14, range = 60 - 93) at the baseline wave and 60.96% were female. The majority of the respondents were non-Hispanic white (83.08%), followed by non-Hispanic African American (11.00%), and Hispanic (5.92%). The respondents on average received 13 years of education (*SD* = 2.71, range = 0 - 17). The mean scores of self-rated health and functional limitation were 2.44 (*SD* = 0.96, range = 0 - 4) and 2.83 (*SD* = 2.66, range = 0 - 12), respectively.

Loneliness reported by the respondents increased slightly across waves. On a scale from 0 to 22, the reported mean scores of loneliness were 4.83 (*SD* = 4.45), 4.94 (*SD* = 4.34), and 5.34 (*SD* = 4.54). The reported depressive symptoms were stable across waves, with a slight increase: the mean depressive symptoms were 1.02 (*SD* = 1.65, range = 0 - 8) at wave 1, 1.02 (*SD* =1.62, range = 0 - 8) at wave 2, and 1.10 (*SD* = 1.66, range = 0 - 8) at wave 3. Respondents had a high level of resilience at the baseline wave (*M* = 9.67, *SD* = 1.65, range = 2.10 - 12). On average, respondents reported a high level of positive social support (*M* = 22.74, *SD* = 6.71, range = 0 - 36) and a low level of negative social support (*M* = 8.10, *SD* = 6.05, range = 0 - 37) from their social network at the baseline wave. Overall, respondents lived in neighborhoods with good conditions. On the scales from 0 to 24, the reported social cohesion was 18.54 (*SD* = 5.22) and physical disorder was 5.38 (*SD* = 5.23).

Table 1 Sample Characteristics (N = 3,681)

Variables	**Mean (%)**	**SD**	**Min**	**Max**
Social isolation	0.96	0.94	0	5
Loneliness				
Wave 1	4.83	4.45	0	22
Wave 2	4.94	4.34	0	22
Wave 3	5.34	4.54	0	22
Depressive symptoms				
Wave 1	1.02	1.65	0	8
Wave 2	1.02	1.62	0	8
Wave 3	1.10	1.66	0	8
Resilience	9.67	1.65	2.10	12
Positive social support	22.74	6.71	0	36
Negative social support	8.10	6.05	0	37
Physical disorder	5.38	5.23	0	24
Social cohesion	18.54	5.22	0	24
Female	60.96			
Age	70.23	6.14	60	93
Education	13.16	2.71	0	17
Self-rated health	2.44	0.96	0	4
Physical limitation	2.83	2.66	0	12
Race				
Hispanic	5.92			
Non-Hispanic white	83.08			
Non-Hispanic black	11.00			
Income	10.72	0.87	5.70	14.39

4.2 Unconditional Latent Growth Curve Models of Loneliness and Depressive Symptoms

To examine the growth trajectories of loneliness and depressive symptoms among older adults in the sample, two unconditional LGCMs were estimated using the method of maximum likelihood with robust standard errors (MLR) (shown in Figures 3 and 4). Both models fit the data well (Loneliness: $\chi^2(1) = 6.02$, TLI = 0.994, CFI = 0.998, RMSEA = 0.037, SRMR = 0.008; Depressive symptoms: $\chi^2(1) = 3.57$, TLI = 0.993, CFI = 0.998, RMSEA = 0.026, SRMR = 0.007).

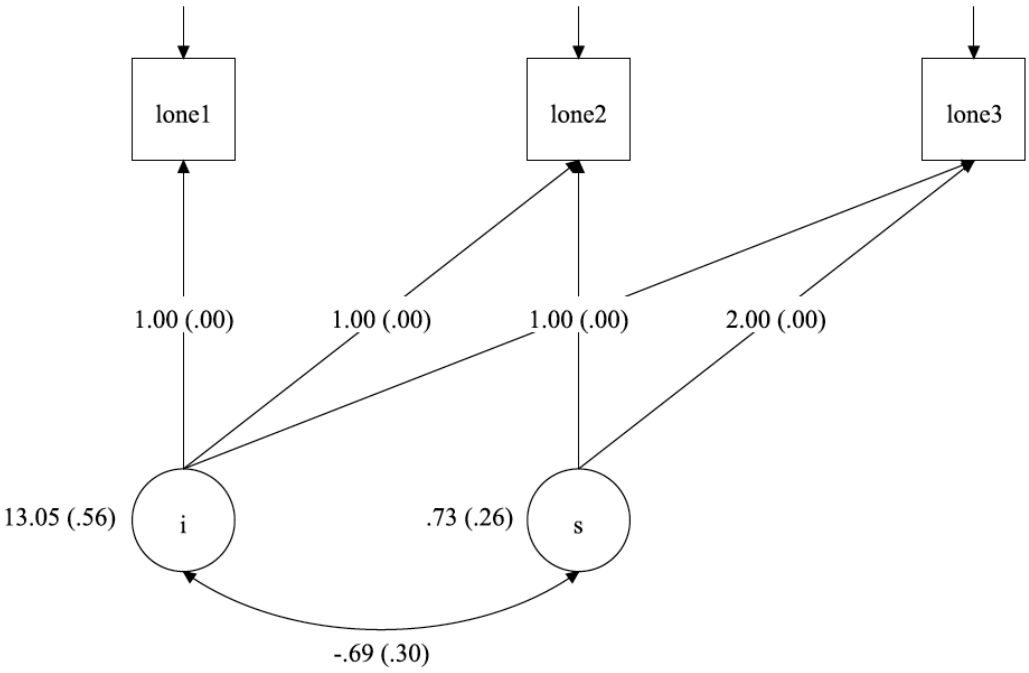
The results indicated that the initial level of loneliness was significant ($M_i = 4.78$, $SE = .07$, $p < .001$), and loneliness significantly increased by each wave ($M_s = .25$, $SE = .03$, $p < .001$). The statistically significant variances of the intercept ($D_i = 13.05$, $SE = .56$, $p < .001$) and slope ($D_s = .73$, $SE = .26$, $p < .01$) suggested substantial variations in the initial level and change rate of loneliness across individuals. The negative correlation between the intercept and slope indicated that respondents with a lower level of loneliness at the baseline wave were more likely to have a faster increase in loneliness in the following waves ($r = -0.69$, $p < .05$).

Similar pattern of the change trajectory was identified for depressive symptoms. The results indicated that the initial level of depressive symptoms was significant ($M_i = 1.00$, $SE = .06$, $p < .001$), and it significantly increased by each wave ($M_s = .04$, $SE = .01$, $p < .01$). There were significant variations in the intercept ($D_i = 1.46$, $SE = .12$, $p < .001$) and slope ($D_s = .16$, $SE = .05$, $p < .01$) of depressive symptoms across individuals. The intercept and slope of depressive symptoms was not significantly correlated.

Table 2 Unconditional Latent Growth Curve Model of Social Isolation, Loneliness, and Depressive Symptoms

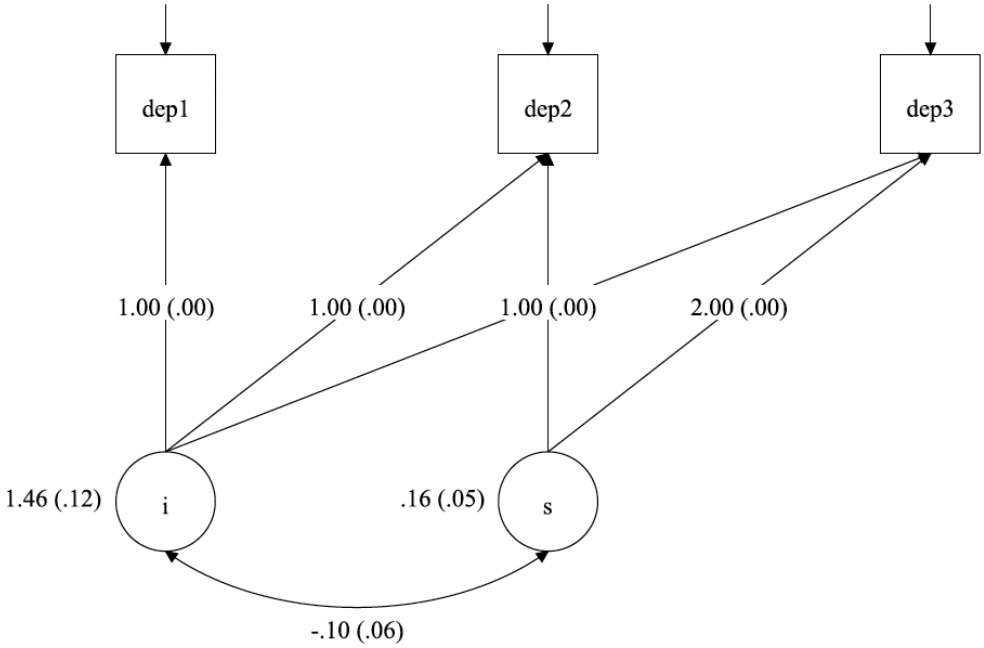
	Model 1: Loneliness	**Model 2: Depressive Symptoms**
Mean of intercept	4.78 (0.07) ***	1.00 (0.03) ***
Mean of slope	0.25 (0.03) ***	0.04 (0.01) **
Variance of intercept	13.05 (0.56) ***	1.46 (0.12) ***
Variance of slope	0.73 (0.26) **	0.16 (0.05) **
Correlation between intercept and slope	-0.69 (0.28) *	-0.11 (0.06)
Model Fit Statistics		
χ^2 (df)	6.02 (1) *	3.57 (1)
TLI	0.994	0.993
CFI	0.998	0.998
RMSEA	0.037	0.026
SRMR	0.008	0.007

Note. *p <.05; **p < .01; ***p < .001.



