Walking alone on empty streets: Reconsidering the effects of social isolation and loneliness on mental health

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1 Introduction

1.1 Motivation and scope

By the time the World Health Organization (WHO) declared COVID-19 to be a global pandemic on 11 March 2020, national governments worldwide had already begun to implement a range of measures to contain the spread of the virus. As a side effect, restrictions on social contact and physical distancing fundamentally changed how we connected with other people. Concerns quickly arose that a mental health crisis might accompany the COVID-19 pandemic due to the potentially higher prevalence of social isolation and loneliness in the general population (e.g., Heyns et al., 2021; Holt-Lunstad, 2021; Koh and Liew, 2022; Torales et al., 2020). As a result, loneliness—the unpleasant feeling that results from a perceived deficiency in one's social connections—and social isolation—the objective absence of social connections—attracted a great deal of public interest after the outbreak of the pandemic (Brodeur et al., 2021; Koh and Liew, 2022). However, social isolation and loneliness are not new challenges for our societies (Cacioppo and Cacioppo, 2018b; Heinrich and Gullone, 2006; Holt-Lunstad et al., 2017), and scientific interest in these issues had already begun to proliferate in the early 2000s (Langenkamp, 2023; Lippke and Warner, 2023). In fact, social isolation and loneliness were widespread on the global level long before the pandemic, possibly affecting hundreds of millions of people (Eurostat, 2018; Surkalim et al., 2022; Teo et al., 2023). Nevertheless, the COVID-19 pandemic created a sense of urgency among public health experts and policymakers with regard to the task of addressing social isolation and loneliness (for one example in Germany, see Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, 2023). Scientific evidence regarding the precise processes linking these two manifestations of social disconnection to mental health can provide an essential frame of reference for designing effective intervention strategies.

The concern that a mental health crisis could accompany the COVID-19 pandemic stems from the belief that social isolation and loneliness pose significant risks to the mental health of the people who experience them. Extensive research has linked both conditions to a range of mental health outcomes, including depression, anxiety, and suicide (e.g., Calati et al., 2019; Erzen and Çikrikci, 2018; McClelland et al., 2020; Park et al., 2020; Santini et al., 2015). However, much less attention has been given to the question of whether these two conditions contribute to the onset of mental health problems, as has commonly been assumed in public debates and the scientific literature. This view is referred to here as the causation hypothesis,

in line with commonly used terminology in health inequalities research (e.g., Foverskov and Holm, 2016; Kröger et al., 2015). However, other explanations for the observed associations have rarely been discussed in the scientific literature. In particular, people with mental health problems might select themselves into social isolation and loneliness, for example, because they are more likely to experience interpersonal problems and negative life events (Liu and Alloy, 2010; Meyer and Curry, 2017) and to exhibit cognitive biases that might lead them to perceive their social relationships in an overly negative way (Gotlib and Joormann, 2010; Mathews and MacLeod, 2005). More specifically, the direct selection hypothesis argues that selection is driven by the presence and symptoms of mental health problems, whereas the indirect selection hypothesis posits that selection is driven by (stable) characteristics that increase the risk of developing mental health problems (e.g., Blane et al., 1993). However, making inferences about the relative importance of these three hypotheses is difficult because most relevant research has been based on cross-sectional data (e.g., Park et al., 2020) or analytical strategies that can provide only limited insights into the underlying causal processes.

More recently, several studies have taken advantage of the benefits of panel data to examine the reciprocal association between experiences of social disconnection and mental health within individuals over time, taking into account prior changes in the outcomes and (un)observed stable characteristics. The use of within estimators has allowed these studies to provide insights into the importance of causation and the two types of selection with regard to explaining why social isolation and loneliness are associated with mental health problems (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021; Vella-Brodrick et al., 2023). This research has found surprisingly little evidence to support the causation hypothesis, thus raising questions about whether social isolation and loneliness are actually the important risk factors for mental health problems that they are often readily believed to be. The strengths of this research lie in its use of panel data and suitable methods of panel data analysis. However, these studies have exhibited major limitations. For example, the analytical approaches used in these studies made strong assumptions about the latency period over which the reciprocal effects unfold. Moreover, these studies have failed to adjust for important time-varying confounders, particularly negative life events such as unemployment, divorce, and widowhood. In addition, most of these studies have analysed data from Australia, the USA, and the UK (Griffin et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021; Vella-Brodrick et al., 2023). However, little research has focused on other countries, such as Germany (Joshanloo, 2022). Moreover, all of these studies have focused on psychiatric outcomes (e.g.,

anxiety, depression), and little attention has been given to the positive aspects of mental health (e.g., subjective well-being). Finally, this research has not fully explored whether causation and selection are equally relevant across different population groups. It therefore remains unclear whether social isolation and loneliness are detrimental to mental health and whether some population groups are more vulnerable to the health risks of social disconnectedness than others.

The main objective of this thesis is to broaden our understanding of the nature of the links between the two types of social disconnection and mental health. The starting point of the thesis is the observation that selection processes remain seriously undertheorised, while the potential mechanisms underlying causation are well understood. Consequently, it is largely unclear why people with mental health problems might be at greater risk of social isolation and loneliness. Therefore, as a first, more theoretical contribution, the thesis reviews relevant fields of research to identify theoretical arguments for the two types of selection. Next, these arguments are systematised into a broader set of mechanisms. Then, the thesis provides a brief review of empirical research to assess the extent to which previous studies can discriminate among the three explanations. As outlined above, this review aims to show that the empirical evidence for the effects of social isolation and loneliness on mental health is not as unambiguous as it is often thought to be. By conducting four empirical studies, the thesis provides new evidence regarding the causation hypothesis by using innovative analytical strategies to consider selection as an alternative explanation. The studies also examine possible gender and age differences in the role of social disconnection. Finally, they assess whether the measurements used for social isolation and loneliness influence the conclusions about the causation hypothesis. In general, the thesis contributes to the literature by addressing the following research questions:

(1) What are the theoretical arguments underlying different explanations for the associations between social isolation, loneliness, and mental health?
(2) Do social isolation and loneliness contribute to mental health problems, as predicted by the causation hypothesis?
(3) Are conclusions regarding the causation hypothesis robust across measurement approaches and broader sociodemographic groups?

To improve our knowledge of the roles of social isolation and loneliness in mental health problems, the thesis extends previous research in several important ways. First, this thesis presents the first study to investigate whether social isolation negatively affects the mental and

physical health of older people in Germany by considering the two types of selection as competing explanations **(Study 1)**. Research on the health effects of objective social isolation is still scarce, as the focus of most studies has been on the subjective experience of loneliness. Second, this thesis presents the first study on the negative effect of loneliness on mental health to be conducted using a nationally representative sample of adults from the UK **(Study 2)**. In contrast, prior studies using within estimators have analysed either non-probability samples of adults, thereby supporting the causation hypothesis (Lim et al., 2016; McDowell et al., 2021), or samples of adolescents from selected Norwegian schools (Kristensen et al., 2022) and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022), thereby providing limited evidence for causation. Using a large high-quality panel dataset from the UK that covers the general adult population, this study aims to conduct a more rigorous empirical test of the causation hypothesis. Third, the thesis contains the first study to address the question of whether loneliness contributes to depressive symptoms in early adulthood, a period in life when people are particularly vulnerable to developing depression **(Study 3)**. Despite the importance of this life stage, previous studies have analysed the depressive effects of loneliness only in samples of adolescents (Kristensen et al., 2022), adults (Lim et al., 2016; McDowell et al., 2021), and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Fourth, the thesis presents the first test of the causation hypothesis to take subjective well-being into account as a positive aspect of mental health **(Study 4)**. As previous research has focused on analysing psychiatric outcomes (e.g., depressive symptoms), further studies are needed to clarify whether conclusions regarding causation can be generalised to other mental health outcomes. Finally, all four studies assess whether the empirical evidence for the causation hypothesis is robust across broader population groups and measurement approaches. The subgroup analysis is not only intended to highlight the robustness of conclusions regarding the causation hypothesis. It also seeks to explain the conflicting results reported in previous research. Through these contributions, these four empirical studies provide broader and more compelling evidence regarding whether social isolation and loneliness contribute to mental health problems.

As described above, the work started by analysing the health effects of objective social isolation on health but then shifted its focus to the subjective experience of loneliness. There are three reasons for this shift. First, much more extensive and robust evidence has indicated that loneliness is associated with mental health problems (Park et al., 2020). Although such associations have also been found in the context of objective social isolation, they are much weaker and less consistent, with differences depending on which aspects of social connection

are considered (Santini et al., 2015; Schwarzbach et al., 2014). Second, loneliness has received a great deal of public attention, particularly following the outbreak of the COVID-19 pandemic (Brodeur et al., 2021; Koh and Liew, 2022). Finally, data limitations prevent a comprehensive study of the impact of social isolation on mental health. For example, the UK Household Longitudinal Study (UKHLS) does not contain sufficient information to identify socially isolated people reliably. In contrast, the data do contain two widely used measures of loneliness (Office for National Statistics, 2018). Nevertheless, it seemed reasonable to address both social isolation and loneliness under the auspices of this thesis, as both conditions reflect common manifestations of social disconnection. Moreover, there is considerable overlap in the literature on the health effects of social isolation and loneliness.

The rest of this chapter is structured as follows. The following section discusses the concepts of social isolation and loneliness in further detail. Next, different explanations for the observed associations between these conditions and mental health are presented, with a particular focus on the theoretical elaboration of the mechanisms underlying selection. Then, the state of empirical research is reviewed to assess the extent to which previous studies can justify conclusions concerning the importance of causation and selection. The final section outlines the empirical studies contained in the thesis and briefly summarises their intended contributions to the literature.

1.2 The concepts of social isolation and loneliness

Although social isolation and loneliness have received a great deal of attention in both public debates and the scientific literature, particularly after the outbreak of the COVID-19 pandemic, some confusion seems to have arisen regarding what these conditions actually are and how they differ from each other. It is therefore necessary to delineate these two concepts before the following section can present common explanations for their associations with mental health.

Loneliness is the unpleasant feeling that results from a perceived deficiency in one's social connections in terms of quantity and/or quality (Peplau and Perlman, 1979; Perlman and Peplau, 1981). The evolutionary theory of loneliness argues that this feeling evolved as a warning signal from the human body that can alert us to threats to our survival in a manner similar to hunger, thirst, and physical pain (Cacioppo et al., 2014; Cacioppo and Cacioppo, 2018a). In particular, loneliness is believed to serve the adaptive function of alerting us to damage in our social relationships, and eliminating this unpleasant feeling serves to motivate us to reconnect socially with other people, which was essential for the survival of our ancestors

(Cacioppo et al., 2006). It is therefore natural to feel lonely at some points in life, but for most people, loneliness is only a temporary state. For some people, however, it becomes a long-lasting and distressing experience (Qualter et al., 2015). Regarding the prevalence of loneliness, a large meta-analysis estimated that 5 to 9% of the adult population in Western Europe suffer from severe loneliness (Surkalim et al., 2022). Contrary to stereotypes of loneliness as a problem pertaining to old age, it occurs at all life stages (Qualter et al., 2015). Empirical studies have revealed that the age distribution of loneliness follows a complex, nonlinear pattern in which high levels of loneliness are present in both young adulthood and old age (Hawkley et al., 2022; Luhmann and Hawkley, 2016).

Social isolation, on the other hand, describes an objective state in which a person's social connections are (almost) completely absent (Eckhard, 2018b). Precise estimates of the prevalence of social isolation are difficult to obtain because this concept has been measured in very different ways (for overviews, see Eckhard, 2018b; Valtorta et al., 2016a; Zavaleta et al., 2017). In particular, no consensus has been reached regarding which aspects of social connections must be lacking for a person to be considered socially isolated. For example, people have been classified as socially isolated if (a) they live alone and have contact with others less than once per month, (b) they have no confidant with whom they can discuss personal matters, or (c) they have no one to whom they would turn for help (Eckhard, 2018b). Other researchers have suggested that a lack of social participation should be viewed as an indicator of social isolation (Zavaleta et al., 2017). In general, loneliness and social isolation are distinct concepts and tend to be weakly correlated (e.g., Coyle and Dugan, 2012) because people differ in terms of their desired level of social connections. For example, people may be married and have regular contact with friends but nevertheless feel lonely, and conversely, people may lack a confidant but nevertheless not feel lonely.[1] Given the lack of conceptual clarity and established measurement tools, few reliable data sources are available for estimating the prevalence of social isolation. Perhaps the most accurate estimates are provided by Eurostat data. In the EU-28 countries in 2015, 15.1% of the adult population reported meeting with family and relatives less than once per month, 5.9% had no one to whom they could turn for help, and 6.0% had no one with whom they could discuss personal matters (Eurostat, 2018). As in the case of loneliness, social isolation is often assumed to be more

[1] Social isolation and loneliness are also different from solitude, which is the positive experience of being alone. Solitude is created deliberately, for example, when people withdraw socially to escape the worries of everyday life.

prevalent among older people, but the age distribution of its prevalence depends on how social isolation is measured (Eckhard, 2018b; Eurostat, 2018).

1.3 Theoretical mechanisms

In social epidemiological research on health inequalities, three central explanations have been formulated, which are adapted in this book to explain the more frequent mental health problems experienced by socially isolated or lonely people (Blane et al., 1993; Foverskov and Holm, 2016; Kröger et al., 2015). The **causation hypothesis** argues that social isolation and loneliness are detrimental to mental health. Alternatively, two selection hypotheses have been proposed, suggesting that people with mental health problems self-select into social isolation and loneliness. The **direct selection hypothesis** argues that this selection is due to the presence and symptoms of mental health problems. In contrast, the **indirect selection hypothesis** argues that such selection is due to stable, trait-like characteristics that affect the risks of developing mental health problems and becoming socially disconnected simultaneously. The following section elaborates the theoretical arguments underlying these three explanations. It is important to note that although considerable research has explored the possible pathways of causation in recent decades, direct and indirect selection are still noticeably undertheorised in the literature. Hence, an essential contribution of this thesis lies in its identification of the theoretical arguments used in various relevant fields of research to explain why people with mental health problems are at greater risk of social isolation and loneliness as well as its systematisation of these arguments into a broader set of mechanisms.

1.3.1 Causation

The most common explanation, which is referred to here as the causation hypothesis, argues that social isolation and loneliness have negative impacts on mental health. This section describes a range of psychosocial, behavioural, and biological mechanisms through which the two types of social disconnection could harm mental health (Andersen et al., 2021; Hawkley and Cacioppo, 2010; Thoits, 2011a). Table 1.1 summarises the key terms and concepts related to these pathways.

Psychosocial pathways

The first pathway argues that social disconnection is harmful to mental health because it results in a lack of satisfaction of the basic human need to belong, thus causing high levels of emotional distress (Baumeister and Leary, 1995; Heinrich and Gullone, 2006). In a widely

cited review, Baumeister and Leary (1995) concluded that the need to belong is a universal human motivation that drives us towards others. This need may have evolved over the course of human evolution because our physical disadvantages compared to other species forced our ancestors to group together to improve their chances of survival and reproduction (Baumeister and Leary, 1995; Cacioppo et al., 2006). Consequently, natural selection promoted the need to belong as a mechanism that rewards the formation of social bonds by generating positive emotions and punishes the loss of these bonds by producing negative emotional states (Baumeister and Leary, 1995; Heinrich and Gullone, 2006). According to this view, social connections are beneficial to mental health simply by satisfying the need to belong (Andersen et al., 2021). Conversely, by acutely threatening the satisfaction of this need, social isolation and loneliness can produce severe emotional distress (Baumeister and Leary, 1995; Cacioppo et al., 2006), thereby increasing the risk of mental illness.

Second, the sociocognitive model of loneliness emphasises the role of the maladaptive social cognition caused by loneliness (Cacioppo and Hawkley, 2009). This model argues that loneliness not only motivates people to renew their social connections but also leads to hypervigilance towards social threats as a protective mechanism that promotes self-preservation (Cacioppo and Cacioppo, 2018a). This hypervigilance towards social threats may in turn lead to negative biases at all stages of social information processing (Cacioppo and Hawkley, 2009), including negative evaluations of oneself and others, self-blaming attributional styles, and the anticipation of social rejection (for a review, see Spithoven et al., 2017). These negative cognitive biases may elicit problematic social behaviours in lonely people, such as social avoidance and hostility (Segel-Karpas and Ayalon, 2020; Spithoven et al., 2017), to which others respond with actual rejection, thus confirming and reinforcing these biases (Cacioppo and Hawkley, 2009). At the end of this process, lonely people are often trapped in a downward spiral of increasing loneliness, negative cognitive biases, and negative social interactions, resulting in high levels of negative affect and interpersonal stress (Cacioppo and Hawkley, 2009). Ultimately, the high stress levels caused by loneliness can activate maladaptive biological processes that increase the risk of mental illness (see the Section “Biological pathways” for further details).

Finally, social disconnection can harm mental health by depriving people of the psychosocial resources typically provided by meaningful and stable social ties (Andersen et al., 2021; Thoits, 2011a). Cohen and Wills (1985) explained the beneficial effects of social bonds using two primary models. On the one hand, the stress-buffering model argues that social bonds promote mental health by mitigating the damaging effects of negative life events

(Cohen and Wills, 1985). Stress buffering occurs because social connections provide access to emotional, instrumental, and informational support. Even the perceived availability of social support may be sufficient to prevent a negative event from being appraised as stressful and thus to attenuate stress responses (Cohen and Wills, 1985). Accordingly, the stress-buffering model implies that the mental health problems experienced by socially isolated people result from a lack of social support that increases their vulnerability to stress. On the other hand, the direct-effect model argues that social relationships are generally beneficial to mental health, regardless of whether a potentially stressful situation is present (Cohen and Wills, 1985). The beneficial effect occurs because social bonds provide people with social roles and role identities (as friends, relatives, etc.) that enhance their self-esteem and meaning in life (Cohen and Wills, 1985; Thoits, 2011a). According to this view, the poorer mental health experienced by socially isolated people can be explained by feelings of worthlessness, lethargy, and meaninglessness (Lambert et al., 2013; Twenge et al., 2003).

These two models can also be applied to loneliness. As described above, lonely people tend to be overly negative about others (Spithoven et al., 2017). As a result, they may expect others to be unsupportive or unavailable in times of need, making it more likely for these lonely people to appraise a negative situation as stressful. Moreover, the tendency of lonely people to engage in problematic social behaviours can damage their social bonds, thus depriving them of meaningful social roles and different types of social support. In this way, maladaptive social cognition may also deprive lonely people of the psychosocial resources typically provided by meaningful social ties.

Behavioural pathways

Furthermore, research has identified certain behavioural factors as potential mechanisms linking social (dis)connection to mental health (Thoits, 2011a; Umberson et al., 2010; Umberson and Montez, 2010). According to this view, socially isolated or lonely people report more mental health problems due to their tendency to engage in risky and unhealthy behaviours, such as being physically inactive, smoking, and having inadequate diets (e.g., Delerue Matos et al., 2021; Hawkley et al., 2009; Richard et al., 2017; Shankar et al., 2011), which may lead to a decline in mental health (Firth et al., 2020), for example, by lowering their overall moods and preventing stress reduction.

Social (dis)connection can influence health behaviour in a number of ways (e.g., Hawkley and Cacioppo, 2010; Thoits, 2011a; Umberson et al., 2010; Umberson and Montez, 2010). First, other people in the social network may actively try to control a person's health-related

behaviour (Thoits, 2011a). Social control refers to attempts by other people to monitor a person's behaviour and, when undesirable practices are observed, to demand behaviour change actively. Therefore, because socially isolated people are subject to less social control by others, they are more likely to engage in unhealthy behaviour (Thoits, 2011a). Additionally, socially isolated people may also not have others around them who can notice the serious psychiatric symptoms and behavioural changes following the onset of mental illness and thus encourage the person to seek professional help (Thoits, 2011a, 2011b). Second, social ties assign people to social roles, which entail certain obligations and expectations that regulate a person's behaviour (Thoits, 2011a). In particular, social roles may promote a sense of responsibility towards role partners that pressures individuals to avoid health risks and take care of themselves (Thoits, 2011a; Umberson et al., 2010). In addition, social roles may introduce social routines into people's daily lives that promote health (e.g., regular sport activities with friends) or facilitate healthy practices (e.g., fixed mealtimes with the family; Umberson et al., 2010). Finally, it has been argued that the capacity for self-regulation is impaired in lonely people (Hawkley and Cacioppo, 2010). Impairments in self-regulation can be explained by the fact that lonely people are often in a bad mood (Cacioppo et al., 2006) and may prioritise the short-term regulation of their emotions over the long-term pursuit of self-regulatory goals such as adopting a healthy lifestyle (Tice et al., 2001; Tice and Bratslavsky, 2000).