Note. Lone represents loneliness. Only significant results are shown in the figure. Reported statistics are mean (SE) for intercept (i) and slope (s), correlation (SE) between intercept and slope, and factor loading (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave.

Figure 3 The Unconditional Latent Growth Curve Model of Social Isolation and Loneliness



Note. Dep represents depressive symptoms. Only significant results are shown in the figure. Reported statistics are mean (SE) for intercept (i) and slope (s), correlation (SE) between intercept and slope, and factor loading (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave.

Figure 4 The Unconditional Latent Growth Curve Model of Social Isolation and Depressive Symptoms

4.3 The Relationship between Social Isolation, Loneliness, and Depressive Symptoms

To answer the first research question on the long-term impact of social isolation on loneliness and depressive symptoms, two conditional LGCMs were estimated (Model 3 and 4), after controlling for the covariates of age, gender, race, education, income, health status, and physical limitation. Each model had two paths simultaneously estimating the relationship between social isolation and the latent factors (intercept and slope) of loneliness (Ilone and Slone) or depressive symptoms (Idep and Sdep). To be specific, the first path was to estimate the effects of social isolation on Ilone. The second path was included to estimate the effects of social isolation on Slone. The same model was then performed on the outcome of depressive symptoms. The fit statistics indicated that both models had acceptable model fit (Model 3: $\chi^2(10) = 23.15$, TLI = 0.991, CFI = 0.997, RMSEA = 0.019, SRMR = 0.008; Model 4: $\chi^2(10) = 7.71$, TLI = 1.000, CFI = 1.000, RMSEA = 0.000, SRMR = 0.005).

Model 3 examined the relationship between baseline social isolation and the growth trajectory of loneliness (Ilone and Slone). As shown in Table 3, the results showed that after controlling for the covariates, social isolation was positively associated with Ilone ($B = 1.08$, $SE = 0.08$, $p < .001$) but negatively associated with Slone ($B = -0.12$, $SE = 0.04$, $p < .01$), indicating that social isolation was associated with more loneliness at the baseline wave but a slower increasing rate of loneliness across waves.

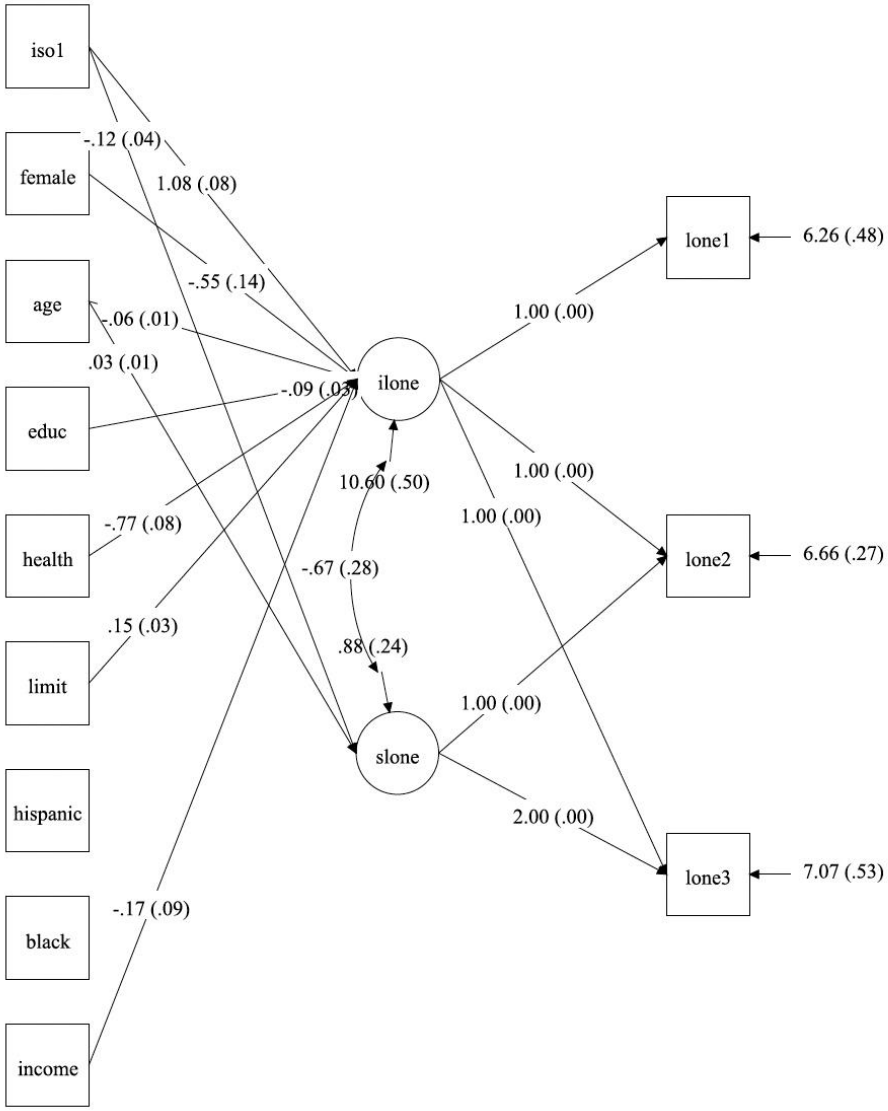
Model 4 examined the relationship between the growth trajectory of depressive symptoms (Idep and Sdep). The results of Model 4 indicated that after controlling for the covariates, social isolation was positively associated with Idep ($B = 0.14$, $SE = 0.03$, $p < .001$), indicating respondents with a higher level of social isolation reported more depressive symptoms at the baseline wave. There was no significant relationship between social isolation and Sdep.

The results of Model 3 examining the relationship between social isolation and loneliness showed that being male, younger age, having fewer years of education, having worse health status, having more physical limitations, having lower income were significantly associated with a higher level of loneliness at the baseline wave. In addition, older age was associated with faster increasing rate of loneliness. The results of Model 4 examining the relationship between social isolation and depressive symptoms showed that being female, younger age, worse health status, more physical limitations, being Hispanic, and lower income were significantly associated with more depressive symptoms at the baseline wave. In addition, older age was significantly associated with a faster increasing rate of depressive symptoms over time.

Table 3 Conditional Latent Growth Curve Models with Covariates

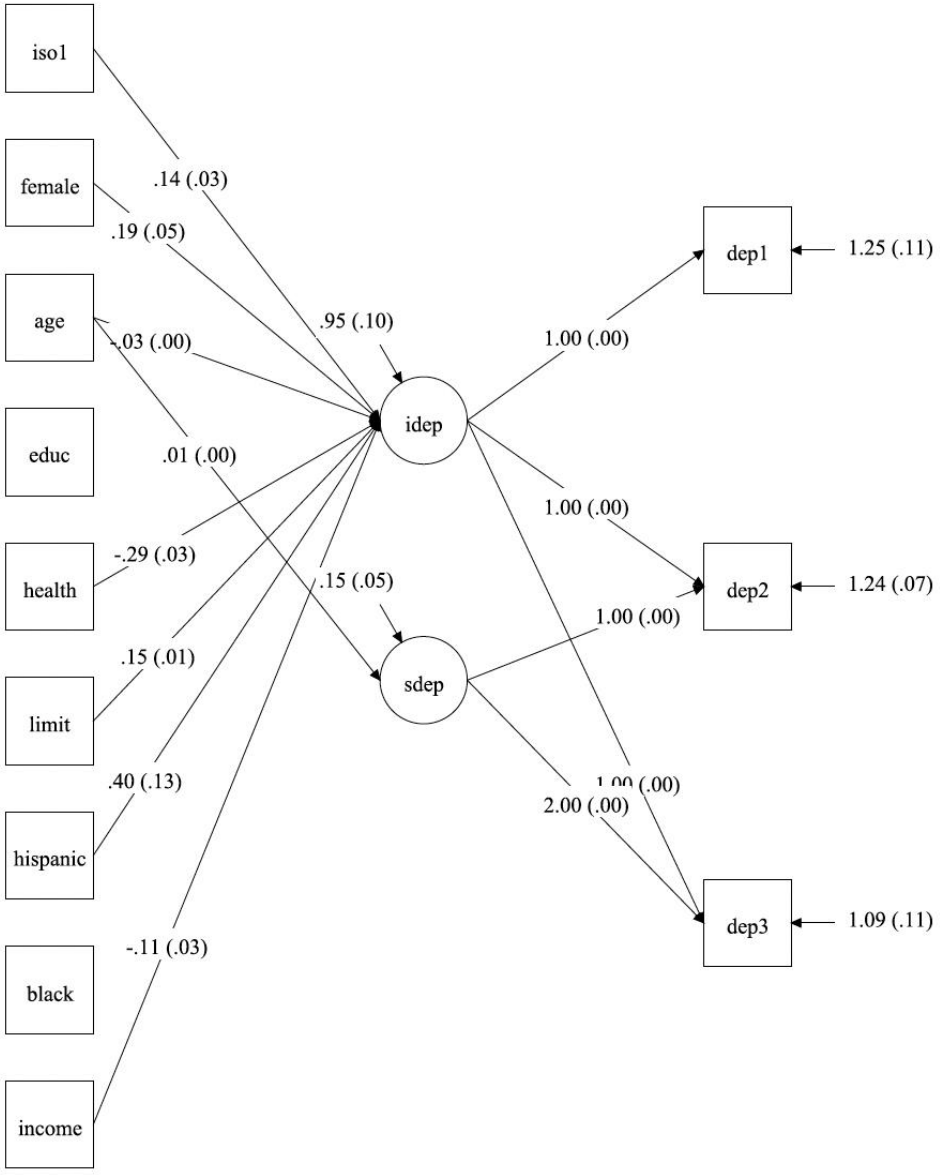
	Model 3		**Model 4**	
	Loneliness intercept (Ilone)	Loneliness slope (Slone)	Depressive symptoms intercept (Idep)	Depressive symptoms slope (Sdep)
Social isolation	1.08 (0.08) ***	-0.12 (0.04) **	0.14 (0.03) ***	-0.01 (0.02)
Female	-0.55 (0.14) ***	0.05 (0.07)	0.19 (0.05) ***	0.02 (0.03)
Age	-0.06 (0.01) ***	0.03 (0.01) ***	-0.03 (0.004) ***	0.01 (0.002) **
Education	-0.09 (0.03) **	0.03 (0.02)	-0.02 (0.01)	-0.002 (0.01)
Self-rated health	-0.77 (0.08) ***	-0.001 (0.04)	-0.29 (0.03) ***	-0.007 (0.02)
Physical limitation	0.15 (0.03) ***	0.01 (0.02)	0.15 (0.01) ***	-0.01 (0.01)
Race (ref: non-Hispanic white)				
Hispanic	0.11 (0.31)	-0.01 (0.18)	0.40 (0.13) **	-0.09 (0.07)
Non-Hispanic black	-0.19 (0.22)	-0.01 (0.11)	-0.04 (0.08)	0.08 (0.05)
Income	-0.17 (0.09) *	0.06 (0.05)	-0.11 (0.03) ***	0.01 (0.02)
Model Fit Statistics				
χ^2 (df)	23.15 (10) *		7.71 (10)	
TLI	0.991		1.000	
CFI	0.997		1.000	
RMSEA	0.019		0.000	
SRMR	0.008		0.005	

Note. *p <.05; **p < .01; ***p < .001.



Note. iso1 represents baseline social isolation, ilone represents loneliness intercept, slone represents loneliness slope. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE), correlation (SE) between intercept and slope, and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave.

Figure 5 The Conditional Latent Growth Curve Model of Social Isolation and Loneliness



Note. iso1 represents baseline social isolation, idep represents depressive symptoms intercept, sdep represents depressive symptoms slope. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE) and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave.

Figure 6 The Conditional Latent Growth Curve Model of Social Isolation and Depressive Symptoms

4.4 The Mediation Effects of Social Support

To answer the second research question, LGCMs with mediation analysis were performed to examine the mediating effects of positive social support and negative social support on the relationships of social isolation with loneliness and depressive symptoms, respectively. Tables 4 to 7 present the direct and indirect effects of positive social support and negative social support on the relationships, after controlling for covariates. The bias-corrected 95% confidence interval produced by bootstrapping was also reported in the tables.

4.4.1 The Mediation Effects of Positive Social Support

Model 5 simultaneously estimated the mediating effect of positive social support on both paths of the relationship between social isolation and loneliness in a single model: social isolation to Ilone and social isolation to Slone. Model 5 had an acceptable model fit: $\chi^2(11) = 34.79$, TLI = 0.987, CFI = 0.997, RMSEA = 0.025, SRMR = 0.009.

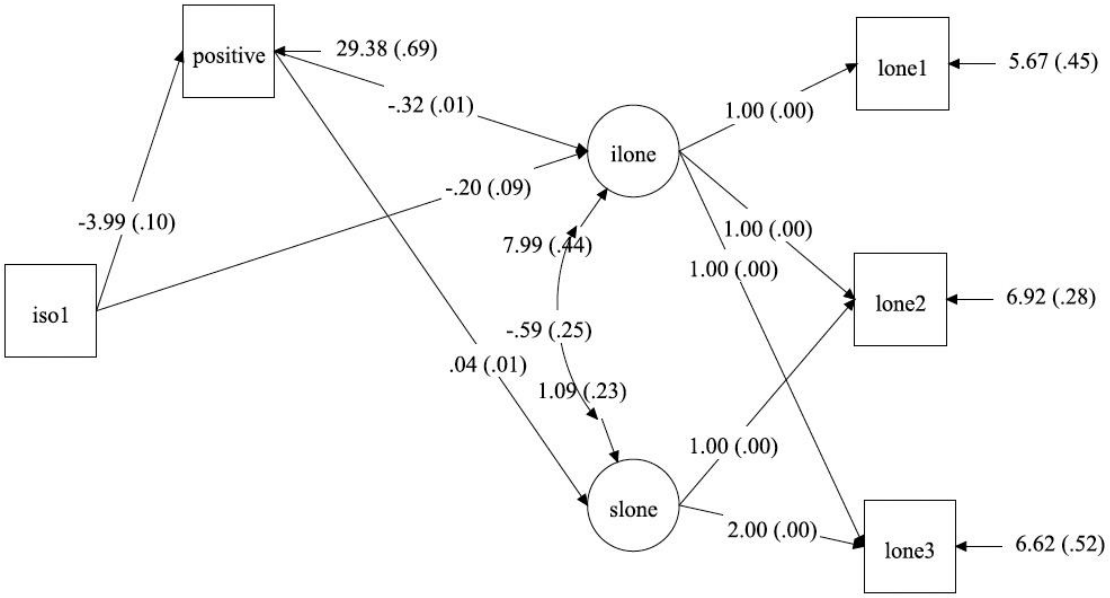
As shown in Table 4, social isolation was associated with a lower level of positive social support ($B = -3.99$, $SE = 0.10$, $p < .001$); a lower level of positive social support was in turn associated with more Ilone ($B = -0.32$, $SE = 0.01$, $p < .001$) and smaller Slone ($B = 0.04$, $SE = 0.01$, $p < .001$). The results indicated that positive social support had a significant indirect effect on the relationship between social isolation and Ilone ($B = 1.28$, $SE = 0.06$, $p < .001$), as it partially mediated the relationship. Additionally, after adding the mediator of positive social support to the model, the direct effect of social isolation on Slone was no longer significant, but the indirect effect of positive social support was significant ($B = -0.16$, $SE = 0.03$, $p < .001$). The

results indicated that positive social support completely mediated the relationship between social isolation and the slope of loneliness.

Table 4 The Mediation Effects of Positive Social Support on the Relationship between Social Isolation and Loneliness

Model 5	*B* (*SE*)	*Bias-corrected 95% CI*
Social isolation → positive social support	-3.99 (0.10) ***	
Positive social support → loneliness intercept	-0.32 (0.01) ***	
Positive social support → loneliness slope	0.04 (0.01) ***	
Direct Effects		
Social isolation → loneliness intercept	-0.20 (0.09) *	-0.34 – -0.05
Social isolation → loneliness slope	0.04 (0.05)	-0.05 – 0.12
Indirect Effects		
Social isolation → positive social support → loneliness intercept	1.28 (0.06) ***	1.19 – 1.37
Social isolation → positive social support → loneliness slope	-0.16 (0.03) ***	-0.20 – -0.12
Total Effects		
Social isolation → loneliness intercept	1.08 (0.08) ***	0.96 – 1.22
Social isolation → loneliness slope	-0.12 (0.04) **	-0.19 – -0.05
Model Fit Statistics		
χ^2 (df)	35.79 (11) ***	
TLI	0.987	
CFI	0.997	
RMSEA	0.025	
SRMR	0.009	

Note. *p <.05; **p < .01; ***p < .001.



Note. iso1 represents baseline social isolation, ilone represents loneliness intercept, slone represents loneliness slope, positive represents positive social support. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE), correlation (SE) between intercept and slope, and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave. Covariates are included in the model, but the results are not shown in this figure.

Figure 7 The Mediating Effect of Positive Social Support on the Relationship between Social Isolation and Loneliness

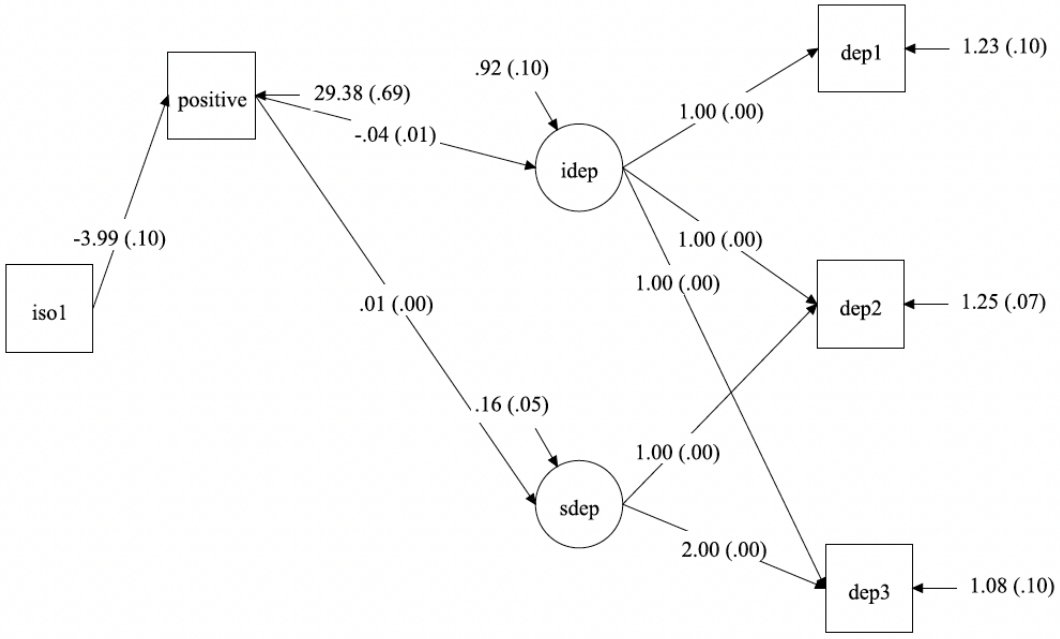
Model 6 simultaneously estimated the mediating effect of positive social support on the relationship between social isolation and depressive symptoms in a single model. To be specific, the model estimated the indirect effects of positive social support on two paths: social isolation to Idpe and social isolation to Sdep. Model 6 exhibited an acceptable model fit to the data: $\chi^2(11) = 13.32$, TLI = 0.998, CFI = 1.000, RMSEA = 0.008, SRMR = 0.006.