Biological pathways

A final set of pathways is related to the effects of social disconnection on biological risk factors for mental illness. Social isolation and loneliness can be distressing experiences to which the body responds with certain biological processes that can have pathological effects, particularly when both conditions become intense or chronic experiences. Support for these biological pathways has been provided by research suggesting a link between social disconnection and increased levels of inflammation (Smith et al., 2020; Uchino et al., 2018) and increased activation of the hypothalamic-pituitary-adrenal (HPA) axis (Cacioppo et al., 2015), which may contribute to the development of mental disorders such as depression (LeMoult, 2020).

In addition, sleep problems have been discussed as another biological factor linking social disconnection to mental health (e.g., Hawkley and Cacioppo, 2010). In general, sleep has an essential restorative function for the human organism by allowing the body to regenerate and repair itself. Throughout human history, sleep has required a sense of security, which is usually provided by the physical presence of caregivers or confidants. It has been argued that this sense of security can be lost when people become disconnected from reliable others or when

people become hypervigilant towards threats in the social world (Hawkley et al., 2010). This argument has been supported by several meta-analyses and reviews that have found poor social connections and loneliness to be associated with poor sleep (Gordon et al., 2021; Hom et al., 2020). In addition, research has shown that mental health is closely linked to sleep quality (Scott et al., 2021), and sleep problems are included among the diagnostic criteria for mental disorders such as anxiety and depression (American Psychiatric Association, 2022).

Table 1.1 Overview of key terms and potential mechanisms underlying causation

Psychosocial pathways	
Emotional distress	Social isolation and loneliness cause high levels of emotional distress because they threaten the satisfaction of the basic human need to belong.
Maladaptive social cognition	Loneliness causes hypervigilance towards social threats, which may in turn lead to negative biases in social information processing (e.g., negative evaluations of oneself and others).
Problematic social behaviours and interpersonal stress	The cognitive biases caused by loneliness may elicit problematic social behaviours in lonely people, to which others may respond with rejection, thus confirming and reinforcing these biases. As a result, lonely people are often trapped in a downward spiral of increasing loneliness, cognitive biases, and interpersonal stress.
Lack of psychosocial resources	Social isolation and loneliness deprive people of the psychosocial resources typically provided by social connections, such as meaning in life, self-esteem, and perceived social support.
Behavioural pathways	
Lack of social control	Social isolation implies that people are subject to less social control and therefore receive less encouragement to engage in healthy behaviour and seek professional help for mental health problems.
Lack of a sense of responsibility	Social isolation deprives people of social roles that involve a sense of responsibility towards role partners and thus encourage the avoidance of risky behaviour.
Lack of routines in daily life	Social isolation deprives people of social roles that can introduce routines into their daily lives, which can in turn promote health (e.g., regular sport activities with friends) or offer incentives to engage in healthy practices (e.g., fixed mealtimes with the family).
Impaired capacity for self-regulation	Loneliness leads to impairments in self-regulation because lonely people prioritise the short-term regulation of their emotions over the long-term pursuit of self-regulatory goals (e.g., a healthy lifestyle).
Biological pathways	
Maladaptive biological stress reactivity	Social isolation and loneliness are severe stressors that activate a range of biological processes that can have pathological effects (e.g., dysregulation of the HPA axis).
Sleep problems	Social isolation and loneliness lead to sleep problems because, throughout human evolution, they represented states in which people lacked the sense of security that is essential for restorative sleep.

1.3.2 Selection

Another explanation for the observed associations focuses on the selection of people with mental health problems into social isolation and loneliness. In general, selection effects occur because both conditions are not randomly assigned to people. Instead, people with certain characteristics are more likely to become socially isolated or feel lonely. Following the terminology used in research on health inequalities (Blane et al., 1993; Foverskov and Holm, 2016; Kröger et al., 2015), direct selection occurs when mental health problems per se increase the risk of social disconnection. In contrast, indirect selection occurs when the selection is due to stable characteristics that increase a person's vulnerability to mental health problems.

Although the potential role of selection has long been recognised, the precise mechanisms underlying selection effects are still poorly understood. This gap is primarily due to the lack of an overarching theoretical framework that explicitly addresses selection processes. Thus, an essential contribution of my thesis lies in its review of research from different disciplines to identify mechanisms through which people with mental health problems might self-select into social isolation and loneliness. This literature review highlights several mechanisms that can potentially underlie the two types of selection. In general, it seems plausible to assume that selection may occur because people with mental health problems experience interpersonal problems and negative life events at higher rates (Liu, 2013; Liu and Alloy, 2010; Meyer and Curry, 2017), which can reduce the quality of their social relationships and prevent the formation of long-lasting social bonds. In addition, people with mental health problems may exhibit negative cognitive biases (LeMoult and Gotlib, 2019; Mathews and MacLeod, 2005), making it more likely for them to perceive their social relationships as inadequate in some way. In the following sections, the theoretical arguments underlying direct and indirect selection are elaborated in further detail.

1.3.2.1 Direct selection

Mental illness is characterised by a wide range of symptoms that affect how people feel, think, and behave (American Psychiatric Association, 2022). These symptoms can also affect how others perceive individuals with mental illness and how they behave towards them. Therefore, the direct selection hypothesis suggests that the presence of mental health problems is the primary driver underlying the selection of people into isolation and loneliness. This section elaborates on several potential mechanisms that could drive direct selection in further detail. Table 1.2 summarises the key terms and concepts related to the direct selection hypothesis.

Impairments in social functioning

The first pathway is based on the observation that social functioning is often impaired in people with mental health problems (Kupferberg et al., 2016). Indeed, clinical diagnoses of disorders such as major depressive disorder and generalised anxiety disorder require that the relevant symptoms lead to impairment in social life or other areas of life (American Psychiatric Association, 2022). Social functioning is defined in this thesis in terms of a person's ability to perform the social tasks involved in daily life effectively and to fulfil the role expectations stipulated by the social environment. Research has identified several factors that contribute to social dysfunction among people with mental health problems (Cambridge et al., 2018; Gadassi and Rafaeli, 2015; Kupferberg et al., 2016; Weightman et al., 2019). For example, mental illness may lead to cognitive dysfunction in several domains, such as executive functions and memory (for an overview, see East-Richard et al., 2020), which can disrupt daily routines and make everyday activities such as adapting to new situations, organising social life, and following conversations more challenging (Baune, 2021, p. 13). In addition, mental illness may lead to impairments in the sociocognitive skills that are necessary to navigate the social world successfully, such as emotion recognition and theory of mind, which refers to the ability to understand other people's beliefs, feelings, and intentions (for overviews, see Cotter et al., 2018; van Neerven et al., 2021). As a result, people with mental illness may experience difficulties understanding social situations, predicting other people's behaviour, and responding appropriately to social situations. Overall, extensive evidence has suggested that social life is more challenging for people facing mental health problems, thus increasing their risk of social isolation and loneliness.

Avoidance of social interactions and social withdrawal

Other pathways suggest that people with mental health problems are at greater risk of social isolation and loneliness due to their tendency to avoid social interactions or even to withdraw from social life. Three arguments have been identified in favour of this pathway.

First, people with mental health problems may be socially avoidant because of anhedonia, which refers to the loss of interest and pleasure in activities that were previously enjoyable (American Psychiatric Association, 2022). Anhedonia, alongside a depressed mood, is a cardinal symptom of major depressive disorder and can extend into the realm of social relationships (Barkus and Badcock, 2019). Although humans are born with a need to belong that makes it easy for them to enjoy their social lives (Baumeister and Leary, 1995), the ability to enjoy social life is often diminished among people who have been diagnosed with major

depression (Gandhi et al., 2022; Trøstheim et al., 2020). As such people find social activities to be less enjoyable, they may express reduced interest in social activities and withdraw from social contexts (Barkus, 2021). For example, two studies found that social anhedonia is associated with spending more time alone, preferring to be alone, and disengaging from social situations (Brown et al., 2007; Kwapil et al., 2009). Interestingly, studies have shown that social anhedonia is also related to *stronger* feelings of loneliness (Badcock et al., 2016; Tan et al., 2020). This finding suggests that although social anhedonia decreases the desire to connect with others, it does not entirely suppress the biological warning system of loneliness that alerts us to deficient social connections (Barkus and Badcock, 2019).

Second, people with mental health problems may avoid social situations in an attempt to conceal their illness, for example, because they feel ashamed or guilty about their condition (Kim et al., 2011) or because they anticipate being stigmatised by others (Sheehan et al., 2022). In Germany, a high level of public stigma is attached to mental illness (Angermeyer et al., 2013), and this issue has witnessed little improvement in recent decades (Schomerus et al., 2022). Public stigma is a complex process that involves stereotypes (negative beliefs about people with mental illness), prejudice (endorsement of negative stereotypes and the associated negative emotional reactions), and discrimination (behavioural manifestations of prejudice; Rüsch et al., 2005). Accordingly, anticipated stigma occurs when people with mental health problems are aware of the negative stereotypes pertaining to their stigmatised condition and expect negative reactions and discrimination to be directed at them (Sheehan et al., 2022). To avoid being recognised and classified as having a mental illness, they may avoid coming into contact with other people. For example, in an extensive study of people with depression from 35 countries, Lasalvia et al. (2013) showed that 71% of these people reported that they actively tried to conceal their illness from other people because they expected to be stigmatised, and 37% of them reported that they had stopped initiating close personal relationships. In the European context, Lasalvia et al. (2021) observed similar rates of anticipated stigma in the formation of personal relationships on the part of people with anxiety disorders, affective disorders, and schizophrenia.

Finally, the social withdrawal of people with mental health problems may be due to the fact that they internalise the stigma associated with mental illness and begin to stigmatise themselves. Self-stigma occurs when people are aware of the negative stereotypes pertaining to their condition, endorse them, and apply them to themselves (Rüsch et al., 2005; Sheehan et al., 2022). Self-stigma may lead to social withdrawal due to its negative psychological effects, including low self-esteem, stronger feelings of hopelessness, and reduced self-efficacy

(for overviews, see Boyd et al., 2022; Del Rosal et al., 2021; Livingston and Boyd, 2010). In particular, self-stigma can lead to the "why try" effect, which leads people to stop pursuing major life goals (Corrigan et al., 2016; Corrigan et al., 2009). For example, people who stigmatise themselves may refrain from pursuing opportunities to find a romantic partner because they believe that they are worthless to others and will not be successful in any case. To support this argument, evidence has shown that self-stigma is associated with poorer social relationships (Livingston and Boyd, 2010) and greater loneliness (Chrostek et al., 2016).

Shunning and rejection by other people

Still other pathways pertain to the possibility that people with mental health problems may be more likely to be shunned or rejected by other people. Two theoretical arguments have been identified to support this pathway.

First, this shunning and rejection could result from negative stereotypes about people with mental health problems. For example, a German study reported that a significant proportion of respondents felt uncomfortable (30% in 2011), insecure (21%), or scared (20%) when they were presented with a vignette featuring a person with major depressive disorder (Angermeyer et al., 2013). These emotional reactions may lead to a greater desire to socially distance oneself from people with depression. For example, the study found that 37% of respondents would not introduce people with depression to their friends, 41% would not want them to marry into the family, and 62% would not allow them to take care of children (Angermeyer et al., 2013). Another study found that 79% of people with depression reported experiencing discrimination. Many commonly reported life domains in this context were related to social life, including family (40%), making or keeping friends (33%), marriage or divorce (23%), and dating and intimate relationships (21%). Most importantly, more than a third of the respondents (34%) were shunned by others because of their mental illness (Lasalvia et al., 2013).

Second, people with mental health problems may engage in problematic social behaviours to which others may eventually respond with rejection (Evraire and Dozois, 2011; Hames et al., 2013). For example, Coyne's (1976) interpersonal theory of depression describes a process in which people with mild depression seek reassurance from others who are close to them about their worth as a person. These others may initially provide the desired feedback. However, they become increasingly frustrated when the person with depression doubts the authenticity of the feedback and responds with even more energetic attempts to obtain the desired reassurance. Eventually, this behaviour leads to rejection by the people from whom the positive feedback was sought, thereby creating a downward spiral that exacerbates

depressive symptoms and interpersonal problems (Coyne, 1976). Joiner et al. (1999) referred to this behavioural tendency as excessive reassurance-seeking, which they defined as "the relatively stable tendency to excessively and persistently seek assurances from others that one is lovable and worthy, regardless of whether such assurance has already been provided" (p. 270). Empirical research has supported the main arguments of Coyne's theory, showing that depression is associated with a greater tendency towards excessive reassurance-seeking, which in turn is positively associated with both interpersonal problems and rejection (Evraire and Dozois, 2011; Starr and Davila, 2008; Wakeling et al., 2020).

Although it has been claimed that excessive reassurance-seeking is relatively specific to depression (Hames et al., 2013), researchers have recently observed a similar behavioural pattern in people with anxiety (Cougle et al., 2012; Parrish and Radomsky, 2010; Rector et al., 2011). In particular, people with anxiety also tend to seek excessive reassurance from others, but the reassurance they seek pertains less to their worth as persons according to others and more to perceived general threats (Parrish and Radomsky, 2010; Rector et al., 2011). Thus, while the content of the information being sought may differ across mental disorders, excessive reassurance-seeking seems to be a general behavioural tendency in people with mental health problems that may explain why others shun them.

Biased information processing

Finally, people with mental health problems may exhibit biases with regard to information processing (e.g., Gotlib and Joormann, 2010; LeMoult and Gotlib, 2019; Mathews and MacLeod, 2005), which may result in overly negative perceptions of their social environment. For example, according to Beck's cognitive theory of depression (Beck et al., 1979), people who are at high risk of depression have stable cognitive schemas that contain negative beliefs about the self, the world around them, and the future. For example, people with depression tend to attribute negative experiences to their own shortcomings, to see defeat everywhere, and to assume that their current difficulties will persist into the future. Beck et al. (1979) argue that these schemas are initially formed in response to negative experiences in early life and often remain latent until they are re-activated by a negative life event before the onset of a depressive episode. Once activated, they produce systematic biases at all stages of information processing. For example, studies have increasingly used eye-tracking technology to show that people with depression tend to dedicate more attention to negative stimuli (e.g., sad faces) and less attention to positive stimuli (e.g., happy faces) than do healthy controls (Suslow et al., 2020). Other studies have reported a negative interpretation bias in people with depression,

which is intensified in the case of self-referential stimuli (Everaert et al., 2017), as well as a negative memory bias and a lack of positive memory bias (Everaert et al., 2022). Due to these cognitive biases, people with depression may be more attentive to negative social cues, misinterpret social interactions, and be more likely to remember negative social events. Consequently, cognitive biases may increase the risks of social isolation and loneliness by increasing the likelihood of social relationships being perceived as deficient and by leading to problematic social behaviours (e.g., social avoidance, excessive reassurance-seeking) that damage social connections.

Table 1.2 Overview of key terms and potential mechanisms underlying direct selection

Impairments in social functioning	
Social dysfunction	People with mental health problems may experience greater difficulty dealing with social tasks in daily life, for example, because of cognitive impairment and impaired sociocognitive skills.
Avoidance of social interactions and social withdrawal	
Social anhedonia	People with mental health problems may withdraw from social life because they derive less pleasure from and have less interest in social activities.
Anticipated stigma and feelings of shame	People with mental health problems may avoid social situations to conceal their stigmatised condition, for example, because they feel ashamed or anticipate being stigmatised by others.
Self-stigma	People with mental health problems may apply negative stereotypes to themselves and stop pursuing major life goals, including goals pertaining to interpersonal relationships.
Shunning and rejection by other people	
Actual stigma	People with mental health problems may be shunned or rejected by others due to their stigmatised condition.
Problematic social behaviours	People with mental health problems may engage in problematic behaviours, such as excessive reassurance-seeking, to which others may respond with frustration and eventually rejection.
Biased information processing	
Cognitive biases	People with mental health problems may exhibit negative biases in terms of attention, interpretation, and memory, which may lead them to perceive their social relationships in an overly negative way.

1.3.2.2 Indirect selection

The indirect selection hypothesis claims that selection into social isolation and loneliness is not driven by mental health problems per se but rather by (stable) characteristics that increase a person's vulnerability to mental health problems (Blane et al., 1993; Foverskov and Holm, 2016; Kröger et al., 2015). In contrast to the causation and direct selection hypotheses, this hypothesis suggests that the poorer mental health experienced by socially isolated or lonely people does not reflect causal effects in either direction but rather confounding by shared risk factors. The characteristics most likely to be involved in selection processes are genetic factors (Abdellaoui et al., 2019; Matthews et al., 2016; Rødevand et al., 2021), personality traits such as neuroticism and extraversion (Buecker et al., 2020; Jeronimus et al., 2016; Khazanov and Ruscio, 2016), experiences of maltreatment in childhood (de Heer et al., 2022; Gardner et al., 2019), and certain psychological traits that develop from these experiences, such as insecure attachment styles (Mikulincer and Shaver, 2014; Zhang et al., 2022) and rejection sensitivity (Gao et al., 2017b; Mishra and Allen, 2023). Because such characteristics are difficult to observe and often not measured in the relevant data, many previous studies have not adjusted for them and therefore may have overestimated the relevance of social isolation and loneliness to mental health. Consequently, these associations should be significantly weaker when such characteristics are taken into account. The following sections provide a brief overview of the available evidence regarding genetic predispositions, maltreatment in childhood, and the resulting rejection sensitivity as examples of possible unobserved confounders.

Genetic predispositions

Genome-wide association studies (GWAS) have been used to identify common genetic variants (usually single nucleotide polymorphisms, SNPs) that are significantly associated with phenotypic traits such as social isolation, loneliness, and mental health (Frayling, 2014). This research has shown that common genetic variants account for 4.2 to 27% of the variation in the phenotypic traits of social isolation and loneliness (which is often referred to as SNP-based heritability, Abdellaoui et al., 2019; Bralten et al., 2021; Day et al., 2018; Gao et al., 2017a). These heritability estimates are lower than those found in behavioural genetics, which are typically in the range of 37 to 55% (Matthews et al., 2016; Spithoven et al., 2019). This "missing heritability" is due to the fact that heritability in GWAS reflects the additive effects of common genetic variants that occur in more than 5% of the population but not rare genetic variation or gene-gene interactions (Spithoven et al., 2019). Recent studies have also found 19 genetic variants across 18 and 16 loci (i.e., the specific location of a gene on the chromosome)

that are significantly related to social (dis)connection and loneliness, respectively, and 56 and 58 genes with genome-wide significance (Abdellaoui et al., 2019; Bralten et al., 2021). These findings suggest that genetic predispositions contribute substantially to individual differences in social isolation and loneliness.

In addition, emerging research has found moderate to strong genetic correlations between (perceived) social isolation and a variety of outcomes, including depressive symptoms, major depressive disorder, and subjective well-being (Abdellaoui et al., 2019; Baselmans et al., 2019; Bralten et al., 2021; Rødevand et al., 2021). These correlations indicate some degree of overlap among the genetic influences on the phenotypic traits. Moreover, another study identified 149 loci that are jointly related to social (dis)connection and mental disorders such as major depression (n = 67), schizophrenia (n = 54), and bipolar disorder (n = 28; Rødevand et al., 2021). The shared genetic basis between social isolation, loneliness, and mental health could be due to causal links between these phenotypic traits (e.g., genetic influences on social (dis)connection, which in turn affects mental health, or vice versa) or shared genetic influences that introduce genetic confounding into their associations (Abdellaoui et al., 2019; Lee et al., 2021).

Genetic confounding most likely leads to upwardly biased estimates of the effects of social isolation and loneliness on mental health but is extremely difficult to take into account in observational studies. Lee et al. (2021) attempted to adjust for genetic confounding using panel data from the English Longitudinal Study of Aging. This study found that controlling for polygenic risk scores for loneliness and depressive symptoms, which are estimates of a person's genetic susceptibility to these conditions, did not reduce the prospective effect of loneliness on depressive symptoms among older adults. However, controlling for polygenic risk scores cannot completely rule out genetic confounding, as these scores capture genetic variation only to a certain degree (Lee et al., 2021). Further research to rule out the possibility of genetic confounding is therefore urgently needed.

Childhood maltreatment and rejection sensitivity

Childhood maltreatment, which includes all types of neglect and abuse, is a common and often impactful traumatic experience that has been overlooked as a possible confounder in previous research. Globally, the estimated prevalence of childhood maltreatment ranges from 12.7% for sexual abuse to 36.3% for emotional abuse (Stoltenborgh et al., 2015). Regarding the impact of maltreatment, a large body of research has found associations with negative health outcomes across the life course (Carr et al., 2020), including a greater risk of mental disorders

such as depression and anxiety (Gardner et al., 2019; Li et al., 2016). Other research has shown that childhood maltreatment predicts an unfavourable clinical course of depression, as indicated by an earlier age of onset, an increased risk of recurrent and persistent depressive episodes, and lower treatment responsiveness (Nanni et al., 2012; Nelson et al., 2017). In addition, research has suggested a link between a history of maltreatment and problematic behaviours, such as general impulsivity (Liu, 2019) or anti-social, violent, and aggressive behaviour (Braga et al., 2018; Fitton et al., 2020; Ran et al., 2022). Furthermore, research has linked maltreatment to a smaller network size (Reinhard et al., 2022), lower relationship quality (Cao et al., 2022), and stronger feelings of loneliness (de Heer et al., 2022). Therefore, the available evidence suggests that childhood maltreatment contributes substantially to both interpersonal difficulties and mental health problems across the life span. The following section briefly introduces rejection sensitivity as a potential mechanism by which a history of childhood maltreatment may lead to poor health and social outcomes.

Rejection sensitivity reflects the stable tendency to "anxiously expect, readily perceive, and intensely react to rejection" (Romero-Canyas et al., 2010, p. 120), which may develop early in life as a way of coping with experiences of neglect and rejection (Romero-Canyas et al., 2010). Several meta-analyses have associated rejection sensitivity with poor mental health outcomes such as depression and anxiety (Gao et al., 2017b), as well as increased feelings of loneliness (Gao et al., 2017b), a decreased likelihood of entering a romantic relationship, and poor relationship outcomes for people in romantic partnerships, such as decreased relationship satisfaction and more relationship conflicts (Mishra and Allen, 2023). These associations have been explained by reference to the fact that people who are sensitive to rejection enter social situations with the anxious expectation that others will reject them. As a result, such people are more alert to cues of rejection and are more likely to misinterpret ambiguous social cues as signs of rejection. In addition, they tend to display intense affective and behavioural reactions to social cues that indicate rejection (Romero-Canyas et al., 2010). Thus, to protect themselves from the pain of rejection, they tend to avoid social situations, and when they perceive actual rejection, they often engage in hostile and aggressive behaviours to regain control over the situation and protect their self-esteem (Romero-Canyas and Downey, 2014). It has also been argued that rejection sensitivity increases the risk of developing depression when such rejection is attributed to one's own deficiencies (Levy et al., 2006; Romero-Canyas and Downey, 2014), and one diagnostic criterion for atypical depression is a longstanding pattern of rejection sensitivity (American Psychiatric Association, 2022).

1.3.2.3 Causation and selection in well-being research

Thus far, the thesis has focused on causation and selection in the context of mental health problems, particularly negative outcomes such as psychiatric symptoms. As outlined in the introduction, the causation hypothesis is also tested in this thesis with regard to the association between loneliness and well-being to ensure the robustness of the findings.

Although well-being research has not addressed causation and selection, these hypotheses can be derived from the more general debate concerning bottom-up and top-down influences on well-being (Diener, 1984). The causation hypothesis follows the theoretical rationale underlying bottom-up theories of well-being, which describe people's well-being as a subjective average of their evaluations of different life domains (e.g., Diener, 1984). Therefore, all the arguments formulated for the causation hypothesis can also be applied to the effect of loneliness on subjective well-being. In contrast, the selection hypothesis follows the rationale of top-down theories, which posit that stable dispositions determine people's overall outlooks on their lives, which in turn affect how people evaluate different life domains. Top-down influences can occur for two reasons (Lucas, 2004). First, happy people have been found to be objectively more successful in their social lives, especially with regard to the cultivation of stable, supportive, and positive relationships (Kansky and Diener, 2017; Lyubomirsky et al., 2005; Moore et al., 2018). Second, happy people tend to exhibit positivity bias when evaluating social relationships. For example, research has shown that happy people are more attentive to positive social stimuli, interpret ambiguous and positive social interactions more positively, and recall more positive life experiences (Heintzelman and Diener, 2019; Raila et al., 2015; Seidlitz and Diener, 1993; Tamir and Robinson, 2007). Therefore, it can be argued that chronically unhappy people are more likely to feel lonely because they are objectively less successful in their social lives and tend to interpret social experiences less positively. Overall, it becomes clear that the arguments formulated for psychiatric outcomes can easily be adapted to well-being as a positive mental health outcome.

1.3.2.4 Summary

The previous sections outlined three hypotheses that help explain the associations between social isolation, loneliness, and mental health problems. The causation hypothesis argues that a lack of social connection is detrimental to mental health, and Section 1.3.1 discussed a range of psychosocial, behavioural, and biological mechanisms that could mediate this effect. The direct selection hypothesis posits that the presence and symptoms of mental health problems increase the risks of social isolation and loneliness. In Section 1.3.2.1, direct selection was

explained by reference to the tendencies of people with mental health problems to find social life more challenging, to withdraw from social life, to be shunned by others, and to perceive the social environment in an overly negative way. Finally, the indirect selection hypothesis argues that selection is due to stable characteristics ('vulnerabilities'), such as genetic predispositions, personality traits, and early traumatic experiences, that make people more susceptible to mental illness (Section 1.3.2.2). This hypothesis essentially implies that social isolation and loneliness should no longer be associated with mental health outcomes when these stable confounders are taken into account. Furthermore, the causation and selection hypotheses were contextualised within the broader debate concerning bottom-up and top-down influences on well-being, demonstrating that the theoretical arguments formulated for psychiatric outcomes can easily be generalised to positive mental health outcomes. Although selection is certainly an issue of great social importance, the empirical studies contained in this thesis treat selection primarily as a source of bias that must be statistically eliminated when examining the effects of social isolation and loneliness on mental health.

1.4 Empirical evidence for causation and selection

As noted in the introduction, research has consistently shown that social isolation and loneliness are associated with mental health problems. The preceding sections presented three central explanations for these associations. However, much less research has attempted to disentangle causation from the two types of selection statistically. The following section provides a concise overview of the empirical literature on this topic, considering only studies that investigated the different explanations empirically.

A number of studies have used the cross-lagged panel model to determine the direction of causality. According to this analytical approach, mental health (t_2) can be explained based on social disconnection and mental health at the previous point in time (t_1) and vice versa. Almost all studies that have used this approach have examined depressive symptoms as an outcome. However, this research has produced inconsistent evidence. In some studies, loneliness predicted later depressive symptoms, but not vice versa (Cacioppo et al., 2010; Domènech-Abella et al., 2021; Mayerl et al., 2021). In other studies, depressive symptoms predicted later loneliness, but not vice versa (Danneel et al., 2019; Lasgaard et al., 2011; McHugh Power et al., 2020). Still other studies have found a reciprocal relationship between these two conditions (Groarke et al., 2021; Luo et al., 2012; van Zutphen et al., 2021; Vanhalst et al., 2012; Ward et al., 2023). Although different age groups have been analysed, the review of the literature

does not provide sufficient evidence of systematic age differences. Moreover, very few studies have focused on outcomes other than depressive symptoms. In two studies, loneliness predicted psychotic-like experiences in college students (Tan et al., 2021) and anxiety symptoms in older people during the COVID-19 pandemic (Mayerl et al., 2021), but not vice versa. Another pair of studies revealed a reciprocal association between loneliness and life satisfaction (Cacioppo et al., 2008; Tough et al., 2018). Overall, most research has found some evidence for causation, but evidence has also suggested that direct selection is involved.

Very few studies have used cross-lagged panel models to examine the association between social isolation and mental health. In a study of older people, Santini et al. (2020) observed that social disconnection (as measured, for example, by the size of the social network, the frequency of social interactions, and the number of friends, among other factors) did not directly predict depressive and anxiety symptoms. Conversely, depressive symptoms directly predicted later social disconnection, while anxiety did not. Similarly, Herbolsheimer et al. (2018) found that depressive symptoms affected social isolation from friends, neighbours, and family in older people, but not vice versa. Overall, these two studies indicated that depressive symptoms are more likely to increase the risk of social isolation than social isolation is to contribute to depressive symptoms, thus supporting the direct selection hypothesis.

The standard cross-lagged panel model may be intuitively appealing to many researchers because it establishes a clear sequence of cause and effect. Despite this advantage, it has several shortcomings (e.g., Lucas, 2023), two of which are directly related to its ability to distinguish between causation and the two types of selection. First, the standard cross-lagged panel model is unable to account for the confounding impacts of unobserved stable characteristics (Allison et al., 2017; Hamaker et al., 2015; Lucas, 2023). As a result, the cross-lagged effects used to infer the relative importance of causation and direct selection are likely to be upwardly biased. In particular, the importance of these two hypotheses is likely to be overestimated, as the reciprocal effects between social isolation, loneliness, and mental health may actually reflect indirect selection. Second, the magnitude of cross-lagged effects varies as a function of the time interval between two variables (Kuiper and Ryan, 2018). Unfortunately, theoretical reasoning is often too imprecise to determine the actual latency of these effects. In most cases, the specification of the latency of these effects is not theoretically justified but is rather dictated by the time intervals between observations in the data. Hence, the validity of conclusions concerning the roles of causation and direct selection often depends on the crucial but often implausible assumptions that (a) the specified time interval matches the actual latency of the effects being estimated and that (b) the latency of the effects is

identical in both directions (i.e., for causation and direct selection). In conclusion, while the cross-lagged panel model is a widely used analytical approach, these shortcomings limit its usefulness with regard to identifying the causal processes that link social disconnectedness to mental health.

Another line of research has used the prospective cohort design to study the effects of social isolation and loneliness on mental health. In this approach, the risk of developing an outcome ($t > 1$) is explained by an exposure at baseline (t_1) among a subsample of people who do not exhibit the outcome at baseline. Several studies have found that social isolation and loneliness are prospectively associated with higher risks of developing depression and anxiety (Beutel et al., 2019; Flensborg-Madsen et al., 2012; Noguchi et al., 2021; Weziak-Bialowolska et al., 2022). For example, Noguchi et al. (2021) studied the prospective effect of social isolation on the onset of depression in the UK and Japan. The results showed that the odds of developing depression among the most isolated people were 4.01 (UK) and 1.48 (Japan) times the odds of developing depression among the people who were least isolated. Similar to the standard cross-lagged panel model, the analytical advantage of the prospective cohort design lies in the clear sequence of cause and effect. However, this design cannot rule out confounding by unobserved characteristics (i.e., indirect selection) by restricting the sample to people who did not initially exhibit the outcome.

Very few longitudinal studies have sought to disentangle causation from the two types of selection by using extensions of the cross-lagged panel model, such as dynamic panel models with fixed effects (for more details, see Allison et al., 2017), random intercept cross-lagged panel models (Hamaker et al., 2015), and latent curve models with structured residuals (Curran et al., 2014). These approaches facilitate the analysis of the reciprocal effects between social disconnection and mental health based on the within-individual variation while controlling for any (un)observed stable confounders and prior changes in the outcomes.

With regard to loneliness, this research has found limited evidence for the causation hypothesis, which is surprising given that most of the research discussed thus far has indicated an effect of loneliness on mental health. Based on non-probability samples of adults from the USA, two studies found weak to moderate effects of loneliness on outcomes such as depression, (social) anxiety, and paranoia (Lim et al., 2016; McDowell et al., 2021). In contrast, other studies from Europe and the USA found either very weak ($\beta < 0.1$; Joshanloo, 2022; Luo, 2022) or nonsignificant effects of loneliness on depressive symptoms in three nationally representative samples of older people (Griffin et al., 2022; Joshanloo, 2022; Mayerl et al., 2022). In another study, loneliness did not influence symptoms of anxiety and

depression in adolescents from selected Norwegian schools (Kristensen et al., 2022). Interestingly, evidence for direct selection has also been limited, with only three studies supporting this hypothesis. Specifically, one study found that depressive symptoms were weakly predictive of loneliness in older people over three years but not over six years (Joshanloo, 2022). In another study, social anxiety but not depression and paranoia were found to predict loneliness over six to eight weeks in adults (Lim et al., 2016). Yet another study on adolescents showed that symptoms of anxiety and depression affected loneliness over a one-year period, but only in girls (Kristensen et al., 2022). All other studies have reported either very weak or nonsignificant effects of mental health on subsequent loneliness (Griffin et al., 2022; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). The limited evidence for both the causation hypothesis and the direct selection hypothesis suggests that indirect selection is the driving force underlying the association between loneliness and mental health.

However, this research has exhibited serious shortcomings. First, none of the studies controlled for negative life events (e.g., unemployment, divorce) as potential time-varying confounders. As a result, the evidence in favour of the causation hypothesis may actually reflect confounding by unobserved life changes. Second, the analytical strategies used in this research required strong assumptions concerning the latency of the effects, which may not be tenable. As argued above, establishing a clear temporal sequence of cause and effect is preferable for causal inference. However, simulation studies have demonstrated that within estimators can be severely biased if the time interval between exposure and outcome is not correctly specified, possibly to the extent of reversing the sign of the effect (Leszczensky and Wolbring, 2022; Vaisey and Miles, 2017). In the studies described above, the latency varied from one week (McDowell et al., 2021) to six years (Joshanloo, 2022). Interestingly, studies found evidence for causation only when they assumed that loneliness affected mental health several weeks later rather than multiple years later (Lim et al., 2016; McDowell et al., 2021). It is plausible that other studies did not find evidence of causation because they specified the latency of the loneliness effect incorrectly. However, the studies also differed in terms of sample characteristics and sampling approaches. In particular, the two studies that supported the causation hypothesis were based on non-probability samples that covered the entire adult life span (Lim et al., 2016; McDowell et al., 2021), while the other studies analysed samples of adolescents from selected schools (Kristensen et al., 2022) and nationally presentative samples of older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Hence, it remains unclear whether these inconsistent findings can be explained by differences in the assumed latency of the effect, differences in the vulnerability of age groups, or

differences in sampling. However, it is difficult to determine the exact reasons for these inconsistent findings, especially as little is known about possible differences in the importance of causation and selection across sociodemographic groups.

To my knowledge, no study has utilised similar analytical strategies to explain why people who are socially isolated report poorer mental health before the publication of Study 1 (see Chapter 2). The most closely related research explored the reciprocal effects between three aspects of social relationships and mental health using random-intercept cross-lagged panel models based on Australian panel data (Kiely et al., 2021). The results showed that informal social contact predicted mental health over a four-year period (and vice versa) in people aged 50 and older but not in people less than 50 years of age. In contrast, civic engagement and political participation were not or only weakly predictive of mental health. Since the publication of Study 1, two more studies have investigated whether social isolation leads to worse mental health. Using an Australian sample, Vella-Brodrick et al. (2023) found that social connections did not predict emotional well-being over a four-year period, while emotional well-being was a weak predictor of later social connections. Similarly, Luo (2022) found no support for the causation hypothesis in older people from the USA. More specifically, social isolation did not contribute to depressive symptoms over a four-year period. Conversely, depressive symptoms led to slightly higher levels of social isolation. As argued above, it may simply be the case that social isolation does not affect mental health or, more likely, that the time interval between the two conditions in these studies was specified incorrectly.

Summary

Research has used different analytical strategies to discriminate statistically between causation and selection. In general, it became evident that few studies have focused on social isolation, whereas many more studies have analysed loneliness. Furthermore, the brief review showed that some studies have used analytical strategies that are better suited than cross-sectional studies to the task of determining the direction of causality but do not account for indirect selection (e.g., the standard cross-lagged panel model). In contrast, few studies have attempted to separate causation from *both* types of selection. With regard to loneliness, these studies have provided little support for causation and direct selection, suggesting that indirect selection seems to drive the association between loneliness and mental health. With respect to social isolation, no study prior to Study 1 considered all three explanations, and subsequent studies have found no evidence of causation. The fact that research has failed to find consistent evidence for the causation hypothesis is remarkable because researchers and public health

experts have readily assumed that a lack of social connections represents a significant cause of mental health problems.

1.5 Research gaps and the contributions of the empirical studies contained in this thesis

In the preceding sections, this thesis sought to make a theoretical contribution to the literature by extracting and systematising theoretical arguments regarding direct and indirect selection processes from different fields of research. This contribution is important because the role of selection has been severely undertheorised in the literature. Then, the state of empirical research was reviewed to determine whether prior studies were able to separate causation from selection. It became clear that most studies did not account for both types of selection, and the few empirical studies that used extensions of the cross-lagged panel model and found very limited evidence to support the causation hypothesis have exhibited significant shortcomings. In the following chapters, the thesis presents four empirical studies that reconsider the causal nature of the associations between social isolation, loneliness, and mental health. The empirical chapters seek to advance the literature in several ways.

First, it is necessary to test the causation hypothesis using nationally representative panel data and suitable methods of panel data analysis. In this regard, the studies investigate whether the association between the two types of social disconnection and mental health persists when the selection of people with mental health problems into social isolation and loneliness is taken into account as an alternative explanation. If a substantial association persists when considering the two types of selection, this finding could be interpreted as indicating that social isolation and loneliness affect mental health. In addition, the causation hypothesis must be tested with regard to both negative (psychiatric outcomes) and positive aspects of mental health (subjective well-being). Analysing various outcomes ensures that evidence for causation is not specific to the outcomes under examination. Robust evidence for the causation hypothesis would indicate that the concern that the COVID-19 pandemic might be paralleled by a mental health crisis was well founded and that social disconnection imposes significant costs on health care systems.

Second, it is necessary to explore the possibility that the relevance of causation might differ among sociodemographic groups. This exploratory analysis advances the state of research on this topic for two reasons. The first reason is that previous studies on the effect of loneliness on mental health have supported the causation hypothesis in adults (Lim et al., 2016;

McDowell et al., 2021) but not in adolescents (Kristensen et al., 2022) and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Additionally, no study has tested the causation hypothesis with regard to young adults. It therefore remains unclear whether the inconsistent results are due to methodological factors (e.g., differences in sampling and effect latency) or age-related differences (e.g., a lower vulnerability of older people). Hence, subgroup analyses concerning younger and older people can help reveal the reasons for these inconsistent findings and ensure the robustness of the statistical analyses.

Another reason is that the few studies conducted using within estimators have addressed the question of whether evidence for causation can be demonstrated for both men and women. Gender differences in the roles of social isolation and loneliness might occur for several reasons. On the one hand, it seems plausible to assume that social disconnection affects women more strongly than men, for example, because women are more susceptible to mental illness (Steel et al., 2014), may tend to construe their self in a more interdependent manner in Western societies (Cross and Madson, 1997), and are more sociotropic, which refers to the tendency to overvalue the maintenance of positive social relationships (Yang and Girgus, 2019). On the other hand, some evidence has suggested that depression and related vulnerabilities contribute more to interpersonal problems and negative life events in women than in men (Liu and Alloy, 2010). These arguments point to possible gender differences pertaining to the relevance of causation and selection, but the findings of the few studies that have explored such differences have been somewhat inconclusive. One study observed a weak effect of loneliness on symptoms of anxiety and depression in adolescent girls but no effect in boys. However, the effect was not statistically significant for either gender, possibly due to the small sample size. Furthermore, symptoms of anxiety and depression predicted later loneliness in girls but not in boys (Kristensen et al., 2022). Thus, in support of the theoretical arguments presented above, both causation and direct selection appear to be more important for girls. In contrast, two studies found that the reciprocal association between loneliness and depressive symptoms did not differ between older men and women (Joshanloo, 2022; Mayerl et al., 2022). Moreover, none of these studies analysed gender differences in the effect of social isolation on mental health (Luo, 2022; Vella-Brodrick et al., 2023). It is therefore necessary to stratify the statistical analyses by gender to detect potentially unrecognised gender differences and ensure that evidence for the causation hypothesis can be found in both men and women.

Third, it is necessary to test the causation hypothesis using multiple measures of social isolation and loneliness. It is important to show that the measurement of the two concepts does not affect the conclusions regarding causation because these concepts have been measured in

different ways (Eckhard, 2018b; Mund et al., 2022; Zavaleta et al., 2017). In the case of social isolation, no prevailing definition of the concept has yet been provided, and therefore, no consensus has been reached concerning the aspects of social relationships that must be lacking for a person to be classified as socially isolated (Eckhard, 2018b; Zavaleta et al., 2017). In the case of loneliness, researchers have agreed on its definition, but commonly used measurement approaches have specific strengths and weaknesses (Mund et al., 2022; Office for National Statistics, 2018). Direct measures explicitly ask the respondents about the extent to which or how often they feel lonely. This approach can lead to social desirability bias due to the stigma attached to feelings of loneliness. As a result, respondents may be ashamed to discuss their experience of loneliness openly. In contrast, indirect measures try to overcome this problem by avoiding the use of the term 'lonely' altogether. However, they often measure loneliness using multi-item scales in which some items might not reflect the respondents' understanding of loneliness (e.g., 'how often do you feel left out?'). None of the studies conducted using within estimators has compared the results across different measures of social isolation and loneliness. Therefore, arriving at similar conclusions regarding causation using multiple measurement approaches would further emphasise the robustness of the results.