As shown in Table 5, social isolation was associated with a lower level of positive social support ($B = -3.99$, $SE = 0.10$, $p < .001$), and a lower level of positive social support was in turn associated with more Idep ($B = -0.04$, $SE = 0.01$, $p < .001$) and smaller Sdep ($B = 0.01$, $SE = 0.003$, $p < .01$). After adding the mediator of positive social support, the direct effect of social isolation on Idep and the direct effect of social isolation on Sdep were not significant, suggesting that positive social support completely mediated the relationships ($B = 0.15$, $SE = 0.02$, $p < .001$; $B = -0.03$, $SE = 0.01$, $p < .01$).

Table 5 The Mediation Effects of Positive Social Support on the Relationship between Social Isolation and Depressive Symptoms

Model 6	*B* (*SE*)	*Bias-corrected 95% CI*
Social isolation → positive social support	-3.99 (0.10) ***	
Positive social support → depressive symptoms intercept	-0.04 (0.01) ***	
Positive social support → depressive symptoms slope	0.01 (0.003) **	
Direct Effects		
Social isolation → depressive symptoms intercept	-0.01 (0.03)	-0.07 – 0.04
Social isolation → depressive symptoms slope	0.02 (0.02)	-0.01 – 0.05
Indirect Effects		
Social isolation → positive social support → depressive symptoms intercept	0.15 (0.02) ***	0.12 – 0.18
Social isolation → positive social support → depressive symptoms slope	-0.03 (0.01) **	-0.05 – -0.01
Total Effects		
Social isolation → depressive symptoms intercept	0.14 (0.03) ***	0.09 – 0.19
Social isolation → depressive symptoms slope	-0.01 (0.02)	-0.04 – 0.02
Model Fit Statistics		
χ^2 (df)	13.32 (11)	
TLI	0.998	
CFI	1.000	
RMSEA	0.008	
SRMR	0.006	

Note. *p <.05; **p < .01; ***p < .001.



Note. iso1 represents baseline social isolation, idep represents depressive symptoms intercept, sdep represents depressive symptoms slope, positive represents positive social support. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE) and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave. Covariates are included in the model, but the results are not shown in this figure.

Figure 8 The Mediating Effect of Positive Social Support on the Relationship between Social Isolation and Depressive Symptoms

4.4.2 The Mediation Effects of Negative Social Support

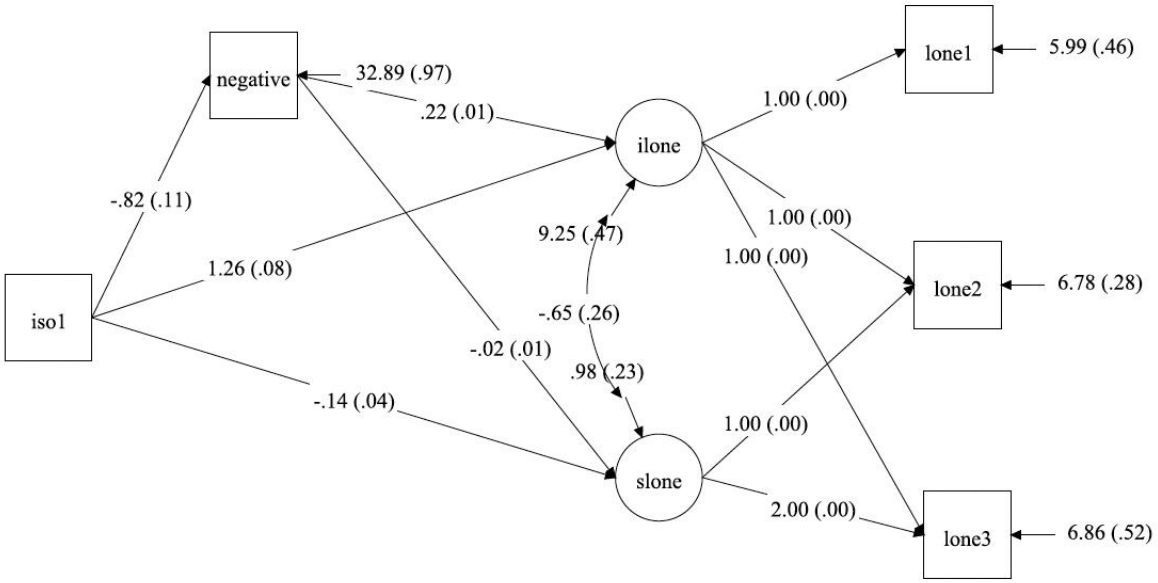
Model 7 simultaneously estimated the indirect effect of negative social support on two paths of the relationship between social isolation and loneliness in a single model: social isolation to Ilone and social isolation to Slone. This model had an acceptable model fit to the data: $\chi^2(11) = 29.38$, TLI = 0.987, CFI = 0.997, RMSEA = 0.021, SRMR = 0.008.

As shown in Table 6, the higher level of social isolation was associated with a lower level of negative social support (B = -0.82, SE = 0.11, $p < .001$), and a lower level of negative social support was in turn associated with a lower level of Ilone (B = 0.22, SE = 0.01, $p < .001$) but greater Slone (B = -0.02, SE = 0.01, $p < .001$). Negative social support partially mediated the relationship between social isolation and Ilone (B = -0.18, SE = 0.03, $p < .001$) and the relationship between social isolation and Slone (B = 0.02, SE = 0.01, $p < .01$). The indirect effects and the direct effects were significant but in opposite direction, indicating the competitive mediation (also referred to inconsistent mediation in some literature), where negative social support act as a suppressor on the relationship between Isi and Ilone and the relationship between Isi and Slone (Hair et al., 2021; MacKinnon et al., 2000; Zhao et al., 2010).

Table 6 The Mediation Effects of Negative Social Support on the Relationship between Social Isolation and Loneliness

Model 7	*B* (*SE*)	*Bias-corrected 95% CI*
Social isolation → negative social support	-0.82 (0.11) ***	
Negative social support → loneliness intercept	0.22 (0.01) ***	
Negative social support → loneliness slope	-0.02 (0.01) ***	
Direct Effects		
Social isolation → loneliness intercept	1.26 (0.08) ***	1.14 – 1.39
Social isolation → loneliness slope	-0.14 (0.04) **	-0.21 – -0.07
Indirect Effects		
Social isolation → negative social support → loneliness intercept	-0.18 (0.03) ***	-0.22 – -0.14
Social isolation → negative social support → loneliness slope	0.02 (0.01) **	0.01 – 0.03
Total Effects		
Social isolation → loneliness intercept	1.08 (0.08) ***	0.96 – 1.22
Social isolation → loneliness slope	-0.12 (0.04) **	-0.19 – -0.05
Model Fit Statistics		
χ^2 (df)	29.38 (11) **	
TLI	0.987	
CFI	0.997	
RMSEA	0.021	
SRMR	0.008	

Note. *p <.05; **p < .01; ***p < .001.



Note. iso1 represents baseline social isolation, ilone represents loneliness intercept, slone represents loneliness slope, negative represents negative social support. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE), correlation (SE) between intercept and slope, and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave. Covariates are included in the model, but the results are not shown in this figure.

Figure 9 The Mediating Effect of Negative Social Support on the Relationship between Social Isolation and Loneliness

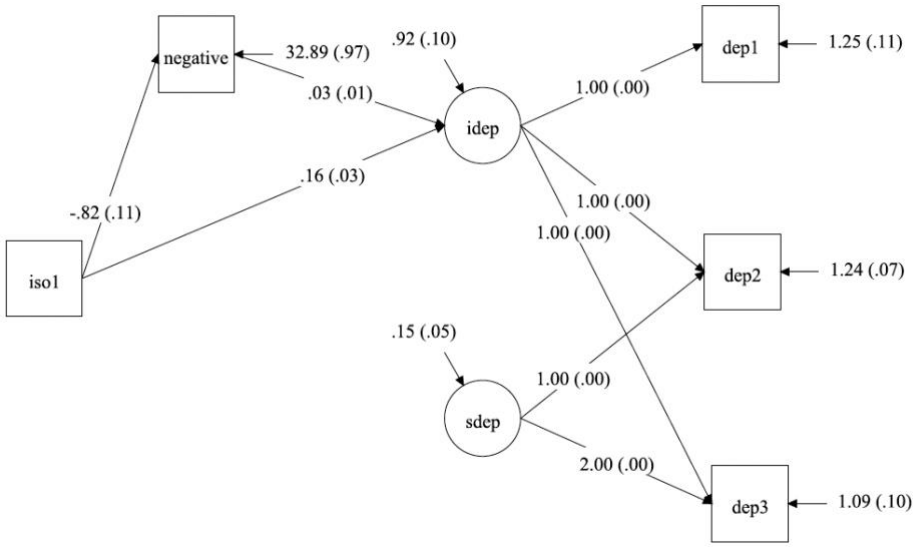
Model 8 simultaneously estimated the mediating effect of negative social support on the relationship between social isolation and depressive symptoms in a single model. To be specific, the model estimated the indirect effects of positive social support on two paths: social isolation to Idpe and social isolation to Sdep. The model exhibited an acceptable model fit to the data: $\chi^2(11) = 9.28$, TLI = 1.000, CFI = 1.000, RMSEA = 0.000, SRMR = 0.004.

As shown in Table 7, the results indicated that a higher level of social isolation was associated with a lower level of negative social support (B = -0.82, SE = 0.11, $p < .001$), and a lower level of negative social support was in turn associated with a lower level of Idep (B = 0.03, SE = 0.01, $p < .001$). Negative social support partially mediated the relationship between social isolation and Idep (B = -0.02, SE = 0.01, $p < .001$), and it had a suppressing effect on the relationship, as indicated by the opposite directions of the indirect effects and the direct effects (Hair et al., 2021; MacKinnon et al., 2000; Zhao et al., 2010). Negative social support did not mediate the relationship between social isolation and the slope of depressive symptoms.

Table 7 The Mediation Effects of Negative Social Support on the Relationship between Social Isolation and Depressive Symptoms

Model 8	*B* (*SE*)	*Bias-corrected 95% CI*
Social isolation → negative social support	-0.82 (0.11) ***	
Negative social support → depressive symptoms intercept	0.03 (0.01) ***	
Negative social support → depressive symptoms slope	0.001 (0.003)	
Direct Effects		
Social isolation → depressive symptoms intercept	0.16 (0.03) ***	0.12 – 0.21
Social isolation → depressive symptoms slope	-0.01 (0.02)	-0.04 – 0.02
Indirect Effects		
Social isolation → negative social support → depressive symptoms intercept	-0.02 (0.01) ***	-0.03 – -0.02
Social isolation → negative social support → depressive symptoms slope	-0.001 (0.002)	-0.004 – 0.003
Total Effects		
Social isolation → depressive symptoms intercept	0.14 (0.03) ***	0.09 – 0.19
Social isolation → depressive symptoms slope	-0.01 (0.02)	-0.04 – 0.02
Model Fit Statistics		
χ^2 (df)	9.28 (11)	
TLI	1.000	
CFI	1.000	
RMSEA	0.000	
SRMR	0.004	

Note. *p <.05; **p < .01; ***p < .001.



Note. iso1 represents baseline social isolation, idep represents depressive symptoms intercept, sdep represents depressive symptoms slope, negative represents negative social support. Only significant results are shown in the figure. Reported statistics are estimated path coefficients B (SE) and factor loadings (SE). The factor loadings for intercept are constrained to be one across three waves, and the factor loadings for slope are constrained to be zero for the baseline wave (not shown in figure), one for the second wave, and two for the third wave. Covariates are included in the model, but the results are not shown in this figure.

Figure 10 The Mediating Effect of Negative Social Support on the Relationship between Social Isolation and Depressive Symptoms

4.5 The Moderation Effects of Resilience, Neighborhood Physical Disorder, and Social Cohesion

To answer the third research question regarding the moderating effects of resilience, neighborhood physical disorder, and social cohesion on the relationships of social isolation with loneliness and depressive symptoms, the interaction terms of 1) resilience with social isolation, 2) physical disorder with social isolation and 3) social cohesion with social isolation were added into the LCGM models with covariates, respectively. To be specific, the moderating effects were examined on four relationships:1) the relationship between social isolation and Ilone, 2) the relationship between the social isolation and Slone, 3) the relationship between social isolation and Idep, and 4) the relationship between social isolation and Sdep.

4.5.1 The Moderation Effects of Resilience

Model 9 and Model 10 examined the moderating effect of resilience on the relationship between social isolation and loneliness. As shown in Table 8, the results of indicated that after controlling for the covariates, resilience was negatively associated with Ilone (B = -1.15, SE = 0.05, $p < .001$) and Slone (B = -0.22, SE = 0.03, $p < .001$). Respondents who reported higher levels of resilience were more likely to have less loneliness at the baseline wave and a slower increasing rate of loneliness across waves. The results also showed that resilience was not a significant moderator on the relationship between social isolation and loneliness.

Table 8 The Moderation Effect of Resilience on the Relationship between Social Isolation and Loneliness

	Model 9		Model 10	
	Loneliness intercept	Loneliness slope	Loneliness intercept	Loneliness slope
Social isolation	1.06 (0.30) ***	-0.12 (0.04) **	1.08 (0.08) ***	-0.39 (0.20) *
Resilience	-1.15 (0.05) ***	-	-	-0.22 (0.03) ***
Social isolation X Resilience	-0.03 (0.03)	-	-	0.03 (0.02)

Note. *p <.05; **p < .01; ***p < .001.

Model 11 and Model 12 examined the moderating effect of resilience on the relationship between social isolation and depressive symptoms. As shown in Table 9, resilience was negatively associated Idep (B = -0.21, SE = 0.02, p < .001) and Sdep (B = -0.07, SE = 0.01, p < .001). There was a significant moderating effect of resilience on the relationship between social isolation and Idpe (B = -0.03, SE = 0.02, p < .05), that is, the positive relationship between social isolation and the initial level of depressive symptoms was stronger among respondents with a low level of resilience. As shown in Figure 5, compared to respondents who reported higher levels of resilience, those with lower levels of resilience had more depressive symptoms as they were more socially isolated.

Table 9 The Moderation Effect of Resilience on the Relationship between Social Isolation and Depressive Symptoms

	Model 11		Model 12	
	Depressive symptoms intercept	Depressive symptoms slope	Depressive symptoms intercept	Depressive symptoms slope
Social isolation	0.40 (0.15) **	-0.01 (0.02)	0.14 (0.03) ***	0.06 (0.08)
Resilience	-0.21 (0.02) ***	-		-0.07 (0.01) ***
Social isolation X Resilience	-0.03 (0.02) *	-		-0.01 (0.01)

Note. *p <.05; **p < .01; ***p < .001.

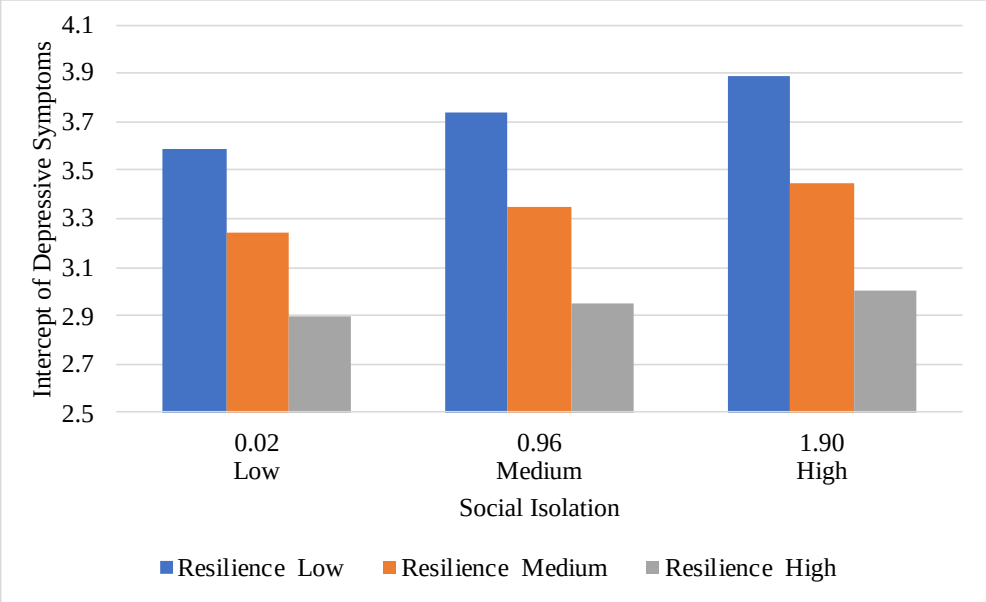


Figure 11 The Moderation Effect of Resilience on the Relationship between Social Isolation and Depressive Symptoms Intercept

4.5.2 The Moderation Effects of Neighborhood Physical Disorder

To examine the moderating effect of neighborhood physical disorder on the relationships of social isolation with loneliness and depressive symptoms, its interaction terms with social isolation were added into Model 13 to 16. As shown in Table 10 and 11, respondents who lived in neighborhoods with more physical disorders were more likely to report a higher level of Ilone (B = 0.06, SE = 0.02, p < .001). Physical disorder was not significantly associated with Slone or Sdep. The moderating effects of physical disorder on the relationships of social isolation with loneliness and depressive symptoms were not significant.

Table 10 The Moderation Effect of Physical Disorder on the Relationship between Social Isolation and Loneliness

	Model 13		Model 14	
	Loneliness intercept	Loneliness slope	Loneliness intercept	Loneliness slope
Social isolation	0.98 (0.10) ***	-0.12 (0.04) **	1.08 (0.08) ***	-0.11 (0.05) *
Physical disorder	0.06 (0.02) ***	-	-	0.02 (0.01)
Social isolation X Physical disorder	0.01 (0.01)	-	-	-0.002 (0.01)

Note. *p <.05; **p < .01; ***p < .001.