Table 1.3 provides an overview of the four empirical studies, all of which aim to achieve the main objective of this thesis, namely, to test the causation hypothesis by considering selection as an alternative explanation. **Study 1** examines the health risks associated with objective social isolation among older people in Germany. As a first and early study in this thesis, Study 1 analyses both physical and mental health. To my knowledge, this study is the first to test the causation hypothesis with regard to social isolation while taking into account both types of selection. **Study 2** shifts the focus of this thesis from the objective state of social isolation to the subjective feeling of loneliness. Specifically, it explores the role of loneliness in mental health among adults in the UK. This study is the first to test the causation hypothesis using nationally representative panel data of the general adult population, whereas two previous studies on adults have used non-probability samples. **Study 3** builds on this study by investigating whether loneliness leads to more severe depressive symptoms in young adults in Germany. Early adulthood has been described as a critical period of life when many people first develop depressive symptoms, but this period has been largely neglected in previous research. **Study 4** shifts the focus of this thesis once again, this time to subjective well-being as a positive aspect of mental health. Although the association between loneliness and well-being is one of the strongest of all mental health outcomes, the study is the first to investigate whether this link reflects an effect of loneliness by analysing a sample of adults from the UK.

In contrast, all previous studies conducted using within estimators have focused on psychiatric conditions. The following sections provide a more detailed overview of these studies.

1.5.1 Study 1: Social isolation and health in older people

This study aims to investigate whether social isolation affects the physical and mental health of older people in Germany. Research has consistently found that socially isolated people report poorer health (Holt-Lunstad et al., 2015; Leigh-Hunt et al., 2017; Santini et al., 2015), but studies conducted using analytical strategies that account for direct and indirect selection simultaneously remain necessary (Liu and Floud, 2017). To fill this gap, this study uses panel data from the German Socio-Economic Panel (GSOEP) study 2004–2012 to estimate dynamic panel models with fixed effects within a novel structural equation modelling framework (Allison et al., 2017; Moral-Benito et al., 2019). This analytical approach facilitates a rigorous test of the causation hypothesis by taking into account prior levels of the outcomes and all stable (un)observed confounders. The models assume that social isolation affects physical and mental health over a one-year period, which is much shorter than the four-year time interval on which subsequently published studies testing the causation hypothesis with regard to social isolation have focused (Luo, 2022; Vella-Brodrick et al., 2023). The models are built step-by-step, with each step further relaxing the model assumptions to account for selection. Unlike other studies, these models account for a rich set of time-varying covariates. All analyses are stratified by gender to explore possible differences in the roles of causation and selection between older men and women. The study also investigates whether the main findings are robust across two widely used measures of social isolation. If social isolation is still prospectively associated with health when this analytical strategy is used, such an association would provide strong evidence for the causation hypothesis in older people.

1.5.2 Study 2: Loneliness and mental health in adults

This study shifts the focus of this thesis from objective social isolation to the subjective feeling of loneliness. Although research has consistently shown that loneliness is related to a variety of mental health problems (Park et al., 2020), studies that have attempted to disentangle causation from selection have provided limited support for the causation hypothesis, according to which the observed associations reflect a negative effect of loneliness on mental health (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). However, this research has exhibited serious shortcomings that call the validity of the results into question, such as assumptions regarding

the latency of the effect, the failure to adjust for time-varying confounders, and limited external validity (see Section 1.4). Hence, the question of whether loneliness affects mental health remains unresolved. Using four waves of panel data from the UKHLS 2017–2022, the study examines whether loneliness affects two mental health outcomes—psychological distress and general mental health—while avoiding the shortcomings of prior studies. In particular, this study is the first to test the causation hypothesis using nationally representative panel data of the general adult population in the UK. This study is also the first to use fixed-effects individual-slopes (FEIS) models to rule out the possibility that people with less favourable mental health trajectories are at greater risk of loneliness as an alternative explanation for any observed association (Brüderl and Ludwig, 2015; Rüttenauer and Ludwig, 2023). In addition, the study investigates whether findings regarding the causation hypothesis are robust across different measures of loneliness, and stratified analyses are conducted to address differences in the role of causation between men and women as well as between younger (< 50 years of age) and older people (50 years or older). Overall, the study provides a more rigorous test of the causation hypothesis by introducing an innovative analytical strategy to loneliness research, and it ensures the robustness of the findings across sociodemographic groups.

1.5.3 Study 3: Loneliness and depressive symptoms in early adulthood

This study investigates whether loneliness affects the severity of depressive symptoms in young adults in Germany. Previous studies on the depressive effects of loneliness have examined samples of adolescents (Kristensen et al., 2022), adults (Lim et al., 2016; McDowell et al., 2021), and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Hence, little research has focused on early adulthood, which is a period of life when depressive symptoms often occur for the first time (Solmi et al., 2022) and when feelings of loneliness can be very intense (Hawkley et al., 2022; Luhmann and Hawkley, 2016). Despite the importance of early adulthood as a period of high vulnerability, the causation hypothesis has not yet been tested in young adults. Using panel data based on the German Family Panel (pairfam) 2011–2021, this study investigates whether loneliness exacerbates depressive symptoms in early adulthood, which is defined in this study as the period between the ages of 18 and 34. Following the analytical approach used in Study 2, this study uses FEIS models to rule out the possibility that young adults with less favourable courses of depressive symptoms select themselves into loneliness. In addition, stratified models are estimated to investigate whether loneliness contributes more to depression in young women than in young men.

Notably, by focusing on early adulthood, this study complements an earlier study conducted in Germany that tested the causation hypothesis in older people using data from the German Ageing Survey (Joshanloo, 2022).

1.5.4 Study 4: Loneliness and subjective well-being in adults

This study explores the role of loneliness in subjective well-being. While previous research has tested the causation hypothesis with regard to psychiatric outcomes, this hypothesis has yet to be tested with respect to positive aspects of mental health. This lack of research is surprising because the association between loneliness and well-being is one of the strongest across all health outcomes analysed (Park et al., 2020). This study addresses this gap in the literature. Accordingly, it contextualises the causation and selection hypotheses within the more general debate regarding the importance of bottom-up and top-down influences on well-being (Diener, 1984; Headey, 2014). Following these two perspectives, the study investigates whether loneliness is detrimental to well-being by taking into account the selection of chronically unhappy people into loneliness using standard FE models and data from the UKHLS 2017–2021. Subjective well-being was measured in terms of life satisfaction, which refers to the cognitive evaluation that one's life is going well. Furthermore, several robustness checks were performed. In particular, FEIS models were estimated to rule out the possibility that selection into loneliness is based on the trajectories of well-being rather than stable levels of well-being. Moreover, similar to Study 2, this study investigates whether the findings are robust across measures of loneliness, gender, and age groups.

Table 1.3 Overview of the empirical studies contained in this thesis

	Study 1	**Study 2**	**Study 3**	**Study 4**
Title	Does social isolation affect physical and mental health? A test of the social causation hypothesis using dynamic panel models with fixed effects	Does loneliness contribute to mental health problems? An analysis of data from the UK Household Longitudinal Study 2017–2022	Loneliness and depressive symptoms in early adulthood: Disentangling causation from selection	The effect of loneliness on subjective well-being: Evidence from the UK Household Longitudinal Study 2017–2021
Country	Germany	United Kingdom	Germany	United Kingdom
Data	GSOEP	UKHLS	pairfam	UKHLS
Period	2004–2012	2017–2022	2011–2021	2017–2021
Sample	Older people (50+ years)	Adults (16+ years)	Young adults (18-34 years)	Adults (16+ years)
Exposure	Social isolation	Loneliness	Loneliness	Loneliness
Outcome	General mental health General physical health	Psychological distress General mental health	Depressive symptoms	Life satisfaction
Analytical strategy	Dynamic panel models with fixed effects	Fixed-effects individual-slopes models	Fixed-effects individual-slopes models	Fixed-effects models
Authorship	First authorship Co-authored with Daniel Seddig and Jan Eckhard	Single authorship	Single authorship	Single authorship

Notes: GSOEP = German Socio-Economic Panel, UKHLS = UK Household Longitudinal Study ('Understanding Society'), pairfam = German Family Panel ('Panel Analysis of Intimate Relationships and Family Dynamics')

2 Does social isolation affect physical and mental health? A test of the social causation hypothesis using dynamic panel models with fixed effects (Study 1)[2]

Abstract

Objectives: The widely acknowledged negative association between social isolation and physical and mental health has commonly been interpreted in terms of social causation and has served as an important frame of reference for many interventions. However, evidence of social causation is likely biased because most studies have been unable to differentiate between social causation and health selection. The public attention given to this field of research highlights the need for analytical strategies that improve the understanding of the underlying link between social isolation and physical and mental health.

Methods: Using data from the German Socio-Economic Panel (GSOEP) study (2004–2012) of 6,740 men and 7,189 women aged 50 and above, we estimated dynamic panel models with fixed effects that allowed us to investigate the social causation hypothesis while accounting for direct selection (reverse causality) and indirect selection (unobserved heterogeneity). All analyses were conducted for women and men separately.

Results: We found that social isolation adversely affected mental health among older men and women to a degree that suggests practical relevance. However, we could not find a similar effect on physical health. A considerable portion of the association between social isolation and both health outcomes was attributable to indirect selection, whereas direct selection led to underestimating the relevance of social isolation for mental health.

Discussion: The results provide more convincing evidence indicating that social isolation has adverse effects on mental health among older people. We conclude that effective interventions targeting social isolation might indeed be suitable for improving mental health among older people.

[2] This chapter is a slightly modified version of the study published as

Seifert, N., Seddig, D., Eckhard, J., 2022. Does social isolation affect physical and mental health? A test of the social causation hypothesis using dynamic panel models with fixed effects. Aging & Mental Health 26, 1353–1367. https://doi.org/10.1080/13607863.2021.1961125.

2.1 Introduction

Social isolation has received considerable attention as a growing public health threat in aging societies (Holt-Lunstad, 2017; Lubben, 2017). Social isolation, which refers to an objective state in which contact with other people is lacking, needs to be distinguished from loneliness, which is the negative feeling that arises from a lack of meaningful relationships (De Jong Gierveld et al., 2012). According to Eurostat, in 2015, approximately 6.0% of the adult population in EU-28 countries had no one with whom to discuss personal matters. The share of people without a confidant sharply increased from 2.7% among young people (aged 16-24) to 9.2% among the very old (aged 75+) (Eurostat, 2018). In Germany, between 5% and 25% of older people aged 50 and above are considered socially isolated because they lack social relationships with regular contact (Eckhard, 2018b). Given its high prevalence in older age, public health experts have affirmed the importance of addressing social isolation (Holt-Lunstad, 2017; Lubben, 2017), and many countries have implemented interventions and programmes to alleviate social isolation among their older citizens and its consequences on health and well-being (Fakoya et al., 2020).

2.1.1 Social isolation as a major risk factor for morbidity and mortality

Scientific evidence has provided an important frame of reference for these interventions and programmes. Cross-sectional studies have consistently shown that social isolation is associated with poor physical and mental health (e.g., Achat et al., 1998; Cornwell and Waite, 2009; Coyle and Dugan, 2012; Hawton et al., 2011; López García et al., 2005; Rhee et al., 2021). Moreover, several meta-analytic reviews have suggested that social isolation is a major risk factor for early mortality (e.g., Holt-Lunstad et al., 2015; Holt-Lunstad et al., 2010) that rivals established risk factors, such as smoking, obesity, and physical inactivity (Holt-Lunstad et al., 2010). Further studies have linked social isolation to specific physical and mental health problems (Leigh-Hunt et al., 2017), including dementia and cognitive decline (Kuiper et al., 2016; Kuiper et al., 2015), cardiovascular disease (Valtorta et al., 2016b), and depression (Santini et al., 2015; Schwarzbach et al., 2014). Although evidence points to a close link between social isolation and mental and physical health, the debate regarding the underlying causal processes is ongoing (Liu and Floud, 2017).

2.1.2 Explanations for the association between social isolation and health

Many scholars have interpreted the existing evidence in terms of the social causation hypothesis, which posits that social isolation is detrimental to health. Over the past decades,

several psychosocial, behavioural, and physiological pathways that potentially link social isolation to health have been identified (Thoits, 2011a; Uchino, 2006). For instance, social support theory highlights the health-promoting functions of social contact. Being socially integrated not only provides a source of emotional, instrumental, and informational assistance but also strengthens individuals' self-esteem, facilitates a sense of belonging, and serves as a buffer against stress (Thoits, 2011a). A further function of strong relationships is social control, which can prevent risky and unhealthy behaviours (Umberson, 1992).

In addition, the absence of social contacts is probably a health threat on its own. Being socially isolated is a deviation from social standards and usually involves feelings of anxiety and personal failure. Therefore, social isolation can be a tenacious source of stress. Moreover, social isolation has been found to directly evoke biological and bodily reactions, including the downregulation of the immune system (Uchino, 2006), higher levels of inflammation (Uchino et al., 2018), hypertension (Yang et al., 2015), and poor sleep quality (Gordon et al., 2021).

Another explanation, although less frequently discussed, is the direct selection hypothesis, which states that health problems cause older people to have a higher risk of social isolation (Liu and Floud, 2017). Although it has been theorised that health problems might motivate individuals to renew social connections because they entail an increased need for support and care (Lillard and Panis, 1996), most scholars assume that poor health is more likely to impede the perpetuation of social ties among older people (Rapp, 2018; Sluzki, 2010). Long-lasting health problems might impair the functioning of older people in everyday life, reducing their opportunities to reach out to and maintain networks with people outside their households (Kupferberg et al., 2016; Rapp and Gruhler, 2018). Because of the burden of illness, older people might also not feel motivated or energetic to initiate or participate in social activities (Sluzki, 2010). Moreover, social ties to chronically ill individuals might be perceived as less rewarding while requiring more time and effort due to the provision of care and support (Sluzki, 2010). Altogether, these mechanisms suggest that causality could also flow from health to social isolation.

While social causation and direct selection suggest a causal process between social isolation and health in either direction, the indirect selection hypothesis assumes that their association is largely driven by unobserved confounders (Liu and Floud, 2017). It is highly likely that socially isolated individuals differ from socially integrated individuals with respect to many other characteristics for which measures are often unavailable in commonly used datasets, such as childhood experiences and personality traits (Harris and Vazire, 2016).

2.1.3 The present study and limitations of existing research

The public attention given to this field of research and its importance for designing effective interventions indicate a strong need for research designs and analytical strategies that improve our understanding of the underlying processes linking social isolation and health. Most studies have been based on research designs that are unable to account for both types of selection (Liu and Floud, 2017). Cross-sectional studies are inherently limited in establishing causality and are likely biased by unobserved heterogeneity (indirect selection) and reverse causation (direct selection) (Brüderl and Ludwig, 2015). Prospective cohort studies are better suited to rule out reverse causality because they control for baseline health and establish a clear temporal order between social isolation and health. However, any effects are still derived from a comparison of different individuals, and the results are possibly biased by unobserved heterogeneity among these individuals (Brüderl and Ludwig, 2015; Liu and Floud, 2017). This problem also affects similar research designs, such as the standard cross-lagged panel model, which does not distinguish between within-individual and between-individual variation (Allison et al., 2017; Hamaker et al., 2015).

Consequently, evidence supporting social causation is likely biased (Liu and Floud, 2017), and the actual effect of social isolation on health may be much smaller than the associations observed in previous research. Hence, there is a strong need for studies adopting research designs that simultaneously account for unobserved heterogeneity (indirect selection) and reverse causality (direct selection). To fill this gap, our study implements an alternate analytical approach to investigate the impact of social isolation on health among older people aged 50 and above in Germany. Using data from the German Socio-Economic Panel (GSOEP) study, we estimate dynamic panel models with fixed effects by structural equation modelling (Allison et al., 2017; Moral-Benito et al., 2019) to enable a more comprehensive probe of the social causation hypothesis by accounting for direct and indirect selection. Using this research design, the finding that social isolation is prospectively related to health would provide strong evidence suggesting that social isolation has adverse effects on health among older people.

2.2 Data and methods

2.2.1 Study sample

The study sample was derived from the GSOEP (version 33, Schupp et al., 2017), a longitudinal panel survey of private households in Germany conducted by the German Institute for Economic Research (DIW Berlin). The main purpose of the GSOEP is to gather

detailed information regarding trends and changes in the social and economic conditions of private households in Germany. The target population that the GSOEP aims to represent is the residential population of Germany. The study started in West Germany in 1984 and was extended to East Germany after the German reunification in 1990. In the annual interviews, all household members aged 17 years or older are surveyed regarding a broad range of topics (Wagner et al., 2007). Since its introduction, several additional samples with different sampling designs have been added to the GSOEP to account for panel attrition and the changing sociodemographic composition of the population in Germany. More details are provided by Wagner et al. (2007).

The statistical analysis was based on data from all survey waves between 2004 and 2012. Further waves were not included because the questions regarding social contact were altered in 2003 and 2013. During the observation period, mental and physical health was assessed biennially starting in 2004, while social isolation and all covariates were measured biennially starting in 2005. Hence, by design, social isolation was lagged by one year. Because the study focuses on the population aged 50 or older, only respondents born before 1956 were included in the analysis. The final sample consisted of 6,740 men and 7,189 women living in private households.

The amount of missing data in the GSOEP data was generally low and ranged from 0 to 2%, except for the health outcomes, where 12% of the data were missing (see Table 2.7 and Table 2.8 in the Appendix). The main reason for the higher proportion of missing values was unit nonresponse because health was measured one year after the explanatory variables. Additional analyses showed that unit nonresponse was related to old age (≥ 80 years), unemployment, income poverty, poor housing, social isolation, and poor mental and physical health in the previous year (see Table 2.9 in the Appendix).

2.2.2 Measures

Physical and mental health were measured by the Physical Component Summary (PCS) and Mental Component Summary (MCS) scales of the Short Form-12 Health Survey, Version 2 (SF-12v2), a modified 12-item version of the SF-36 Health Survey (Ware et al., 1996). The SF-12 is a widely used measure of general health, functioning, and health-related quality of life based on respondents' self-reports. The raw scores were initially transformed into norm-based scores on a scale from 0 to 100 (mean = 50, SD = 10; Andersen et al., 2007). Moreover, to avoid convergence problems related to large sample variances, the health scores were divided by 10 to adjust their range to that of the covariates.

Social isolation has been measured in many different ways as a result of a lack of conceptual clarity and established measurement instruments (Eckhard, 2018b; Valtorta et al., 2016a; Zavaleta et al., 2017). In this study, two measures of social isolation were used to ensure the robustness of our results. The first measure conceptualises social isolation as a lack of close relationships with regular contact (Eckhard, 2018b). The respondents who met the following three criteria were categorised as socially isolated: 1) lived alone or were a single parent, 2) did not have a partner (with or without a common household), and 3) met with friends, relatives, or neighbours less than once per month. All other respondents were categorised as socially integrated. We refer to this indicator as the social contact indicator.

The second measure, which resembles the Berkman-Syme social network index (Berkman and Syme, 1979), considers all three criteria mentioned above and additionally considers whether 4) social activities took place less frequently than once per month, including cultural activities, such as cinema, concert, and theatre attendance, and civil and political engagement. A dummy variable was generated for all four aspects of social isolation. The four dummy variables were then summed, yielding a count variable of the number of aspects of social life an individual is socially isolated from. Scores of 3 and 4 were combined into a single category due to the low frequency of individuals who were isolated from all aspects of social life. Thus, this variable consisted of four categories from 0 ‘socially integrated’ to 3 ‘socially isolated’. We included a dummy variable for each category, except for ‘socially integrated’, which served as a reference category, to allow a nonlinear relationship between the degree of social isolation and health. We refer to this indicator as the social network indicator.

The models further included several *time-varying variables* that are known to be linked to health and social isolation and, therefore, could confound their association. A frequently observed risk factor for social isolation is income poverty (Eckhard, 2018a; Mood and Jonsson, 2016). Additional research has shown that being at risk of poverty rather than income losses in general leads to an increased risk of social isolation (Eckhard, 2021). Therefore, the models included a dummy variable for income poverty defined by an annual equivalised disposable income of less than 60% of the median income of the population in Germany. The equivalised disposable income was calculated using the modified OECD scale (Hagenaars et al., 1994).