Table 11 The Moderation Effect of Physical Disorder on the Relationship between Social Isolation and Depressive Symptoms

	Model 15		Model 16	
	Depressive symptoms intercept	Depressive symptoms slope	Depressive symptoms intercept	Depressive symptoms slope
Social isolation	0.09 (0.04) *	-0.01 (0.02)	0.14 (0.03) ***	-0.02 (0.02)
Physical disorder	0.00 (0.01)	-		0.00 (0.00)
Social isolation intercept X Physical disorder	0.01 (0.01)	-		0.00 (0.00)

Note. *p <.05; **p < .01; ***p < .001.

4.5.3 The Moderation Effects of Social Cohesion

To examine the moderating effect of social cohesion, the interaction terms of social cohesion with social isolation were added into Model 17 to 20. As shown in Table 12 and 13, social cohesion was negatively associated with Ilone (B = -0.16, SE = 0.02, p < .001), Slone (B = -0.03, SE = 0.01, p < .01), and Idep (B = -0.01, SE = 0.01, p < .05). In other words, respondents who reported higher levels of social cohesion were more likely to have less loneliness and fewer

depressive symptoms at the baseline wave, and a slower increasing rate of loneliness across waves. However, the results indicated that the relationships of social isolation with loneliness and depressive symptoms were not significantly moderated by social cohesion.

Table 12 The Moderation Effect of Social Cohesion on the Relationship between Social Isolation and Loneliness

	Model 17		Model 18	
	Loneliness intercept	Loneliness slope	Loneliness intercept	Loneliness slope
Social isolation	1.09 (0.26) ***	-0.12 (0.04) **	1.08 (0.08) ***	-0.25 (0.14)
Social cohesion	-0.16 (0.02) ***	-	-	-0.03 (0.01) **
Social isolation X Social cohesion	-0.01 (0.01)	-	-	0.01 (0.01)

Note. *p <.05; **p < .01; ***p < .001.

Table 13 The Moderation Effect of Social Cohesion on the Relationship between Social Isolation and Depressive Symptoms

	Model 19		Model 20	
	Depressive symptoms intercept	Depressive symptoms slope	Depressive symptoms intercept	Depressive symptoms slope
Social isolation	0.18 (0.10)	-0.01 (0.02)	0.14 (0.03) ***	-0.02 (0.05)
Social cohesion	-0.01 (0.01) *	-		-0.01 (0.00)
Social isolation X Social cohesion	-0.003 (0.01)	-		0.00 (0.00)

Note. *p <.05; **p < .01; ***p < .001.

5.0 Discussion

5.1 Overview of Key Findings

Social isolation is a serious health risk factor, particularly for older adults who are likely to have limited socioeconomic resources, worsened health conditions, more functional limitations, and reduced social network size due to the death of family members and friends and retirement (Courtin & Knapp, 2017). Although the negative health outcomes of social isolation have been increasingly examined in previous research, the longitudinal relationships between social isolation and psychological well-being and the underlying mechanisms remain largely unclear. Through analyzing the longitudinal data of a sample of adults aged 60 and older in the United States, this study aimed to fill the research gap and answer three research questions: 1) What is the long-term impact of social isolation on loneliness and depressive symptoms? 2) Do positive social support and negative social support at the baseline wave mediate the relationships of social isolation with loneliness and depressive symptoms, respectively? and 3) Do resilience, neighborhood physical disorder, and social cohesion at the baseline wave moderate the relationships of social isolation with loneliness and depressive symptoms, respectively?

The results of this study addressed each research question:

1) As hypothesized, social isolation was significantly associated with more loneliness and depressive symptoms at the baseline wave. However, contradicting the hypothesis, social isolation was associated with a slower increasing rate of loneliness. In addition, social isolation was not significantly associated with the slope of depressive symptoms.

2) As hypothesized, social support had a significant mediating effect on the relationships of social isolation with loneliness and depressive symptoms. To be specific, social isolation was associated with a lower level of positive social support, and a lower level of positive social support was in turn associated with more loneliness and depressive symptoms at the baseline wave, and slower increasing rates of loneliness and depressive symptoms across waves. The relationship between social isolation and the slope of loneliness, the relationship between social isolation and the intercept of depressive symptoms, and the relationship between social isolation and the slope of depressive symptoms were fully mediated by positive social support. The relationship between social isolation and the intercept of loneliness was partially mediated by positive social support.

Additionally, social isolation was associated with less negative social support, and less negative social support was in turn associated with lower levels of loneliness and depressive symptoms at the baseline wave, and a faster increasing rate of loneliness. Negative social support partially mediated the relationship between social isolation and the intercept of loneliness, the relationship between social isolation and the slope of loneliness, and the relationship between social isolation and the intercept of depressive symptoms.

3) Partially aligned with the hypotheses, resilience only moderated the relationship between social isolation and the intercept of depressive symptoms. The relationship between baseline social isolation and depressive symptoms was stronger for respondents with low resilience. However, contradicting the hypotheses, resilience was not a significant moderator on the relationship between social isolation and loneliness.

In addition, although a higher level of neighborhood physical disorder and a lower level of social cohesion were associated with more loneliness and depression at the baseline wave, and

a faster increasing rate of loneliness, these two factors were not significant moderators on the relationships of social isolation with loneliness and depressive symptoms.

5.2 The Relationships of Social Isolation with Loneliness and Depressive Symptoms

The results of the conditional LCGMs with covariates suggest that social isolation is associated with greater loneliness and more depressive symptoms at the concurrent wave, indicating that social isolation may have an immediate negative effect on psychological well-being. This finding is consistent with previous literature highlighting the detrimental effects of social isolation on psychological well-being among older adults (Cohen-Mansfield et al., 2016; Domènech-Abella et al., 2017; Santini et al., 2020; Taylor, 2020). As social isolation in this study was assessed by counting the presence of five indicators, a higher level of social isolation implies the exposure to multiple socially isolated situations, which may have a cumulative negative effect on psychological well-being. Compared to those who are living alone but have sufficient social contact with social network, individuals who are experiencing multiple situations of social isolation may at the greater risk for loneliness and depressive symptoms (Holt-Lunstad, 2017).

Though social isolation was significantly associated with the intercepts of loneliness and depressive symptoms, the disadvantages accompanying social isolation may not accumulate over time. The results of this study suggest that social isolation significantly predicts a slower increasing rate of loneliness in later years, and it has no long-term relationship with the change rate of depressive symptoms. Multiple reasons may explain these counterintuitive results. First, social isolation might be a dynamic process that fluctuates with the changes in the objective

status of social interaction and social participation, which means that the high level of social isolation at the baseline wave may not persist for the study period of eight years. A study examining the changes in social isolation across 10 years indicated that when social isolation reached a certain high level, it started to decrease in the following waves (Read et al., 2020). Individuals with a high level of social isolation at the baseline wave may adopt positive strategies to mitigate their socially isolated situation by actively participating in social activities, making new friends, or increasing the frequency of contact with friends and family members. These positive strategies may result in a significant decrease in social isolation in later waves. While social isolation may have a strong immediate effect on loneliness and depressive symptoms, its long-term impact can be weakened, as the mitigated social isolation may lead to an immediate reduction in feelings of loneliness and depression. Moreover, while some older adults may have a consistent high level of social isolation throughout the study period, their levels of loneliness and depressive symptoms may also be consistently stable over time, which leave no room for further increase. Further research is needed to examine the dynamics of social isolation using data collected with shorter study intervals, and to explore whether the increased change rate of social isolation or persistent high levels of social isolation may have greater impact on psychological well-being than the static measures taken at baseline only.

Second, as individuals age, they may have reduced energy to cope with frequent social contacts and negative experiences associated with social interactions. While social isolation has been demonstrated to be associated with negative outcomes, there might be a reduced likelihood of such negative outcomes for older adults who deliberately choose to be socially isolated as a desirable lifestyle to avoid excessive and unpleasant social interactions (Cornwell & Waite, 2009; Coyle, 2014; de Jong Gierveld et al., 2006; Finlay & Kobayashi, 2018). Though older

adults may have smaller social network sizes and less frequent social connections, they may put more effort into maintaining the most satisfying and intimate relationships and have increased emotional closeness with these relationships, which can be beneficial for their psychological well-being (Carstensen et al., 1999; Cacioppo et al., 2010).

5.3 The Mediating Effect of Positive Social Support and Negative Social Support on the Relationships of Social Isolation with Loneliness and Depressive Symptoms

While a growing body of literature has established the positive relationship between social isolation and psychological distress, the causal mechanism by which social isolation affects loneliness and depressive symptoms remains less well understood. Moreover, findings from the conditional LGCMs of this study indicated that social isolation may have an immediate but no long-term negative effect on loneliness and depressive symptoms. In order to fill this research gap and gain a better understanding of the findings, this study further investigated the relationships of social isolation with loneliness and depressive symptoms by examining the mediating effects of positive social support and negative social support.

The findings suggest that social isolation is significantly associated with not only a lower level of positive social support but also less negative social support. These significant relationships are intuitive, as the primary sources of social support are social relationships, including spouse, children, and friends. Due to the deficiencies in social network and social interactions, older adults who are socially isolated have limited access to positive social support. Meanwhile, they are less likely to experience the negative aspects of social interactions, such as interpersonal conflicts, criticism, excessive demands, and disappointment.