However, the economic situation of older citizens depends on not only income but also, to a considerable extent, other financial resources, such as savings and assets. To account for financial resources other than income, two further indicators of poverty were included in the models. First, perceived economic strain was assessed with a single item capturing the

respondents' degree of concern regarding their economic situation. The categories were dichotomised into economic strain ('somewhat' and 'very concerned') and no strain ('not concerned at all'). Second, the housing condition was measured by a binary variable indicating whether the respondents' accommodations were in good condition or in need of renovation.

Moreover, unemployment and economic inactivity were found to entail reduced social participation and infrequent contacts (Dieckhoff and Gash, 2015), especially among older people (Rözer et al., 2020), and this isolating impact of unemployment cannot completely be traced back to the economic disadvantages of unemployed individuals (Eckhard, 2022). Therefore, the models also included a set of dummy variables indicating whether the respondents were employed, unemployed, retired, or not employed. Finally, the models included the respondents' age, which was categorised into the following six age groups: 50 to 59, 60 to 64, 65 to 69, 70 to 74, 75 to 79 and ≥ 80 years. Table 2.1 and Table 2.2 provide the descriptive statistics of all variables for women and men separately.

Table 2.1
Descriptive statistics of women (N = 7,189)

	2004				2005/2006				2007/2008				2009/2010				2011/2012			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Mental health (MCS)	0.56	7.77	5.00	1.05	0.89	7.59	4.97	1.09	1.05	7.48	5.07	1.03	1.03	7.68	5.04	1.06	0.82	7.68	5.02	1.04
Physical health (PCS)	1.05	7.53	4.44	1.02	1.29	7.01	4.35	1.03	1.23	7.11	4.34	1.03	1.07	7.17	4.34	1.03	1.23	7.08	4.30	1.01
Social network indicator																				
Socially integrated					0.00	1.00	0.38		0.00	1.00	0.38		0.00	1.00	0.36		0.00	1.00	0.36	
Rather integrated					0.00	1.00	0.23		0.00	1.00	0.22		0.00	1.00	0.23		0.00	1.00	0.22	
Rather isolated					0.00	1.00	0.25		0.00	1.00	0.26		0.00	1.00	0.26		0.00	1.00	0.27	
Socially isolated					0.00	1.00	0.14		0.00	1.00	0.14		0.00	1.00	0.15		0.00	1.00	0.16	
Social contact indicator																				
Socially isolated					0.00	1.00	0.07		0.00	1.00	0.07		0.00	1.00	0.08		0.00	1.00	0.09	
Age																				
Age 50-59					0.00	1.00	0.37		0.00	1.00	0.32		0.00	1.00	0.25		0.00	1.00	0.19	
Age 60-64					0.00	1.00	0.17		0.00	1.00	0.16		0.00	1.00	0.16		0.00	1.00	0.21	
Age 65-69					0.00	1.00	0.18		0.00	1.00	0.20		0.00	1.00	0.20		0.00	1.00	0.16	
Age 70-74					0.00	1.00	0.11		0.00	1.00	0.14		0.00	1.00	0.17		0.00	1.00	0.20	
Age 75-79					0.00	1.00	0.09		0.00	1.00	0.09		0.00	1.00	0.10		0.00	1.00	0.11	
Age 80+					0.00	1.00	0.09		0.00	1.00	0.10		0.00	1.00	0.11		0.00	1.00	0.12	
Employment status																				
Employed					0.00	1.00	0.31		0.00	1.00	0.28		0.00	1.00	0.26		0.00	1.00	0.23	
Unemployed					0.00	1.00	0.04		0.00	1.00	0.04		0.00	1.00	0.03		0.00	1.00	0.03	
Retired					0.00	1.00	0.54		0.00	1.00	0.58		0.00	1.00	0.63		0.00	1.00	0.67	
Other not employed					0.00	1.00	0.12		0.00	1.00	0.10		0.00	1.00	0.09		0.00	1.00	0.08	
Material situation																				
Economic strain					0.00	1.00	0.69		0.00	1.00	0.66		0.00	1.00	0.67		0.00	1.00	0.60	
Income poverty					0.00	1.00	0.10		0.00	1.00	0.12		0.00	1.00	0.14		0.00	1.00	0.15	
Poor housing					0.00	1.00	0.23		0.00	1.00	0.22		0.00	1.00	0.23		0.00	1.00	0.23	
N_{year}	4,490				4,788				4,733				4,577				4,647			

Notes: The numbers of cases vary across variables and waves due to the use of the FIML estimator.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.2
Descriptive statistics of men (N = 6,740)

	2004				2005/2006				2007/2008				2009/2010				2011/2012			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Mental health (MCS)	1.34	7.67	5.22	0.99	0.79	7.66	5.21	1.02	1.34	7.44	5.24	0.97	0.97	7.94	5.26	0.99	0.88	7.65	5.22	0.99
Physical health (PCS)	1.13	7.45	4.60	1.00	1.06	6.89	4.52	1.01	1.23	6.99	4.49	1.01	1.13	7.10	4.44	1.01	1.30	6.86	4.43	0.99
Social network indicator																				
Socially integrated					0.00	1.00	0.46		0.00	1.00	0.46		0.00	1.00	0.44		0.00	1.00	0.44	
Rather integrated					0.00	1.00	0.26		0.00	1.00	0.26		0.00	1.00	0.27		0.00	1.00	0.27	
Rather isolated					0.00	1.00	0.22		0.00	1.00	0.22		0.00	1.00	0.22		0.00	1.00	0.22	
Socially isolated					0.00	1.00	0.06		0.00	1.00	0.06		0.00	1.00	0.07		0.00	1.00	0.07	
Social contact indicator																				
Socially isolated					0.00	1.00	0.03		0.00	1.00	0.04		0.00	1.00	0.04		0.00	1.00	0.04	
Age																				
Age 50-59					0.00	1.00	0.38		0.00	1.00	0.32		0.00	1.00	0.25		0.00	1.00	0.18	
Age 60-64					0.00	1.00	0.18		0.00	1.00	0.17		0.00	1.00	0.18		0.00	1.00	0.21	
Age 65-69					0.00	1.00	0.19		0.00	1.00	0.21		0.00	1.00	0.21		0.00	1.00	0.19	
Age 70-74					0.00	1.00	0.12		0.00	1.00	0.14		0.00	1.00	0.17		0.00	1.00	0.21	
Age 75-79					0.00	1.00	0.08		0.00	1.00	0.09		0.00	1.00	0.10		0.00	1.00	0.12	
Age 80+					0.00	1.00	0.05		0.00	1.00	0.07		0.00	1.00	0.08		0.00	1.00	0.10	
Employment status																				
Employed					0.00	1.00	0.43		0.00	1.00	0.38		0.00	1.00	0.35		0.00	1.00	0.30	
Unemployed					0.00	1.00	0.05		0.00	1.00	0.04		0.00	1.00	0.04		0.00	1.00	0.03	
Retired					0.00	1.00	0.51		0.00	1.00	0.57		0.00	1.00	0.61		0.00	1.00	0.66	
Other not employed					0.00	1.00	0.01		0.00	1.00	0.01		0.00	1.00	0.01		0.00	1.00	0.01	
Material situation																				
Economic strain					0.00	1.00	0.68		0.00	1.00	0.63		0.00	1.00	0.64		0.00	1.00	0.56	
Income poverty					0.00	1.00	0.08		0.00	1.00	0.08		0.00	1.00	0.10		0.00	1.00	0.11	
Poor housing					0.00	1.00	0.23		0.00	1.00	0.21		0.00	1.00	0.24		0.00	1.00	0.24	
N_{year}	4,190				4,437				4,359				4,212				4,302			

Notes: The numbers of cases vary across variables and waves due to the use of the FIML estimator.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

2.2.3 Statistical analysis

To investigate whether social isolation has a negative impact on physical and mental health while addressing both types of selection, dynamic panel models with fixed effects were estimated using structural equation modelling (SEM) and maximum likelihood (ML) estimation (Allison et al., 2017; Moral-Benito et al., 2019; Seddig, 2020). Compared to classic approaches, such as the Arellano-Bond estimator and generalised method of moments, the ML-SEM approach yields generally very similar results (Leszczensky and Wolbring, 2022) but is more efficient and less biased under a wide range of conditions. Moreover, this approach avoids uncertainty in the choice of instrumental variables (Allison et al., 2017). The technical basis and assumptions of the ML-SEM approach are described elsewhere in further detail (Moral-Benito et al., 2019).

The starting point of our analysis is the following random-effects model:

$$y_{it} = \mu_t + x_{it-1}b + \alpha_i + \varepsilon_{it} \quad (1)$$

where y is the health status of individual i at time t, and x is a vector of explanatory variables, including social isolation and covariates, at $t-1$. Moreover, μ is an intercept that varies over time, and b is a vector of the regression coefficients to be estimated. With panel data, it is further possible to decompose the error term into two components. The individual-specific effect α captures the combined effect of all time-constant unobserved factors that lead to stable health differences among individuals. In the ML-SEM approach, the individual-specific effect is modelled as a latent variable that has a constant effect (1.0) on health across time (Allison et al., 2017; Bollen and Brand, 2010). The idiosyncratic error ε captures the effect of all time-varying factors that are not included in the model, thus varying over individuals and time. The random-effects model is based on the following two assumptions: α must not be correlated with x (random-effects assumption, which implies that there must be no unobserved heterogeneity), and ε must not correlate with past, current, and future values of x (strict exogeneity assumption, which implies that there must be no reverse causality). Thus, this model yields an unbiased estimate of the isolation effect only if there is neither indirect nor direct selection. The model specification is illustrated in Figure 2.1. Following the convention in the SEM literature, observed variables are represented by rectangles, and latent variables are represented by ellipses. Furthermore, the relationships between the variables are represented by two types of arrows as follows: correlations are indicated by bidirectional

arrows (dashed), and effects are indicated by unidirectional arrows (solid). If no arrow is drawn for a relationship, it is assumed that the relationship does not exist (i.e., is equal to zero).

According to the indirect selection hypothesis, some individuals are more disposed to become socially isolated than others. Therefore, socially isolated individuals likely differ from (better) integrated individuals in manifold characteristics, of which only a few have been recognised as potential confounders. As a result, the individual-specific effect α, which captures unobserved heterogeneity in stable factors, will be correlated with the risk of social isolation. The fixed-effects model accounts for indirect selection by incorporating the correlations between α and the explanatory variables into the model (Allison et al., 2017). This model specification is illustrated in Figure 2.2.

As a result, only the variation within individuals over time is used to estimate the effect of social isolation on health (Allison et al., 2017). Table 2.10 to Table 2.13 in the Appendix show that there are sufficient transitions between states of isolation in the data that can be exploited to estimate effects. Comparing the health of the same individual in time-varying states of social isolation effectively eliminates the possibility that any observed association is driven by stable unobserved differences between socially isolated and integrated individuals (i.e., indirect selection). However, the fixed-effects model is still based on the assumption of strict exogeneity and, thus, is potentially biased by direct selection.

According to the direct selection hypothesis, physical and mental health problems directly increase the risk of social isolation among older people. To account for reverse causality, first, social isolation is specified as sequentially exogenous by allowing the idiosyncratic error ε at each time point to be correlated with all subsequent measurements of social isolation (Allison et al., 2017). In Figure 2.3, these correlations are signified by dashed arrows between ε and all future x variables. All other covariates are still assumed to be strictly exogenous (i.e., ε is uncorrelated with past, current, and future values of these covariates).

Second, we also considered previous health a potential confounder because we expect this variable to possibly affect both current health (autoregressive effect) and the risk of future social isolation (reverse causality). The dynamic panel model with fixed effects is illustrated in Figure 2.4, and the unidirectional arrows between the y variables represent the effects of health on itself over time.[3] These two adjustments to the fixed-effects model rule out the possibility that any observed association is caused by individuals becoming socially isolated

[3] The two-year lags between previous and current health and the one-year lags between social isolation and health in our model are implemented to account for the lags in the GSOEP data by design.

because they suffered a decline in health in the previous year (i.e., direct selection). The initial conditions y_{i04}, which capture the whole process of health dynamics prior to the observation period, are treated as predetermined.[4]

To fully understand the mechanisms at work, we estimated four models with increasingly less restrictive assumptions. We started our analysis with random-effects models that considered neither of the two types of selection (M1, Figure 2.1). We proceeded with fixed-effects models to account for indirect selection (M2, Figure 2.2), and then, we relaxed the assumption of strict exogeneity to consider direct selection (M3, Figure 2.3). Finally, we included autoregressive effects in the dynamic panel model with fixed effects to consider previous health as a potential confounder (M4, Figure 2.4).[5] In all models, the variances of the idiosyncratic error and the intercepts were allowed to differ across time. Specifying time-varying intercepts is equivalent to accounting for time by a set of dummy variables.

All four models were estimated separately for women and men because the magnitude of direct and indirect selection may vary by gender. For instance, previous studies have shown

[4] There is a critical discussion in the literature about whether and when it is appropriate to include autoregressive effects. If misspecified, they can lead to biases in the estimates for all other variables in the model. For example, the random-effects model (M1) could conflate spurious and true state dependence by not considering unobserved heterogeneity, which could lead to an upwardly biased autoregressive effect and, thus, downwardly biased estimates for social isolation and other variables in the model. We decided to proceed cautiously and not include autoregressive effects unless theoretically justified. We adjusted the models step-by-step according to the three theoretical explanations to understand how the specific changes in the model affect the estimates.

[5] Standard cross-lagged panel models are often used to estimate reciprocal associations between variables but are potentially biased by unobserved heterogeneity (indirect selection). In contrast, fixed-effects models are well suited to control for unobserved heterogeneity but are potentially biased by reverse causality (direct selection). The ML-SEM approach combines the advantages of cross-lagged panel models and fixed-effects regressions and allows us to analyse the effect of isolation on health while considering both direct and indirect selection. However, using this approach, we were unable to directly estimate the reverse effect of health on the risk of social isolation because social isolation was a categorical variable in this study, and simulation studies have not yet shown that the ML-SEM approach to dynamic panel models with fixed effects can be generalised to categorical outcomes. However, the reverse effect of health on the risk of social isolation was still considered in M3 and M4 because these models allow for a correlation between the idiosyncratic error at each time point and social isolation in all subsequent waves. Thus, we considered reverse causality without obtaining a direct estimate of the reverse effect.

significant gender differences in the link between physical and mental health and the occurrence of union formations and union dissolutions (Karraker and Latham, 2015; Percheski and Meyer, 2018; Rapp and Gruhler, 2018).

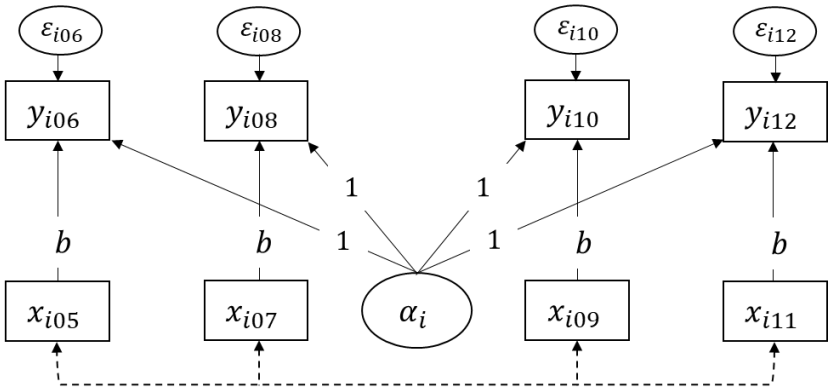

Figure 2.1 Random-effects model (M1)

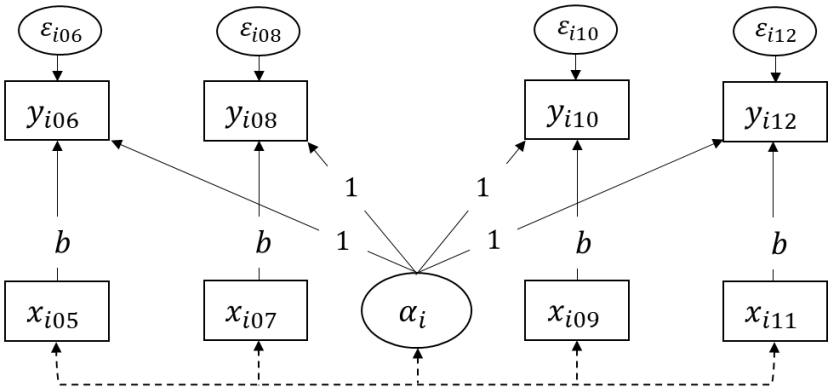

Figure 2.2 Fixed-effects model with strict exogeneity (M2)

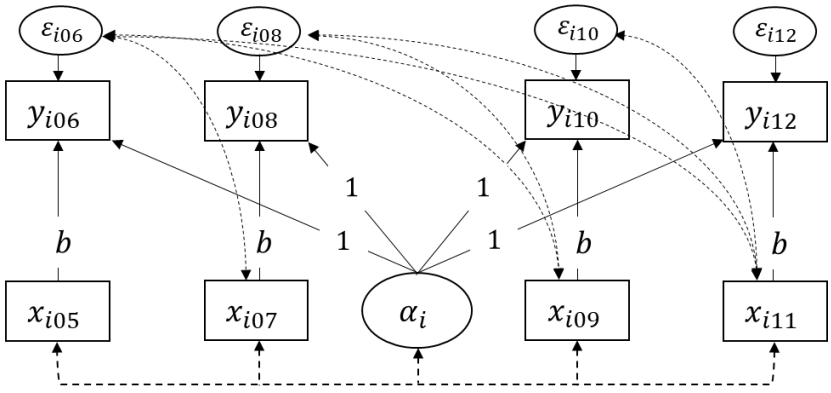

Figure 2.3 Fixed-effects model with sequential exogeneity (M3)

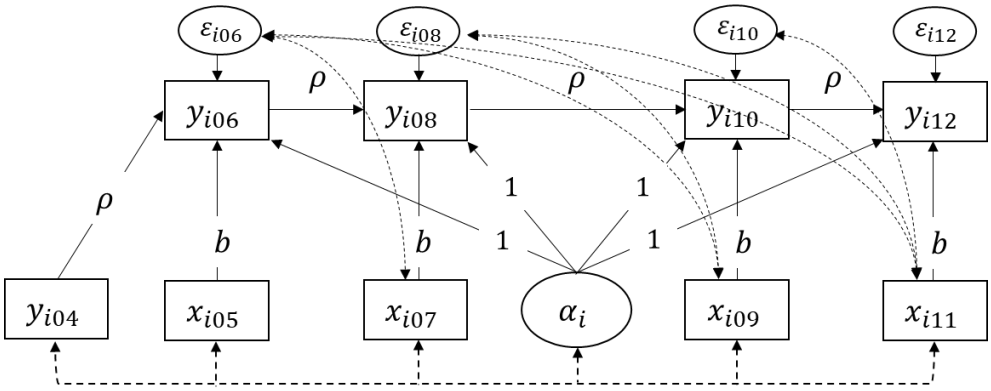

Figure 2.4 Dynamic panel model with fixed effects (M4)

To assess and compare the fit of the four models to the observed data, we inspected the model chi-square (Chi^2) fit statistic and the following alternative fit indices, which are less sensitive to the sample size: root mean square error of approximation (RMSEA), comparative fit index (CFI), and standardised root mean square residual (SRMR). We considered the model fit acceptable when RMSEA ≤ 0.06, CFI ≥ 0.95, and SRMR ≤ 0.08 (West et al., 2012). We used goodness-of-fit measures and standard errors robust to deviations from normality (Yuan and Bentler, 2000). All missing data were assumed to be at least missing at random (MAR) after controlling for a broad range of variables, including time-varying confounders (M1-M4), unobserved stable characteristics (M2-M4), and prior health (M4), and addressed by a full-information maximum likelihood (FIML) estimation (Enders and Bandalos, 2001). The analysis was carried out using Mplus 8.1 (Muthén and Muthén, 1998–2017).

2.3 Results

In this section, we first present the results for the social network indicator (categorical) before discussing the results for the social contact indicator (dichotomous). Table 2.3 and Table 2.4 show the results for the effect of social isolation on mental and physical health, respectively, for the social network indicator. All tables show unstandardised regression coefficients with robust standard errors in parentheses and various indices used to evaluate the model fit. The regression coefficients of the covariates in M4 are shown as an example in Table 2.14 and Table 2.15 in the Appendix.

In the random-effects model (M1), which accounts for neither indirect nor direct selection, social isolation in older men and women was associated with poorer mental and physical health in the following year. The association gradually increased with the degree of social isolation and was stronger for mental health than physical health. Comparing individuals who

were ‘socially isolated’ with those who were ‘socially integrated’, we found a difference in physical health of -0.141 and -0.109 points on a scale from 0 to 10 among older women and men, respectively. The difference in mental health was more pronounced and amounted to -0.237 scale points among older women and -0.370 scale points among older men. Altogether, the results confirm that a close link exists between social isolation and health, as reported in previous studies. However, the low CFI value of this model suggests a rather poor fit to the data.

In the fixed-effects model (M2), we allowed unobserved heterogeneity among individuals to be correlated with the risk of social isolation to consider indirect selection. In the fixed-effects model, the regression coefficients reflect differences in health before and after changes in the degree of social isolation within the same individuals but no longer differences among individuals.

In contrast to the random-effects model (M1), we found no consistent association between a higher degree of social isolation and both health outcomes among women. Among men, only becoming ‘socially isolated’ was related to slightly poorer mental health. This result indicates that without controlling for indirect selection, the relevance of social isolation for mental and physical health would have been overestimated due to unobserved heterogeneity among individuals. However, while providing an improved fit to the data, the fixed-effects model still assumes strict exogeneity, implying that there must be no direct selection into social isolation.

In the following step, we relaxed the assumption of strict exogeneity and specified social isolation as sequentially exogenous to further consider direct selection. In this model (M3), a higher degree of social isolation was still unrelated to physical health but was again associated with worse mental health one year later. This association indicates a threshold effect that differs between the genders. Only becoming ‘rather isolated’ or ‘socially isolated’ among older women and only becoming ‘socially isolated’ among older men were associated with a noticeable decline in mental health in the following year. The differences in mental health ranged from -0.377 to -0.479 scale points and, thus, were even stronger than those initially found in the random-effects model (M1).

As shown in the comparison of models M2 and M3, treating social isolation as sequentially exogenous (and thus accounting for reverse causality) avoided biasing the effect of social isolation on mental health towards zero. This direct selection was also indicated by negative correlations between the idiosyncratic error and a higher degree of social isolation in subsequent years (not shown). Thus, people with better mental health were at a lower risk of subsequent social isolation. Therefore, health problems were not only a consequence but also

a cause of social isolation. Ignoring reverse causality may have led to a bias in the fixed-effects models by conflating different causal processes. Finally, controlling for previous health in the dynamic panel model with fixed effects (M4) did not change this result for either health outcome.

Table 2.3
Association between social isolation and mental health among women and men (social network indicator)

	M1 Random-effects model		**M2** Fixed-effects model (strict exogeneity)		**M3** Fixed-effects model (sequential exogeneity)		**M4** Dynamic panel model with fixed effects	
Women								
Socially integrated	Reference		Reference		Reference		Reference	
Rather integrated	-0.090	***	-0.036		-0.093	**	-0.084	*
	(0.020)		(0.024)		(0.035)		(0.037)	
Rather isolated	-0.209	***	-0.088	**	-0.377	***	-0.378	***
	(0.023)		(0.033)		(0.057)		(0.062)	
Socially isolated	-0.237	***	-0.022		-0.413	***	-0.398	***
	(0.033)		(0.049)		(0.089)		(0.098)	
Chi^2	635.860 (215)	***	265.605 (159)	***	182.968 (141)	*	149.698 (143)	
RMSEA	0.017		0.010		0.006		0.003	
CFI	0.906		0.976		0.991		0.999	
SRMR	0.014		0.005		0.004		0.004	
N	7,189		7,189		7,189		7,189	
Men								
Socially integrated	Reference		Reference		Reference		Reference	
Rather integrated	-0.098	***	-0.032		-0.040		-0.032	
	(0.018)		(0.021)		(0.032)		(0.034)	
Rather isolated	-0.189	***	-0.036		-0.111	*	-0.105	
	(0.023)		(0.030)		(0.051)		(0.055)	
Socially isolated	-0.370	***	-0.145	*	-0.479	***	-0.485	***
	(0.042)		(0.058)		(0.119)		(0.136)	
Chi^2	670.988 (215)	***	290.478 (159)	***	248.931 (141)	***	223.228 (143)	***
RMSEA	0.018		0.011		0.011		0.009	
CFI	0.894		0.969		0.975		0.985	
SRMR	0.016		0.007		0.006		0.006	
N	6,740		6,740		6,740		6,740	

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.4
Association between social isolation and physical health among women and men (social network indicator)

	M1 Random-effects model		**M2** Fixed-effects model (strict exogeneity)		**M3** Fixed-effects model (sequential exogeneity)		**M4** Dynamic panel model with fixed effects	
Women								
Socially integrated	Reference		Reference		Reference		Reference	
Rather integrated	-0.060	**	-0.012		0.044		0.048	
	(0.017)		(0.019)		(0.027)		(0.029)	
Rather isolated	-0.078	***	-0.024		0.051		0.050	
	(0.020)		(0.025)		(0.042)		(0.046)	
Socially isolated	-0.141	***	-0.029		0.084		0.083	
	(0.027)		(0.037)		(0.062)		(0.069)	
Chi²	821.815 (215)	***	297.988 (159)	***	258.693 (141)	***	184.436 (143)	*
RMSEA	0.020		0.011		0.011		0.006	
CFI	0.928		0.984		0.986		0.996	
SRMR	0.015		0.005		0.004		0.003	
N	7,189		7,189		7,189		7,189	
Men								
Socially integrated	Reference		Reference		Reference		Reference	
Rather integrated	-0.045	**	0.014		0.016		0.019	
	(0.016)		(0.018)		(0.026)		(0.027)	
Rather isolated	-0.076	***	0.029		-0.016		-0.017	
	(0.020)		(0.024)		(0.038)		(0.041)	
Socially isolated	-0.109	**	0.055		-0.032		-0.026	
	(0.037)		(0.047)		(0.082)		(0.094)	
Chi²	907.022 (215)	***	255.299 (159)	***	232.418 (141)	***	169.135 (143)	
RMSEA	0.022		0.009		0.010		0.005	
CFI	0.908		0.987		0.988		0.997	
SRMR	0.019		0.005		0.005		0.003	
N	6,740		6,740		6,740		6,740	

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.5
Association between social isolation and mental health among women and men (social contact indicator)

	M1 Random-effects model	**M2** Fixed-effects model (strict exogeneity)	**M3** Fixed-effects model (sequential exogeneity)	**M4** Dynamic panel model with fixed effects
Women				
Socially integrated	Reference	Reference	Reference	Reference
Socially isolated	-0.173 ***	-0.036	-0.182 **	-0.175 *
	(0.036)	(0.045)	(0.066)	(0.070)
Chi²	571.900 (185) ***	185.617 (137) **	167.901 (131) *	135.142 (133)
RMSEA	0.017	0.007	0.006	0.001
CFI	0.911	0.989	0.991	1.000
SRMR	0.017	0.004	0.004	0.004
N	7,189	7,189	7,189	7,189
Men				
Socially integrated	Reference	Reference	Reference	Reference
Socially isolated	-0.233 ***	-0.050	-0.295 **	-0.278 *
	(0.051)	(0.062)	(0.106)	(0.118)
Chi²	597.097 (185) ***	250.033 (137) ***	235.077 (131) ***	207.330 (133) ***
RMSEA	0.018	0.011	0.011	0.009
CFI	0.900	0.973	0.975	0.986
SRMR	0.018	0.007	0.007	0.007
N	6,740	6,740	6,740	6,740

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.6
Association between social isolation and physical health among women and men (social contact indicator)

	M1 Random-effects model		**M2** Fixed-effects model (strict exogeneity)		**M3** Fixed-effects model (sequential exogeneity)		**M4** Dynamic panel model with fixed effects	
Women								
Socially integrated	Reference		Reference		Reference		Reference	
Socially isolated	-0.039		0.008		0.058		0.064	
	(0.027)		(0.032)		(0.050)		(0.053)	
Chi²	758.778 (185)	***	246.033 (137)	***	242.216 (131)	***	169.341 (133)	*
RMSEA	0.021		0.011		0.011		0.006	
CFI	0.932		0.987		0.987		0.997	
SRMR	0.017		0.005		0.005		0.003	
N	7,189		7,189		7,189		7,189	
Men								
Socially integrated	Reference		Reference		Reference		Reference	
Socially isolated	-0.010		0.051		0.005		0.050	
	(0.041)		(0.048)		(0.073)		(0.080)	
Chi²	861.902 (185)	***	231.228 (137)	***	220.058 (131)	***	158.903 (133)	
RMSEA	0.023		0.010		0.010		0.005	
CFI	0.909		0.987		0.988		0.997	
SRMR	0.021		0.005		0.005		0.004	
N	6,740		6,740		6,740		6,740	

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.5 and Table 2.6 further show very similar results for the social contact indicator. In the random-effects model (M1), social isolation was moderately associated with poorer mental health in men and women but, in contrast to the social network indicator, not with poorer physical health. The association with mental health was again markedly reduced after controlling for indirect selection in the fixed-effects model (M2) but substantially increased after specifying social isolation as sequentially exogenous to account for direct selection (M3). Furthermore, the association was not altered after controlling for previous health in the dynamic panel model with fixed effects (M4) and was stronger among men than women. Compared to a state of being 'socially integrated', being 'socially isolated' was associated with a decline in mental health of -0.175 scale points among older women and -0.278 scale points among older men.

2.4 Discussion

2.4.1 Summary of findings

The aim of this study was to investigate whether social isolation is still associated with mental and physical health after considering indirect and direct selection. Therefore, dynamic panel models with fixed effects were estimated in a novel ML-SEM framework. The results show that becoming socially isolated was associated with a decrease in mental health among older men and women even after controlling for both indirect and direct selection but unrelated to physical health. This finding highlights the importance of social causation in explaining the relationship between social isolation and mental health but challenges previous studies arguing in favour of a univocal effect of social isolation on health.

However, the results also show that conclusions regarding the relative importance of social causation and selection heavily depend on the model specification. In the random-effects model, we confirmed the negative relationship between social isolation and physical and mental health reported in previous studies using the same measure of health (Achat et al., 1998; Hawton et al., 2011; López García et al., 2005; Rhee et al., 2021). However, the considerably weaker association in the standard fixed-effects models suggests that previous research may have overestimated the effect of social isolation on mental and physical health by failing to consider important confounding factors.

Although this finding implies that indirect selection partially explains the relationship between social isolation and both health outcomes, the most interesting result was that ignoring the isolating effect of mental health problems (direct selection) would have led to

underestimating the impact of social isolation on mental health. A possible explanation for this finding is that mental health problems also impair the social functioning of affected individuals, thereby increasing their risk of social isolation (Kupferberg et al., 2016). Our results indicate that scholars need to consider the potential effect of health problems on the risk of social isolation when attempting to analyse the health consequences of social isolation.

2.4.2 Practical relevance

An important question for policy debates and interventions is whether the statistical significance of the small to moderate impact of social isolation on mental health is of practical importance. To answer this question, benchmarks against which observed health differences can be compared are needed. According to a literature review by Samsa et al. (1999), the minimal clinically important difference (MCID) using the physical and mental health scales of the SF-36 is 'typically in the range of 3 to 5 points' (p. 149). Similarly, Vilagut et al. (2013) showed that in six European countries, the optimal cutoff scores for the MCS of the SF-12 for screening for 30-day and 12-month depressive disorders were 45.6 and 48.9 points, respectively (see also Gill et al., 2007). On the original scale ranging from 0 to 100, these cutoff scores are approximately 2 to 6 scale points below the sample means of the MCS in this study.[6] Accordingly, declines in mental health of 2 to 4 scale points following a transition to social isolation suggest that social isolation affects mental health to an extent that has practical and likely even clinical relevance.

2.4.3 Limitations

Despite its methodological innovation, this study is not free from limitations. First, although fixed-effects models use only variation within individuals to estimate causal effects and, thus, are effective in ruling out any bias due to unobserved heterogeneity among individuals (indirect selection), effects could be obtained only among individuals for whom a transition between states of social isolation was observed in the data. Although the effects might not be generalisable to the general population in Germany, this trade-off between internal and external validity is necessary for a causal analysis with observational data.

Second, while our models allowed for improved control for indirect and direct selection, other sources of bias that could affect our results need to be discussed. First, the isolation effect on mental health could still be upwardly biased if there are unobserved changes in time-

[6] The means and regression coefficients reported in our study must be multiplied by 10 to obtain values on the original scale ranging from 0 to 100.

varying variables that affect both the risk of social isolation and mental health. Although this possibility can never be ruled out, we expect any bias to be small because the most important time-varying confounders found in the literature were included in our models. Relatedly, time-varying unobservables could also lead to a violation of the assumption of parallel trends, such as if individuals with steeper age-related declines in mental health self-select into social isolation. However, the dynamic panel model accounts for previous changes in health, making it very unlikely that the assumption of parallel trends is violated.

Furthermore, in the FIML estimation, we assumed that missing data were at least missing at random (MAR) after adjusting for covariates. It is not possible to test this assumption because in the case of missing not at random (MNAR), the missingness depends on the missing values. If there are reasons to believe that the missing values are not random, a common approach is to include auxiliary variables in the estimation process to reduce the impact of MNAR (Graham, 2003). In our study, we accounted for not only several observed factors that are likely related to missingness but also prior health (M4) and even unobserved time-constant variables (M2-M4), such as personality and pre-existing chronic diseases. Therefore, we expect the potential influence of MNAR on the results to be small.

Nevertheless, individuals who were socially isolated, lacked material resources, were aged ≥ 80, and reported poor health in the previous year were more likely to drop out of the survey. Health-selective attrition becomes a problem of effect heterogeneity in fixed-effects models that estimate effects by comparing individuals to themselves in different states over time. The individuals who remained in the survey likely tended to have more health-related material resources and, thus, were better able to cope with the lack of social contact (Heritage et al., 2008). Moreover, it is possible that the individuals most likely to drop out of the survey were those for whom social isolation caused severe health problems or even death. Thus, we expect that selective attrition leads to an underestimation of the effect of social isolation on health.

Third, we were unable to differentiate between short- and long-term social isolation due to gaps in our data. Thus, failing to observe any effects over a period of one year does not necessarily imply that social isolation does not affect physical health. Further studies should investigate whether long-term isolation is particularly harmful to health. Finally, there is no prevailing opinion regarding which instruments are the most appropriate for measuring social isolation (Eckhard, 2018b). However, the two measures of social isolation in our study led to very similar findings regarding the influence of social isolation on physical and mental health.

Nevertheless, further studies should investigate whether our findings also apply to other measures of social isolation.

2.4.4 Conclusion

This study provides further evidence supporting the notion that social isolation is an important risk factor for mental health among older people but questions the general relevance of social isolation for physical health. We conclude that interventions aiming to reduce social isolation might indeed be an effective measure for improving mental health in the older population. However, we caution against overemphasising this finding until further studies analysing the health effect of social isolation with other causality-oriented research designs reach similar conclusions.

2.5 Appendix Study 1

Table 2.7 Amount and patterns of missing data in the analytic sample (women)

	Observations			Missing data patterns		
	Missing	Not missing	% Missing	a	b	c
Mental health (MCS)	2,871	20,642	0.122	1	0	1
Physical health (PCS)	2,871	20,642	0.122	1	0	1
Social network indicator						
Socially integrated	290	18,455	0.015	1	1	1
Rather integrated	290	18,455	0.015	1	1	1
Rather isolated	290	18,455	0.015	1	1	1
Socially isolated	290	18,455	0.015	1	1	1
Social contact indicator						
Socially integrated	71	18,674	0.004	1	1	1
Socially isolated	71	18,674	0.004	1	1	1
Age						
Age 50-59	0	18,745	0.000	1	1	1
Age 60-64	0	18,745	0.000	1	1	1
Age 65-69	0	18,745	0.000	1	1	1
Age 70-74	0	18,745	0.000	1	1	1
Age 75-79	0	18,745	0.000	1	1	1
Age 80+	0	18,745	0.000	1	1	1
Employment status						
Employed	289	18,456	0.015	1	1	0
Unemployed	289	18,456	0.015	1	1	0
Retired	289	18,456	0.015	1	1	0
Other not employed	289	18,456	0.015	1	1	0
Material situation						
Economic strain	191	18,554	0.010	1	1	1
Income poverty	0	18,745	0.000	1	1	1
Poor housing	33	18,712	0.002	1	1	1
$\mathbf{N}_{\mathbf{observations}}$				15,564	2,415	245
$\mathbf{\%}_{\mathbf{observations}}$				83%	13%	1%

Notes: The total numbers of observations of MCS and PCS are higher than those of the other variables because there is an additional year of measurement. See also Table 2.1 and Table 2.2.
All missing data patterns in the years 2005/2006 to 2011/2012 with a percentage of 1% or higher are shown. In a pattern, 1 indicates that a variable is not missing, and 0 indicates that a variable is missing in an observation.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.8 Amount and patterns of missing data in the analytic sample (men)

	Observations			Missing data patterns		
	Missing	Not missing	% Missing	a	b	c
Mental health (MCS)	2,592	19,124	0.119	1	0	1
Physical health (PCS)	2,592	19,124	0.119	1	0	1
Social network indicator						
Socially integrated	194	17,116	0.011	1	1	1
Rather integrated	194	17,116	0.011	1	1	1
Rather isolated	194	17,116	0.011	1	1	1
Socially isolated	194	17,116	0.011	1	1	1
Social contact indicator						
Socially integrated	23	17,287	0.001	1	1	1
Socially isolated	23	17,287	0.001	1	1	1
Age						
Age 50-59	0	17,310	0.000	1	1	1
Age 60-64	0	17,310	0.000	1	1	1
Age 65-69	0	17,310	0.000	1	1	1
Age 70-74	0	17,310	0.000	1	1	1
Age 75-79	0	17,310	0.000	1	1	1
Age 80+	0	17,310	0.000	1	1	1
Employment status						
Employed	307	17,003	0.018	1	1	0
Unemployed	307	17,003	0.018	1	1	0
Retired	307	17,003	0.018	1	1	0
Other not employed	307	17,003	0.018	1	1	0
Material situation						
Economic strain	121	17,189	0.007	1	1	1
Income poverty	0	17,310	0.000	1	1	1
Poor housing	26	17,284	0.002	1	1	1
$\mathbf{N}_{\mathbf{observations}}$				14,449	2,238	264
$\mathbf{\%}_{\mathbf{observations}}$				83%	13%	2%

Notes: The total numbers of observations of MCS and PCS are higher than those of the other variables because there is an additional year of measurement. See also Table 2.1 and Table 2.2.
All missing data patterns in the years 2005/2006 to 2011/2012 with a percentage of 1% or higher are shown. In a pattern, 1 indicates that a variable is not missing, and 0 indicates that a variable is missing in an observation.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.9 Association between the explanatory variables and success of the personal interview in the following year by indicator of social isolation

	Successful vs. unsuccessful interview			
	Model 1		Model 2	
Social network indicator				
Socially integrated	Reference			
Rather integrated	0.007			
	(0.004)			
Rather isolated	0.017	***		
	(0.004)			
Socially isolated	0.027	***		
	(0.006)			
Social contact indicator				
Socially integrated			Reference	
Socially isolated			0.014	*
			(0.007)	
Mental health (t-1)	-0.004	**	-0.005	***
	(0.002)		(0.002)	
Physical health (t-1)	-0.010	***	-0.010	***
	(0.002)		(0.002)	
Male	0.007	*	0.005	
	(0.003)		(0.003)	
Age				
Age 50-59	Reference		Reference	
Age 60-64	-0.006		-0.006	
	(0.005)		(0.005)	
Age 65-69	-0.008		-0.009	
	(0.005)		(0.005)	
Age 70-74	0.003		0.005	
	(0.006)		(0.006)	
Age 75-79	0.009		0.010	
	(0.007)		(0.007)	
Age 80+	0.047	***	0.055	***
	(0.009)		(0.009)	
Employment status				
Employed	Reference		Reference	
Unemployed	-0.020	*	-0.020	*
	(0.008)		(0.008)	
Retired	-0.010		-0.009	
	(0.005)		(0.005)	
Other not employed	0.010		0.006	
	(0.009)		(0.008)	

Table 2.9 Continued

	Successful vs. unsuccessful interview			
	Model 1		Model 2	
Material situation				
Economic strain	-0.003		-0.002	
	(0.003)		(0.003)	
Income poverty	0.018	**	0.022	***
	(0.006)		(0.006)	
Poor housing	0.009	*	0.010	**
	(0.004)		(0.004)	
$N_{persons}$	9,884		9,905	
$N_{observations}$	28,230		28,490	