Aligned with previous studies examining the effect of social support on psychological well-being of older adults (Cacioppo et al., 2010; Chen & Feeley, 2014; Santini et al., 2015; Santini et al., 2016; Teo et al., 2013), this study indicated that individuals who receive more positive social support and less negative social support are less likely to experience loneliness and depressive symptoms at the baseline wave. Positive social support is crucial for older adults to maintain psychological well-being. Emotional support, a major type of social support, is a protective factor against loneliness and depression by providing individuals with empathy, comfort, and understanding, which can alleviate the feelings of being alone and depressed. In contrast, negative social support, or the negative experience in the process of receiving social support from others, can undermine psychological well-being among older adults (Chen & Feeley, 2014; Newsom et al., 2005; Santini et al., 2016). Research suggests that the effects of negative aspects of social interaction on psychological well-being can outweigh the benefits of positive social support (Bertera, 2005; Offer, 2021; Teo et al., 2013). The negative aspects of social interaction are considered as major sources of stress, which lead to psychological distress (Newsom et al., 2005; Offer, 2021). Moreover, compared to the positive social interactions, individuals are more likely to remember the negative ones and invest great efforts to mitigate its negative effects (Baumeister et al. 2001; Harrigan et al. 2020; Labianca & Brass 2006; Offer, 2021).

It should be noted that social support examined in this study refers only to the perception of emotional support from family and friends, that is, a sense of understanding, reliance, and trust provided by the social network. This kind of perception is quite subjective, as it can be significantly influenced by how people evaluate the quality of social support, which may differ from the actual social support they receive from others. Additionally, this perception of social

support can be closely related to loneliness. Loneliness is usually defined as the discrepancy between the expected and actual social network size and frequency of social contact, which is also a subjective evaluation of the current situation (Cornwell & Waite, 2009). People who have a high expectation towards the quality of their social network may also have an elevated need for emotional support from others.

The results of the mediation analysis indicate that the relationship between social isolation, loneliness, and depressive symptoms can be explained by the significant mediating role of positive social support. Specifically, the effect of social isolation on the intercept of depressive symptoms and the slopes of both loneliness and depressive symptoms can be completely explained by social support, indicating the significance of social support for socially isolated older adults to maintain psychological well-being. In the absence of supportive social network, older individuals who are socially isolated are more likely to have unfulfilled needs for positive social support, which in turn leads to psychological distress. In addition, socially isolated older adults with limited access to emotional social support may experience stronger feelings of disconnectedness and have more difficulty coping with stressful events often associated with social isolation, such as the loss of spouse.

Aligned with the hypotheses, the findings of the competitive mediation – or inconsistent mediation in some studies - imply that negative social support acts as a suppressor on the relationships of social isolation with loneliness and depressive symptoms, respectively. As shown in this study, while the direct effects of social isolation on loneliness and depressive symptoms were still shown to be positive, the mediator of negative social support suppresses the direct effect by weakening its magnitude. Although social isolation has negative impact on psychological well-being, people who are socially isolated are less likely to be exposed to

negative social support, which may counteract the negative effects of social isolation on loneliness and depressive symptoms.

In addition, the results also implicate the complex interplay between social isolation and psychological distress. Negative social support can only partially explain the effect of social isolation on loneliness and depressive symptoms, probably because there are omitted mechanisms that can be more substantially explain the relationship between social isolation and psychological well-being. Future studies are required to further explore other potential mechanisms to better understand the long-term impact of social isolation on loneliness and depressive symptoms.

5.4 The Moderating Effect of Resilience on the Relationship between Social Isolation, Loneliness, and Depressive Symptoms

To gain a more precise understanding of the relationship between social isolation, loneliness, and depressive symptoms, in addition to the casual mechanisms of social support, this study further examined the moderators to understand whether the negative long-term impact of social isolation on loneliness and depressive symptoms varied by individual resilient traits and perceived neighborhood environment characteristics.

The present study partially aligns with previous literature indicating that resilience significantly moderated the concurrent association between social isolation and depressive symptoms. Specifically, the findings suggest the negative effects of social isolation on depressive symptoms are weaker among older adults with high resilience. Resilience may act as a protective factor against the negative consequences of social isolation by potentially influencing how older

adults activate the external resources to compensate for the negative effect of social isolation and how they cope with the stressors that arise from social isolation. Resilience involves a process of the activation of external resources through reconfiguring the existing resources or mobilizing the previously unavailable resources in response to stressors and adversities (Schafer et al., 2009). Although socially isolated older adults may have limited social relationships and deficiency in external resources, highly resilient individuals are more effective in activating and utilizing currently available resources to counteract the negative outcomes of social isolation.

In addition to the external resources, resilience is related to the internal resources of individual characteristics and adaptive skills, which may be more important for socially isolated older adults who lack external resources (King et al., 2019). Previous studies suggest that high resilience is associated with internal resources of adaptive coping styles, problem-solving skills, and positive emotion regulation skills, which are the critical capacities for older adults to make positive adjustments to the stressful situation of social isolation and to maintain psychological well-being (MacLeod et al., 2016). Furthermore, resilient individuals usually possess attributes of optimism, perseverance, determination, and self-efficacy, which are important protective factors in the face of adversity, as people with these attributes are more likely to be motivated to see the bright side of life and move on (Wilson et al., 2021).

Social isolation itself is a stressor associated with negative consequences, and more importantly, social isolation is usually related to disruptive life events, such as retirement, loss of spouse and friends, and physical health problems, which may have great impacts on psychological well-being. Resilience is particularly important for socially isolated older adults, since it may protect individuals from the negative outcomes of challenging life events by aiding them in making successful adaptations and quickly recovering from the adversity. Though

resilient individuals may have a high level of social isolation, they are to a lesser degree affected by social isolation than people with low resilience.

This study, however, indicates that resilience does not moderate the relationship between social isolation and loneliness. Different from depressive symptoms that mainly measures the experiences of depressed mood and behaviors, loneliness is the perception of being isolated and being unsatisfied with the quality of existing social relationships (Dickens et al., 2011). Through activation of external and internal resources, resilience helps individuals make successful adaptions to the adversities and protect them from the onset of depressive symptoms. However, resilience may not have a significant effect on changing the subjective perception of social relationships, particularly for those socially isolated older adults who lack adequate social interactions.

5.5 The Moderating Effects of Neighborhood Physical Disorder and Social Cohesion on the Relationship between Social Isolation, Loneliness, and Depressive Symptoms

Consistent with previous studies, the results of the models with moderation analysis suggest that neighborhood physical disorder is significantly associated with psychological distress among older adults; however, the significant relationship is only established with loneliness but not with depressive symptoms. To be specific, older individuals who reside in neighborhoods with elevated physical disorders appear to experience more loneliness at the baseline wave. Neighborhood physical disorder refers to the visible signs of dirtiness and unsafety of the neighborhood environment where individuals reside, including graffiti, vandalism, rubbish, and deserted houses. It may exacerbate the situation of social isolation and

the perception of loneliness, as residents may hesitate to engage in social interactions due to the safety issue or the lack of available places for social participation (Barnett et al., 2018; Domènech-Abella et al., 2021; Kearns et al., 2015).

Social cohesion has protective effect on psychological well-being; it is not only associated with lower levels of loneliness and depressive symptoms at the baseline wave, but also predicts a slower increasing rate of loneliness across waves. Social cohesion is a subjective perception of social connections with other members of the community and the degree of belongingness to the neighborhood. Residents of the socially cohesive neighborhoods are more likely to have a strong sense of social trust, commitment, and reciprocity with other residents, which can benefit their psychological well-being (Sampson et al., 1997). Studies have demonstrated that social cohesion is associated with higher levels of resilience and self-management abilities, which can in turn mitigate psychological distress (Zhang et al., 2020; Zhang et al., 2021). Moreover, socially cohesive neighborhoods may provide more opportunities for social engagement through volunteering activities, cultural and art festivals, or other community events, which promote social interaction and the development of a broader social network and finally mitigate the feeling of loneliness and depressive symptoms (Stephens & Phillips, 2022).

In line with previous studies examining social cohesion (Kim et al., 2020), the results of this study indicate that social cohesion has a long-term impact on loneliness. Individuals who reported a high level of social cohesion at the baseline wave are more likely to engage in volunteer activities (Johnson et al., 2018). This active engagement may promote a better perception of the neighborhood, which encourages individuals to continue the active participation in community events, and consequently has a lasting effect on reducing loneliness.

In addition, close social relationships established through social engagement can persist for a long time, serving as a long-lasting source of social support and continually mitigating the feeling of loneliness.

Despite the result that physical disorder and social cohesion are significant protective factors for loneliness and depressive symptoms, the findings of this study indicate that neither factor is a significant moderators on the relationships. The effects of social isolation on loneliness and depressive symptoms are consistent across individuals with varying degrees of perceived neighborhood physical disorder and social cohesion. This result indicates that other aspects of the neighborhood environment, such as the built environment, may play a significant moderating role on the relationship.

5.6 Limitations

This study has several limitations. First, social isolation is a multifaceted concept, which can be measured differently by using a wide variety of indicators. In this study, social isolation was examined by the indicators of marital status, frequency of contact with family members and friends, and participation in clubs or organizations. Though the selection of these indicators was guided by the approach provided by previous studies (Steptoe et al., 2013; Shankar, 2017; Peng & Roth, 2021), the current measure was limited by the availability of variables in the HRS dataset and might not comprehensively evaluate different aspects of social isolation. In addition, the measurement validity and reliability might be threatened by response bias related to the self-report measure of social isolation. Potentially worrying about the stigma of being socially isolated, the study participants may overreport their levels of social interactions and social

participation. As a result, the data may not fully capture the actual levels of social isolation experienced by older adults.

Second, limited by the study design of the HRS, this study used three waves of data collected across eight years with the interval of four years to examine the relationships among the same cohort of respondents. The relatively long intervals may result in an insufficient investigation on the changes of loneliness and depressive symptoms that occur within a shorter period than that between study waves (Read et al., 2020).