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Analysis of cases with complete information for all variables. All models are adjusted for the survey year. Average marginal effects estimated from binomial logistic regression models are shown with robust standard errors in parentheses.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.10 Transitions between states of social isolation between adjacent time points among women (social network indicator)

Social isolation at time t	Social isolation at time t+1				Total
	Socially integrated	Rather integrated	Rather isolated	Socially isolated	
Socially integrated	3,105	893	294	33	4,325
	71.79	20.65	6.80	0.76	100.00
Rather integrated	768	1,248	522	80	2,618
	29.34	47.67	19.94	3.06	100.00
Rather isolated	172	389	1,755	513	2,829
	6.08	13.75	62.04	18.13	100.00
Socially isolated	3	32	345	1,053	1,433
	0.21	2.23	24.08	73.48	100.00
Total	4,048	2,562	2,916	1,679	11,205
	36.13	22.86	26.02	14.98	100.00

Notes: Absolute and relative row frequencies are shown.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.11 Transitions between states of social isolation between adjacent time points among men (social network indicator)

Social isolation at time t	Social isolation at time t+1				Total
	Socially integrated	Rather integrated	Rather isolated	Socially isolated	
Socially integrated	3,467	988	338	17	4,810
	72.08	20.54	7.03	0.35	100.00
Rather integrated	839	1,319	553	51	2,762
	30.38	47.76	20.02	1.85	100.00
Rather isolated	236	492	1,235	220	2,183
	10.81	22.54	56.57	10.08	100.00
Socially isolated	4	23	142	411	580
	0.69	3.97	24.48	70.86	100.00
Total	4,546	2,822	2,268	699	10,335
	43.99	27.31	21.94	6.76	100.00

Notes: Absolute and relative row frequencies are shown.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.12 Transitions between states of social isolation between adjacent time points among women (social contact indicator)

Social isolation at time t	**Social isolation at time t+1**		
	Socially integrated	Socially isolated	**Total**
Socially integrated	10,224	487	10,711
	95.45	4.55	100.00
Socially isolated	344	417	761
	45.20	54.80	100.00
Total	10,568	904	11,472
	92.12	7.88	100.00

Notes: Absolute and relative row frequencies are shown.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.13 Transitions between states of social isolation between adjacent time points among men (social contact indicator)

Social isolation at time t	**Social isolation at time t+1**		
	Socially integrated	Socially isolated	**Total**
Socially integrated	9,982	202	10,184
	98.02	1.98	100.00
Socially isolated	153	209	362
	42.27	57.73	100.00
Total	10,135	411	10,546
	96.10	3.90	100.00

Notes: Absolute and relative row frequencies are shown.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.14 Association between social isolation and mental and physical health (Model 4, social network indicator)

	Mental health		Physical health	
	Women	Men	Women	Men
Social isolation				
Socially integrated	Reference	Reference	Reference	Reference
Rather integrated	-0.084 *	-0.032	0.048	0.019
	(0.037)	(0.034)	(0.029)	(0.027)
Rather isolated	-0.378 ***	-0.105	0.050	-0.017
	(0.062)	(0.055)	(0.046)	(0.041)
Socially isolated	-0.398 ***	-0.485 ***	0.083	-0.026
	(0.098)	(0.136)	(0.069)	(0.094)
Mental health (t-1)	0.143 ***	0.139 ***		
	(0.017)	(0.020)		
Physical health (t-1)			0.177 ***	0.181 ***
			(0.017)	(0.018)
Age				
Age 50-59	Reference	Reference	Reference	Reference
Age 60-64	0.078 *	0.053	0.046	-0.007
	(0.034)	(0.034)	(0.027)	(0.027)
Age 65-69	0.049	0.068	0.055	-0.028
	(0.055)	(0.053)	(0.044)	(0.044)
Age 70-74	0.004	-0.039	0.064	-0.016
	(0.071)	(0.069)	(0.057)	(0.057)
Age 75-79	0.051	-0.140	0.066	-0.003
	(0.093)	(0.088)	(0.073)	(0.073)
Age 80+	-0.023	-0.235 *	0.060	-0.012
	(0.118)	(0.115)	(0.091)	(0.092)
Employment status				
Employed	Reference	Reference	Reference	Reference
Unemployed	-0.144 **	0.039	0.048	-0.039
	(0.055)	(0.057)	(0.044)	(0.049)
Retired	-0.011	0.108 **	0.022	0.074 *
	(0.040)	(0.035)	(0.035)	(0.031)
Other not employed	-0.052	-0.166	-0.003	0.127
	(0.051)	(0.116)	(0.043)	(0.090)

Table 2.14 Continued

	Mental health		Physical health	
	Women	Men	Women	Men
Material situation				
Economic strain	-0.027	-0.032	-0.011	-0.011
	(0.022)	(0.021)	(0.018)	(0.019)
Income poverty	0.055	-0.105 *	-0.014	-0.057
	(0.040)	(0.047)	(0.029)	(0.037)
Poor housing	0.014	-0.015	-0.043 *	0.038
	(0.028)	(0.027)	(0.021)	(0.022)
Chi^2	149.698 (143)	223.228 (143) ***	184.436 (143) *	169.135 (143)
RMSEA	0.003	0.009	0.006	0.005
CFI	0.999	0.985	0.996	0.997
SRMR	0.004	0.006	0.003	0.003
N	7,189	6,740	7,189	6,740

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses. The reported coefficients were retrieved from Model 4.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

Table 2.15 Association between social isolation and mental and physical health (Model 4, social contact indicator)

	Mental health		Physical health	
	Women	Men	Women	Men
Social isolation				
Socially integrated	Reference	Reference	Reference	Reference
Socially isolated	-0.175 *	-0.278 *	0.064	0.050
	(0.070)	(0.118)	(0.053)	(0.080)
Mental health (t-1)	0.141 ***	0.140 ***		
	(0.017)	(0.019)		
Physical health (t-1)			0.176 ***	0.180 ***
			(0.017)	(0.018)
Age				
Age 50-59	Reference	Reference	Reference	Reference
Age 60-64	0.082 *	0.061	0.045	-0.005
	(0.034)	(0.034)	(0.027)	(0.027)
Age 65-69	0.055	0.086	0.053	-0.027
	(0.055)	(0.053)	(0.044)	(0.043)
Age 70-74	0.005	-0.017	0.063	-0.015
	(0.070)	(0.069)	(0.057)	(0.057)
Age 75-79	0.038	-0.123	0.067	-0.003
	(0.092)	(0.088)	(0.072)	(0.073)
Age 80+	-0.060	-0.229 *	0.064	-0.012
	(0.117)	(0.115)	(0.091)	(0.091)
Employment status				
Employed	Reference	Reference	Reference	Reference
Unemployed	-0.124 *	0.040	0.047	-0.038
	(0.054)	(0.057)	(0.044)	(0.049)
Retired	-0.001	0.109 **	0.022	0.077 *
	(0.039)	(0.034)	(0.035)	(0.030)
Other not employed	-0.029	-0.153	-0.005	0.124
	(0.051)	(0.117)	(0.043)	(0.090)
Material situation				
Economic strain	-0.024	-0.034	-0.011	-0.012
	(0.022)	(0.021)	(0.018)	(0.019)
Income poverty	0.046	-0.107 *	-0.013	-0.057
	(0.040)	(0.047)	(0.029)	(0.037)
Poor housing	0.004	-0.017	-0.042	0.037
	(0.028)	(0.027)	(0.021)	(0.022)
Chi^2	135.142 (133)	207.330 (133) ***	169.341 (133) *	158.903 (133)
RMSEA	0.001	0.009	0.006	0.005
CFI	1.000	0.986	0.997	0.997
SRMR	0.004	0.007	0.003	0.004
N	7,189	6,740	7,189	6,740

Notes: Significance levels are *p<0.05, **p<0.01, and ***p<0.001. Unstandardised regression coefficients are shown with robust standard errors in parentheses. The reported coefficients were retrieved from Model 4.

Source: German Socio-Economic Panel (GSOEP) 2004–2012, own calculations.

3 Does loneliness contribute to mental health problems? An analysis of data from the UK Household Longitudinal Study 2017–2022 (Study 2)

Abstract

Background: Although the fact that lonely people report poor mental health has been well documented, it is still unclear whether this link reflects a negative effect of loneliness on mental health. Many studies have not fully ruled out alternative explanations, such as the selection of people with mental health problems into loneliness. This study aimed to investigate whether loneliness is detrimental to mental health by ruling out selection as an alternative explanation.

Methods: This study was based on four-wave panel data from Understanding Society, the UK Household Longitudinal Study (UKHLS), 2017–2022. Two measures of mental health were used: psychological distress (GHQ-12) and general mental health (SF-12 MCS). Loneliness was assessed using the three-item UCLA Loneliness Scale and a single-item measure. Fixed-effects individual-slopes (FEIS) models were estimated to account for the possibility that people with less favourable mental health trajectories select themselves into loneliness.

Results: The FEIS models showed that loneliness contributes to mental health problems even after accounting for selection. Specifically, loneliness was significantly associated with higher levels of psychological distress and poorer general mental health. The regression coefficients indicated moderate to large differences relative to typical levels of within-individual change in the outcomes. Furthermore, the results revealed some more or less pronounced gender- and age-specific differences, but substantial effects could be observed in all the sociodemographic groups analysed. The evidence was also robust across measures of loneliness.

Conclusion: The results provide further evidence to support the claim that loneliness plays a causal role in the onset of mental health problems. Given its high prevalence worldwide, reducing loneliness is key to the prevention of mental disorders.

3.1 Introduction

Loneliness is the unpleasant feeling that results from a perceived deficiency in one's social relationships (e.g., Perlman and Peplau, 1981). According to evolutionary theory (Cacioppo and Cacioppo, 2018a), loneliness evolved as an aversive signal that alerts us to deficits in our social connectedness and motivates us to take actions that facilitate the restoration of social ties (e.g., Qualter et al., 2015). Thus, loneliness is a common human experience that affects most people at some point in their lives. However, for some people, it becomes a prolonged and distressing experience (Qualter et al., 2015). Estimates have suggested that 5 to 9% of the adult population in Western European countries experience severe feelings of loneliness (Surkalim et al., 2022). Contrary to popular belief, loneliness is not an issue that occurs solely in old age but is rather experienced by people of all ages (Qualter et al., 2015). Recently, the high prevalence of loneliness has been identified as a major public health concern due to its robust associations with a variety of health outcomes (e.g., Leigh-Hunt et al., 2017; Park et al., 2020). For example, multiple meta-analyses have revealed substantial associations between loneliness and mental health outcomes, most notably depression, anxiety, and suicide (Erzen and Çikrikci, 2018; McClelland et al., 2020; Park et al., 2020). These associations are typically moderate to large in size, and they appear to be robust across a variety of populations.

Although it has commonly been assumed that loneliness is detrimental to mental health, most studies on this topic have relied on research designs that are poorly suited to the task of ruling out alternative explanations, such as the selection of people with mental health problems into loneliness. In this study, I seek to elucidate the causal nature of these associations by using a novel analytical strategy based on fixed-effects individual-slopes (FEIS) models and nationally representative panel data from Understanding Society, the UK Household Longitudinal Study (UKHLS), 2017–2022. Specifically, I examine whether loneliness is still associated with mental health after taking selection into account. Clarifying the causal role of loneliness is crucial because of the potentially high costs that the negative mental health effects of loneliness could impose on health care systems (Meisters et al., 2021; Mihalopoulos et al., 2020).

3.1.1 Explanations for the associations between loneliness and mental health

3.1.1.1 Causation

Several explanations for why lonely people report poorer mental health have been proposed in the literature. Most researchers seem to believe that loneliness contributes to the onset of mental health problems, a claim which is referred to here as the causation hypothesis (Seifert et al., 2022). The specific mechanisms underlying such an effect are still debated, but researchers have proposed a set of interrelated pathways. First, loneliness may cause high levels of emotional distress because it signals that the satisfaction of the basic need to belong is threatened (Baumeister and Leary, 1995; Heinrich and Gullone, 2006). Second, social relationships are a source of psychosocial resources (e.g., meaning in life, self-esteem), which protect against mental health problems (Cohen and Wills, 1985; Thoits, 2011a). Loneliness may deprive people of these resources, thus leaving them more vulnerable to mental illness. Third, loneliness may lead to hypervigilance towards social threats (Cacioppo and Hawkley, 2009), which in turn may produce negative cognitive biases that activate a range of processes related to mental health problems, such as negative evaluations of the self and others (Spithoven et al., 2017), a self-blaming attributional style (Spithoven et al., 2017), increased levels of inflammation (Smith et al., 2020), and dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis (Cacioppo et al., 2015). Finally, cognitive biases may elicit problematic social behaviours in lonely people, to which others may respond with rejection. These negative reactions in turn confirm and reinforce lonely people's negative thoughts (Cacioppo and Hawkley, 2009), thereby trapping them in a vicious cycle of increasing loneliness, cognitive biases, and high levels of interpersonal stress that exacerbate their mental health problems (Cacioppo and Hawkley, 2009).

3.1.1.2 Selection

An alternative explanation is that people with mental health problems are more likely to be affected by loneliness because they may be more frequently exposed to interpersonal problems and negative life events (Hammen, 2006; Meyer and Curry, 2017) and may tend to perceive social relationships in an overly negative way (Gotlib and Joormann, 2010; Mathews and MacLeod, 2005). Depending on the specific form of this explanation, this selection process may be driven by either the presence of mental health problems or related symptoms (the direct selection hypothesis) or by stable vulnerabilities that cause people to face a higher risk of

mental illness (the indirect selection hypothesis). In the following, I briefly introduce theoretical arguments for both types of selection.

The direct selection hypothesis posits that selection is caused by mental health problems directly (Seifert et al., 2022). Several mechanisms have been discussed that might contribute to such direct selection. First, several studies have shown that people with mental health problems may exhibit significant impairments in sociocognitive skills and social functioning (Cotter et al., 2018; Kupferberg et al., 2016), which can make it difficult for them to perform social activities in their daily lives. Second, they may actively withdraw from social life, for example, because they derive less pleasure from social activities (Trøstheim et al., 2020), a symptom which is also known as social anhedonia. In addition, they may avoid social situations because they feel ashamed of their condition (Kim et al., 2011) or anticipate being stigmatised by others (Sheehan et al., 2022). Third, people with mental health problems may be actively avoided by others (Lasalvia et al., 2013), for example, because those others believe in stereotypes regarding mental disorders and feel uncomfortable interacting with people with mental health problems (Angermeyer et al., 2013). In addition, people with mental health problems may engage in problematic social behaviours, such as excessive reassurance-seeking (Joiner et al., 1999; Parrish and Radomsky, 2010). Finally, such people may be more likely to perceive their social relationships as deficient due to negative biases in information processing (Gotlib and Joormann, 2010; Mathews and MacLeod, 2005). Collectively, these arguments suggest that mental health problems may increase the risk of loneliness.

The indirect selection hypothesis argues that selection is not the result of mental health problems per se but rather that of stable, enduring vulnerabilities that predispose people to mental illness. The basic idea of this hypothesis is that loneliness and mental health problems share a set of risk factors that may confound their association (Seifert et al., 2022). Evidence from different fields of research has linked both conditions to genetic factors (Matthews et al., 2016; Spithoven et al., 2019), experiences of neglect and abuse in childhood (de Heer et al., 2022; Gardner et al., 2019), personality traits such as neuroticism and extraversion (Buecker et al., 2020; Kotov et al., 2010), and other psychological traits such as insecure attachment styles (Zhang et al., 2022) and rejection sensitivity (Gao et al., 2017b). Accordingly, the indirect selection hypothesis implies that once such confounding by shared vulnerabilities is taken into account, loneliness should no longer be associated with mental health.

3.1.2 Empirical evidence

Only a few longitudinal studies have attempted to disentangle causation from selection using extensions of the cross-lagged panel model. These analytical approaches allow the association between loneliness and mental health to be analysed using within-individual variation while controlling for prior changes in the outcomes and any stable unobserved confounders. Overall, these studies have offered surprisingly limited evidence for the causation hypothesis. Two studies found weak to moderate effects of loneliness on symptoms of (social) anxiety, depression, and paranoia using non-probability samples of adults from the USA (Lim et al., 2016; McDowell et al., 2021). In contrast, other studies analysing samples of older people from Europe and the USA have found only very weak effects on depressive symptoms ($\beta < 0.1$; Joshanloo, 2022; Luo, 2022) or no significant effects (Griffin et al., 2022; Joshanloo, 2022; Mayerl et al., 2022). Another study was unable to find an effect of loneliness on symptoms of depression and anxiety in adolescents (Kristensen et al., 2022). These findings put the claim that loneliness is actually a risk factor for mental health problems, as has been readily assumed in the scientific literature, into question.

Nevertheless, previous studies that have used within estimators have been limited in several ways. First, none of these studies adjusted for negative life events, which have previously been linked to loneliness and mental health problems. Consequently, the two studies that have offered support for the causation hypothesis might have overestimated the effect of loneliness, which might instead reflect the influence of changing living conditions. Second, the analytical strategies used in this studies have been based on strong assumptions regarding the latency of the effect of loneliness on mental health, with time intervals ranging from one week (McDowell et al., 2021) to six years (Joshanloo, 2022). This issue is problematic because existing theories are too imprecise to provide guidance regarding the correct specification of this latency. Additionally, simulation studies have shown that within estimators can yield severely biased estimates, even including coefficients with the opposite sign, if the time interval between exposure and outcomes is not specified correctly (Leszczensky and Wolbring, 2022; Vaisey and Miles, 2017). In general, such studies found evidence for the causation hypothesis only when they assumed relatively short time intervals of several weeks rather than multiple years (Lim et al., 2016; McDowell et al., 2021). Finally, previous research has estimated only the average effect of loneliness on mental health, ignoring the possibility that the role of causation and selection might differ across sociodemographic groups. Specifically, only the two studies that analysed non-probability

samples of adults found evidence for the causation hypothesis (Lim et al., 2016; McDowell et al., 2021), while studies on adolescents (Kristensen et al., 2022) and older people found very limited evidence (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). In addition, only three studies addressed the possibility of gender differences in the roles of causation and selection, and these studies also focused on specific age groups (Joshanloo, 2022; Kristensen et al., 2022; Mayerl et al., 2022). These shortcomings indicate a strong need for further research to clarify the causal nature of the association between loneliness and mental health.

This study aims to reconsider this evidence by testing the causation hypothesis using a novel analytical strategy based on FEIS models. While previous studies have attempted to rule out selection by controlling for prior mental health and unobserved stable confounders, this study is based on a more holistic view of selection processes. In particular, the FEIS model builds on empirical research that has shown that stable vulnerabilities such as genetic factors, early life adversity, and personality traits lead to systematic differences in mental health trajectories (Kwong et al., 2021; Nandi et al., 2009; Nanni et al., 2012; Nelson et al., 2017; Rhebergen et al., 2012; Schubert et al., 2017) and that people who exhibit less favourable trajectories are more likely to be socially disconnected or feel lonely (Houtjes et al., 2017; Houtjes et al., 2014; Musliner et al., 2016). In addition, the study examines the robustness of the evidence across genders, age groups, and measures of loneliness. It thus provides a broader and more rigorous test of the causation hypothesis than has been offered by previous research.

3.2 Data and methods

This study uses four waves of panel data from UKHLS, which was conducted by the Institute for Social and Economic Research (ISER; 2022b) at the University of Essex.[7] Since the launch of the UKHLS in 2009, participants aged 16 and older have been asked about a wide range of topics, including family and social life, health, and socioeconomic status, to investigate the long-term effects of social and economic change on the overall well-being of the population of the UK. The study used a mixed-mode design featuring face-to-face, telephone, and web

[7] Understanding Society is an initiative funded by the Economic and Social Research Council and various Government Departments, with scientific leadership by the Institute for Social and Economic Research, University of Essex, and survey delivery by NatCen Social Research and Kantar Public. The research data are distributed by the UK Data Service. Fieldwork for the web survey was carried out by Ipsos MORI and for the telephone survey by Kantar.

interviews. When personal interviews were suspended due to the COVID-19 pandemic and lockdown measures, participants were asked to complete the questionnaire online. Participants who did not complete the interview online were asked to complete it by telephone (for further details, see Institute for Social and Economic Research, 2022a). Although the fieldwork for each wave covered a period of 24 months or longer, each participant was interviewed at approximately 12-month intervals. More information regarding the survey design and data collection can be found elsewhere (Institute for Social and Economic Research, 2022c).