Third, this study used the variables measured at the baseline wave to estimate their effects on the change trajectories of loneliness and depressive symptoms across eight years. However, it should be noted that the levels of these variables may fluctuate over this long period of time, and the use of baseline measures cannot capture their dynamic relationships with psychological well-being over time. Resilience is usually viewed as a dynamic process that is not static over the course of lifetime, and it can be developed as people making positive adaptions when encountering stressful events. In addition, positive social support and negative social support may have significant changes with the increase or decrease in social network. Though social cohesion and physical disorder are relatively stable factors, they may also change as people relocate to different neighborhoods, which was not examined in the present study.

Fourth, this study focused on the mediating and moderating effects of several psychosocial factors within the micro-, meso-, and exo-system; however, it did not thoroughly explore the potential pathways leading social isolation to loneliness and depressive symptoms among older adults. From the microsystem, other individual characteristics, such as personality traits and early life experiences, may have an impact on social isolation and psychological well-being. From the mesosystem, social support is a multidimensional concept encompassing various

domains of support. But this study only examined the domain of emotional support, leaving out other types of social support such as instrumental and informational support, which might also significantly mediate the relationship between social isolation and psychological well-being. Furthermore, this study only examined the social context of neighborhood through individual perceptions of social cohesion and physical disorder, but it did not take into account the objective evaluations of neighborhood environment. The neighborhood physical environment characteristics, such as amenities and services, land use, public transit infrastructure, recreational sites, and parks, may have different effects on social isolation and psychological well-being (Finlay et al., 2022). Lastly, as suggested by the ecological theory and Berkman's framework (Berkman et al., 2000), a comprehensive understanding of the relationship between social isolation and psychological well-being requires the examination of variables from broader systems, including macro- and chrono-system factors, such as societal values, cultural context, and historical components.

Fifth, although the HRS is a nationally representative study of older adults in the United States, this study only used a selected sample for the final analysis, which was limited by the study design and data availability. The latent growth curve modeling used in this study requires the examination of at least three waves of data. However, the fourth wave data for each respondent cohort who participated in the Leave-behind Questionnaire was not available for public use at the beginning of this study. To meet the requirement of the LCGM using data collected at three points of time, respondents who did not participate in the follow-up surveys or those who did not provide any responses on key variables of social isolation, loneliness, and depressive symptoms in any of the three waves were excluded from this study. This sample selection method could be a potential source of bias, as respondents who were not followed up

were likely to be affected by social isolation and its negative outcomes. Furthermore, respondents of the HRS have been shown to be with good health status and are predominantly White (Peng & Roth, 2022). Consequently, the findings of this study cannot be generalized to other groups of older adults with poorer health conditions and those from other racial minorities.

5.7 Implications

5.7.1 Implications for Future Research

The limitations of this study call for future research to provide a more comprehensive and accurate estimation of the relationship between social isolation and psychological well-being among older adults.

First, the variation in the conceptualization of social isolation allows scholars to examine different facets of the socially isolated situation among older adults; however, the lack of consensus regarding the definition and measure of social isolation impedes an explicit understanding of the issue and hinders the development of effective interventions. It is essential for researchers to make efforts to develop a standardized measurement scale with strong psychometric properties that is based on a consensus definition of social isolation. Such consistent measurement can facilitate the utilization across studies and interventions targeting social isolation of older adults.

Second, little is known about the dynamics of social isolation over time and how this change trajectory impacts loneliness and depressive symptoms in later years. This study only examined the variable of social isolation measured at the baseline wave, which treated social

isolation as a static situation. However, social isolation is a dynamic status that may vary dramatically over time. Future studies are in need to explore the dynamics of social isolation and examine how the growth trajectory of social isolation contributes to psychological distress.

Third, the relationship between social isolation and psychological well-being is complex and likely influenced by a wide range of factors at different levels as suggested by the ecological theory. Further research is needed to explore the mediating and moderating effects of a broader set of factors from the micro-, mezzo-, and exo-system. Additionally, a comprehensive understanding of the mechanism through which social isolation impacts psychological well-being among older adults may rely on further investigation of the macro- and chrono-system factors regarding the cultural context and socioeconomic conditions of the neighborhood and society at large, such as socioeconomic development, social dynamics, social policy, cultural perceptions, beliefs and values, residential segregation, and uneven distribution of human and economic capital.

Fourth, a great number of previous studies examining social isolation used samples of community-dwelling older adults, who may have better health conditions and lower risk for social isolation, compared to institutionalized older adults who are typically excluded from the studies (Taylor et al., 2016). Additionally, studies have the sampling selection bias, which leads to the under-representation of older adults who are socioeconomically disadvantaged. This sampling selection bias results in the lack of evidence regarding social isolation among the most vulnerable groups of older adults, who might be disproportionally affected by social isolation. To address this limitation, future studies should aim to target these vulnerable groups of older adults by adopting strategies to access and recruit them into the study. Such strategies may involve collaborations with local organizations or senior housing facilities.

Fifth, previous studies investigating social isolation have primarily used quantitative data. Even though quantitative data collected from nationally representative survey can provide insight into generalizable results at the population level, it has limitations in exploring highly individualized factors, including personal experiences and perceptions of social isolation, underlying reasons for being socially isolated, and individual factors that may exacerbate or ameliorate the situation of social isolation. Therefore, future studies utilizing qualitative or mix-method study designs are needed to explore individual variations of social isolation and provide sufficient information to justify and explain the general patterns identified by quantitative research.

5.7.2 Implications for Social Work Practice, Intervention, and Policy

This study provides implications for social work practice, interventions, and policy. Considering the empirical evidence that social isolation negatively impacts psychological well-being among older adults, there is a pressing need for the development of effective intervention strategies specifically designed to address the issue of social isolation among the aging population. The findings of this study on the significant mediating effects of positive social support and negative social support, as well as the moderating effect of resilience underscore the importance of targeting these factors in interventions to prevent loneliness and depressive symptoms among socially isolated older adults.

The interventions focusing on individual level factors can be helpful in mitigating social isolation and its detrimental effects on psychological well-being. Given the overlapping yet distinct nature of social isolation and loneliness, a combination of different approaches is necessary to address both issues. In addition to providing opportunities for social interactions and

social participation to tackle the objective status of social isolation, interventions aimed at alleviating feelings of loneliness may adopt cognitive-based approaches (Barnes et al., 2021). For example, mindfulness interventions that cultivate awareness and foster acceptance of both pleasant and unpleasant experiences can significantly reduce loneliness and social isolation (Lindsay et al., 2019). Although this type of mindfulness training does not necessarily involve direct social contact, it is beneficial for developing emotion regulation skills and maintaining open attitudes towards social interactions, which ultimately mitigate loneliness and social isolation (Lindsay et al., 2019). Furthermore, interventions aimed to promote resilience can be effective in the treatment of loneliness and depression among socially isolated older adults. In particular, for older adults who are socially isolated due to chronic conditions, physical limitations, or residence in remote areas, intervention focusing on promoting resilience may be more feasible than the traditional approaches targeting increased social interaction and social participation.

In addition to individual factors, the results of this study reveal that psychological distress can be mitigated by the contextual and structural factors at the neighborhood level. Strategies that take these factors at a broader level into account are greatly needed. Specifically, policies and interventions aimed at improving neighborhood environments can be effective in reducing social isolation and psychological distress among older residents. For example, interventions targeting elimination of neighborhood physical disorder can remove both physical and psychological barriers for older adults and optimize the opportunities for social interaction and social engagement. In addition, the interventions of building new amenities and improving access to the existing ones, such as senior centers, parks, and recreation centers, can encourage

social interaction and social support among older residents, which subsequently address social isolation and mitigate psychological distress (Finlay et al., 2022).

In addition to the built environment of the neighborhood, policies and interventions focusing on promoting social cohesion may also be effective in reducing loneliness and depressive symptoms among older adults. The policies and interventions of community involvement have been demonstrated to be effective in addressing social isolation among older adults (MacLeod et al., 2018). Multidimensional approaches, such as volunteering, friendly visitor programs, Meals on Wheels America (MOW), social gatherings and exercise classes provided by senior centers, and "befriending" and mentoring programs, have been demonstrated to be effective in building social connections, getting involved in the community, enhancing social support, and promoting social cohesion, which may ultimately mitigate loneliness and depressive symptoms (MacLeod et al., 2018).

5.8 Conclusion

In conclusion, this study examines the relationship between social isolation and the latent growth trajectories of loneliness and depressive symptoms among a sample of U.S. adults aged 60 and older. This study further investigates the mediating effects of positive social support and negative social support, and the moderating effects of resilience, neighborhood physical disorder, and social cohesion on the relationships. This study contributes to the existing literature by providing evidence on the significant association between social isolation, loneliness, and depressive symptoms at the concurrent wave. More importantly, this study indicates that social isolation has a strong transient effect on psychological well-being, but this negative effect may

taper off over time. Furthermore, this study suggests the complete mediating effect of positive social support, the suppressing effect of negative social support, and the buffering effect of resilience on the relationship between social isolation, loneliness, and depressive symptoms.

The findings of this study provide empirical evidence for policymakers and practitioners to design effective strategies to address the issue of social isolation among older adults. This study highlights the importance of addressing social isolation and its associated negative outcomes through interventions at different levels, including individual characteristics, social support, and neighborhood environment. Moreover, according to the ecological system theory, the issue of social isolation is affected by factors at multiple levels, indicating that interventions designed to address a combination of factors at different levels can have the most effectiveness in mitigating social isolation and its negative consequences (NASEM, 2020). To achieve this goal, collaboration across disciplines of social work, public health, gerontology, and psychology is required.

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