3.2.1 Sample selection

The statistical analyses were based on pooled data from waves 9 to 12, which are the only waves in which participants were asked about loneliness. Participants were not asked about loneliness in wave 12 until the second quarter of fieldwork, when the Understanding Society team decided to augment the questionnaires with specific modules that would offer a better understanding of the social impact of the COVID-19 pandemic. The analytical approach used in this study required at least three observations for each individual. After excluding observations that featured missing values for any analysed variable and individuals with fewer than three observations in total, the final sample consisted of 86,896 observations from 24,988 individuals (55.60% of the observations were from women, and respondents were aged 16 to 100 years with $mean_{age} = 51.79$ and $SD_{age} = 17.69$). The amount of missing data in the pooled data was very low (the highest rate of missing data pertained to general mental health at 7.02%). In the excluded observations, participants exhibited slightly poorer general mental health, and they were lonely slightly more often, less socially connected, more financially deprived, and younger (see Table 3.1). Thus, individuals who were more resilient in terms of social and financial resources tended to remain in the sample.

3.2.2 Measures

Mental health was measured by reference to two outcomes, each of which focused on different aspects of mental health. The aim of this approach was to improve the generalisability of the substantive findings.

Psychological distress was assessed using the 12-item General Health Questionnaire (GHQ-12), which has been widely used as a screening tool for psychological distress in the general population (Goldberg, 1972). The items ask the respondents how often they had experienced twelve typical psychiatric symptoms in the past few weeks. Positive items were measured on a scale ranging from 1 (*more so than usual*) to 4 (*much less than usual*), while

negative items were measured on a scale ranging from 1 (*not at all*) to 4 (*much more than usual*). Responses were scored using the Likert scoring system (0-1-2-3), resulting in a total score ranging from 0 to 36. Higher scores indicate higher levels of psychological distress.

General mental health was measured using the Mental Component Summary (MCS) scale of Version 2 of the Short Form-12 Health Survey (SF-12), which is a modified 12-item version of the SF-36 Health Survey (Ware et al., 2001). The SF-12 is a validated measure of general health, functioning, and health-related quality of life. The scores of the twelve items were aggregated and converted to normalised scores on a scale ranging from 0 to 100 (mean = 50, SD = 10; for more details, see Ware et al., 2001). Higher scores indicate better general mental health. The SF-12 MCS has been found to be a useful screening tool for anxiety and depressive disorders in the general population (Gill et al., 2007; Vilagut et al., 2013).

Loneliness was assessed directly using a single item ('How often do you feel lonely?') and indirectly using the three-item UCLA Loneliness Scale ('How often do you feel a) you lack companionship, b) left out, and c) isolated from others?', Hughes et al., 2004). Response options for all items included 1 (*hardly ever or never*), 2 (*some of the time*), and 3 (*often*). To ensure the compatibility of the two measures (Age UK, 2020), the scores of the three items from the UCLA Loneliness Scale were summed and then categorised into three groups: 'hardly ever or never' (scores of 3 and 4), 'sometimes' (5, 6, and 7), and 'often' lonely (8 and 9). Following the recommendation of the Office for National Statistics (2018), both direct and indirect measures of loneliness were used to ensure the robustness of the analyses, as these measures have different strengths and weaknesses.

Time-varying covariates. I adjusted the models for several time-varying covariates that are shared risk factors for both loneliness and mental health problems. Sociodemographic factors included linear age, which was used to estimate individual-specific mental health trajectories in the FEIS regression. Socioeconomic covariates included employment status (employed, unemployed, retired, sick/disabled, inactive/homemaker, student) and financial deprivation (mild, moderate, severe). Moreover, to account for actual social connectedness, I considered relationship status (single, living apart or living together with a partner), marital status (never married, married, separated/divorced, widowed), living alone, and single parenthood. Finally, to account for period effects due to the COVID-19 pandemic, interview mode (face-to-face, telephone, web) and time period (2017, 2018–2019, January to February 2020, March 2020 to May 2022) were controlled for in all models. The FEIS model already accounts for all stable confounders, even if they are unobserved. Thus, there was no need to

include these factors in the models. The pooled ordinary least squares (POLS) model was additionally adjusted for gender.

Table 3.1 Summary statistics of the analysed and excluded observations

	Analysed observations		Excluded observations	
	Mean	SD	Mean	SD
Psychological distress (GHQ-12)	11.39	5.52	11.87	6.06
General mental health (SF-12 MCS)	48.30	10.49	46.63	11.35
UCLA Loneliness Scale				
Hardly ever/never lonely	0.62		0.58	
Sometimes lonely	0.33		0.35	
Often lonely	0.05		0.07	
Single-item measure				
Hardly ever/never lonely	0.63		0.57	
Sometimes lonely	0.30		0.33	
Often lonely	0.07		0.10	
Age in years	51.79	17.69	45.78	20.83
Female	0.56		0.53	
Employment status				
Employed	0.57		0.51	
Unemployed	0.04		0.07	
Retired	0.28		0.21	
Sick/disabled	0.03		0.05	
Inactive/homemaker	0.04		0.07	
Student	0.04		0.10	
Financial deprivation				
Mild	0.75		0.65	
Moderate	0.19		0.24	
Severe	0.06		0.11	
Relationship status				
Single	0.26		0.33	
Living apart	0.07		0.10	
Living together	0.66		0.58	
Marital status				
Never married	0.26		0.40	
Married	0.58		0.44	
Separated/divorced	0.11		0.09	
Widowed	0.06		0.07	
Living alone	0.17		0.14	
Single parent	0.02		0.04	
Interview mode				
Face-to-face	0.27		0.50	
Telephone	0.05		0.06	
Web	0.68		0.44	
Observations	86,896		32,055	
Individuals	24,988		17,951	

Notes: The excluded observations do not include missing values resulting from the fact that data on loneliness were not collected until the second quarter of the fieldwork in wave 12.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

3.2.3 Statistical analysis

To investigate the association between loneliness and mental health, I first estimated POLS models to replicate previous studies that have reported substantial associations between loneliness and mental health in diverse populations (Park et al., 2020). The POLS estimator is obtained by pooling the data for all individuals across the survey waves and applying an OLS regression to the pooled data. As was the case in many previous studies, the POLS estimator does not allow researchers to distinguish between causation and selection.

Subsequently, I estimated FEIS models to analyse the effect of loneliness on mental health by accounting for the possibility that individuals with less favourable mental health trajectories select themselves into loneliness. The model to be estimated can be illustrated as follows:

$$y_{it} = x_{it}\beta + \alpha_{1i} + w_{it}\alpha_{2i} + \varepsilon_{it} \quad (1)$$

where y is the mental health of individual i at time t, x is a vector that contains loneliness and the time-varying covariates, w_{it} contains age for which individual-specific slopes α_{2i} are estimated, and ε_{it} is an idiosyncratic error term. Furthermore, α_{1i} is an individual-specific intercept that captures the joint influence of all unobserved stable characteristics on mental health. In the FEIS model, this intercept reflects the baseline level of mental health. Statistically, the individual-specific slopes α_{2i} can be understood as stable confounders that interact with age to produce heterogeneous trajectories of mental health. Table 3.2 and Table 3.3 in the Appendix indicate the presence of sufficient within-individual variation in the two measures of loneliness to estimate FEIS models.

The artificial regression test (ART) supports the choice of the FEIS model over the standard fixed-effects (FE) model, which allows only the intercept to vary across individuals and to be associated with the risk of loneliness (Brüderl and Ludwig, 2015). To determine whether selection was also based on heterogeneous slopes, the ART was used to compare the regression coefficients of the FEIS model with those of the standard FE models. For all measures of loneliness and mental health outcomes, the ART was highly significant for the subset of loneliness variables and for all variables combined (see Table 3.4 in the Appendix for more details on the specification tests), thus indicating that the FE models would have yielded biased estimates of the effect of loneliness on mental health.

The FEIS model requires at least $j + 1$ observations per individual, where j is the number of parameters to be estimated separately for each individual. In this study, three observations were needed because in addition to the individual-specific intercept, the slope for age was

estimated for each individual. More details regarding the FEIS regression can be found elsewhere (Brüderl and Ludwig, 2015). All analyses were conducted using Stata 15.1 (StataCorps, Texas) and the xtfeis.ado (Ludwig, 2019).

3.3 Results

3.3.1 Descriptive statistics

Table 3.1 presents the summary statistics for all variables in the analysed sample. Interestingly, the direct and indirect measures of loneliness led to similar results regarding the frequency of loneliness experiences. In 30% and 33% of the observations, the respondents sometimes felt lonely, and in 5% and 7% of the observations, they often felt lonely. In addition, respondents reported a slightly lower level of general mental health compared to the mean of the normalised scores (mean = 48.30 on a scale ranging from 0 ‘poor health’ to 100 ‘excellent health’) and low to moderate levels of psychological distress (mean = 11.39 on a scale ranging from 0 ‘low distress’ to 36 ‘high distress’).

3.3.2 Multivariate analyses

This section presents the results of the regression analyses concerning the effects of loneliness on the two mental health outcomes. All figures show the unstandardised regression coefficients with 95% confidence intervals based on panel-robust standard errors. Further details concerning the full regression models can be found in Table 3.5 and Table 3.6 in the Appendix.

Figure 3.1 and Figure 3.2 show the results of the POLS and the FEIS models for psychological distress and general mental health, respectively, with regard to both direct and indirect measures of loneliness. In a first step, I estimated POLS models to confirm prior research that has revealed substantial associations between loneliness and various mental health outcomes (Park et al., 2020). As shown in the figures, individuals who felt lonely ‘sometimes’ or ‘often’ had significantly higher levels of psychological distress (Figure 3.1) and significantly worse general mental health (Figure 3.2) than individuals who ‘hardly ever/never’ felt lonely. The magnitudes of these associations were very similar for direct and indirect measures of loneliness, thus emphasising the robustness of the results. Nevertheless, the POLS models use both the within- and between-individual variation and are therefore ill-suited to disentangle causation from selection. As in previous research, it therefore remains unclear whether the observed associations reflect the effect of loneliness on mental health.

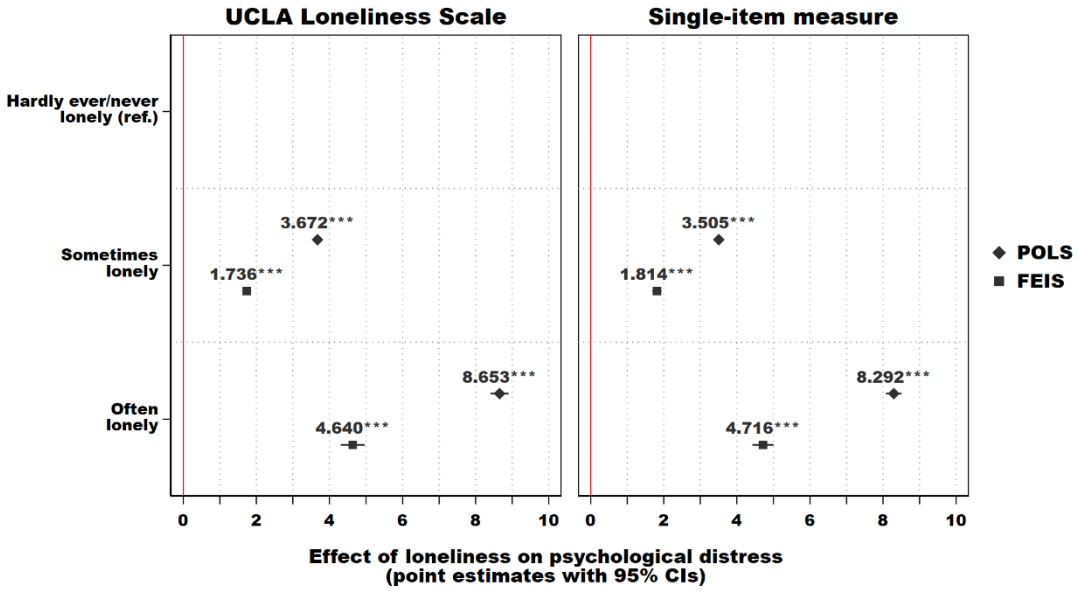

Figure 3.1 Effect of loneliness on psychological distress by measure of loneliness (N_{obs} = 86,896, N_{ind} = 24,988)

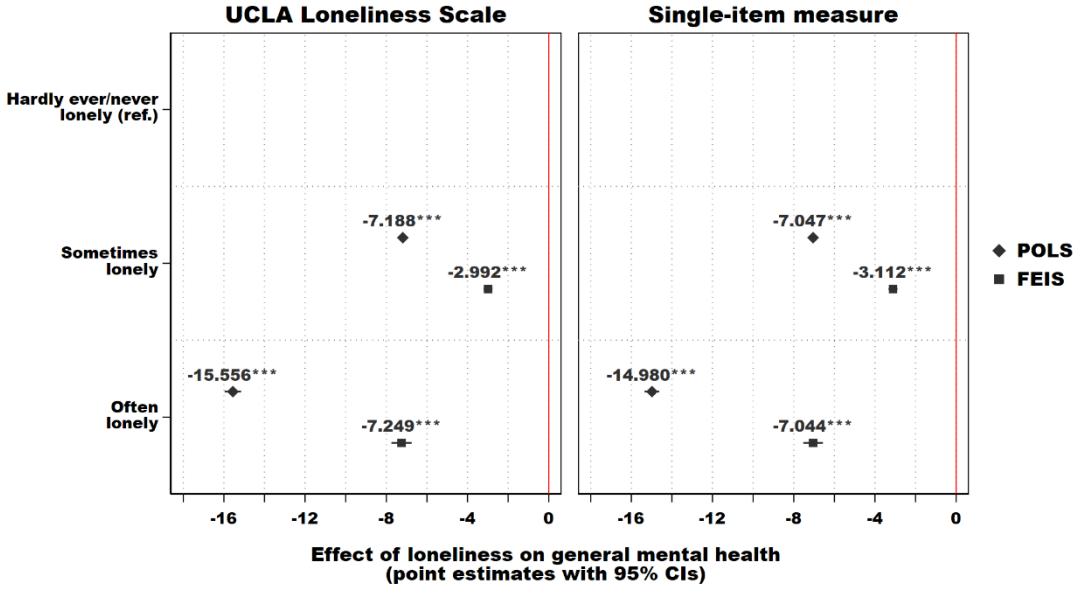

Figure 3.2 Effect of loneliness on general mental health by measure of loneliness (N_{obs} = 86,896, N_{ind} = 24,988)

In a second step, I estimated FEIS models to rule out selection as an alternative explanation. These models allowed me to account for the possibility that individuals with less favourable mental health trajectories are more likely to experience loneliness. The results of the FEIS models showed that feeling lonely 'sometimes' or 'often' was associated with an increase in psychological distress (Figure 3.1) and a decline in general mental health (Figure 3.2). Although these associations were notably weaker than in the POLS models, their magnitude was still substantial. To contextualise these associations, the regression coefficients can be compared with the within-individual standard deviations of the outcomes ($SD_{w)}$. This comparison reveals that the coefficients were approximately 0.5 to 1.5 SD_w for psychological distress and approximately 0.5 to 1.3 SD_w for general mental health. Thus, loneliness contributed to moderate to large changes in both outcomes relative to the typical degree of variation within individuals over time. Furthermore, the results show that this pattern was robust across the two measures of loneliness. Hence, both measures led to identical conclusions regarding the relationship between loneliness and mental health.

As an additional robustness check, I explored the interaction effects between loneliness and the COVID-19 pandemic to rule out the possibility that the results were influenced by exposure or adaptation to social distancing measures (Table 3.7 and Table 3.8 in the Appendix). However, the effects of loneliness on both outcomes differed only slightly before and during the pandemic. Moreover, I re-estimated the models without adjusting for actual social connectedness to determine whether the results were subject to overcontrol bias (Figure 3.3 and Figure 3.4 in the Appendix). Specifically, it has been argued that loneliness might affect mental health by leading to interpersonal problems and negative life events that cause high levels of stress. Once again, the results were almost identical. Overall, the statistical analyses provide strong and robust evidence for the causation hypothesis, as loneliness was still related to both outcomes after accounting for selection.

In a third step, I explored the possibility of gender- and age-specific differences in the roles of causation and selection. First, I estimated the models separately for men and women (Figure 3.5 to Figure 3.8 in the Appendix). The results indicated slightly stronger effects on both outcomes for women than for men, but these effects were too small to be of practical relevance. Second, the models were estimated separately for younger people (aged < 50 years) and older people (aged ≥ 50 years). The cutoff point of 50 years was chosen to replicate previous studies that have used within estimators to test the causation hypothesis in samples of people aged 50 years or older (Griffin et al., 2022; Luo, 2022; Mayerl et al., 2022). The results showed that loneliness had a slightly stronger effect on psychological distress and a

much stronger effect on general mental health in younger people (Figure 3.9 to Figure 3.12 in the Appendix). Overall, the stratified models revealed some gender- and age-specific differences, but substantial effects of loneliness on mental health could be found in all groups.

3.4 Discussion

Loneliness is now widely recognised as a potential risk factor for mental disorders, as a large body of research has found moderate to strong associations between loneliness and a variety of mental health outcomes (Erzen and Çikrikci, 2018; McClelland et al., 2020; Park et al., 2020). However, most research on this topic has relied on research designs that are unable to explain the causal nature of the association between loneliness and mental health. The few studies that have used within estimators to examine panel data with the goal of disentangling the different explanations for these associations have found weak evidence to support the causation hypothesis (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). However, I have argued that these studies faced several shortcomings. Against this backdrop, the present study aimed to provide further evidence to support the claim that loneliness contributes to mental health problems by using an alternative analytical approach based on FEIS models and panel data from the UKHLS 2017–2022. This approach allowed me to rule out the possibility that any observed association between loneliness and mental health is driven by the selection of people with less favourable mental health trajectories into loneliness. Overall, three main conclusions can be drawn from the analyses.

First, the results of this study advance our understanding of why loneliness is associated with mental health. In particular, the FEIS models revealed that feeling lonely was related to higher levels of psychological distress and worse general mental health. Crucially, these associations were not attributable to selection, thus indicating that they represent the effect of loneliness. Subgroup analyses provided robust support for the causation hypothesis in both men and women and in both younger (< 50 years) and older people (50 years or older). As mentioned, few studies have attempted to differentiate causation from both types of selection (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). Unlike the present study, these studies have found only weak support for causation, particularly in older people. The most likely reason for these divergent results is that most of these studies have assumed that the effects of loneliness unfold over long periods of time (two to six years), especially in the case of studies that analysed

samples of older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Nevertheless, the two studies that assumed a short latency period of several weeks also reported that loneliness affects mental health. However, these studies were based on non-probability samples and did not adjust for time-varying covariates (Lim et al., 2016; McDowell et al., 2021). By avoiding these shortcomings, the present study provides more extensive evidence to support the claim that loneliness contributes to mental health problems, and this effect was consistently found in all the sociodemographic groups that were analysed.

Second, the study suggests that selection arguments are relevant to some extent, although it did not test such arguments directly. Specifically, the association between loneliness and both mental health outcomes was smaller in the FEIS models than in the POLS models. This result is consistent with previous longitudinal studies (Griffin et al., 2022; Joshanloo, 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021), which have reported significantly weaker associations than cross-sectional research (Park et al., 2020). This finding suggests that some portion of the associations seems to be attributable to the selection of people with mental health problems into loneliness. However, both types of selection are still undertheorised in the literature, thus highlighting the need for research to elucidate the mechanisms underlying selection processes.

Third, the aforementioned patterns exhibited notable consistency between direct and indirect measures of loneliness, which is an important finding considering the different strengths and weaknesses of these measurement approaches (Office for National Statistics, 2018). Direct measures, which allow individuals to self-report experiences of loneliness, may be biased by social desirability because loneliness is often perceived as a deviation from social standards and often invokes feelings of shame and fear of stigma. As a result, people may not want to discuss their feelings of loneliness openly. Indirect measures address this problem by avoiding the term ‘lonely’ altogether, but it is uncertain whether people interpret these items as representing experiences of loneliness. Encouragingly, the results of this study showed that both measures of loneliness yield very consistent results with regard to the causation hypothesis.

This study has multiple limitations. First, the FEIS model assumes a weaker form of the strict exogeneity assumption, which must hold conditional on the time-varying covariates and the individual-specific intercept and slope for age. This assumption is violated if unobserved time-varying heterogeneity is present (i.e., unobserved changes in living conditions that affect both loneliness and mental health). However, the models were adjusted for a standard set of time-varying covariates, including employment status, financial difficulties, and actual social

connections. Furthermore, strict exogeneity is violated in cases of reverse causality (i.e., if mental health problems put people at greater risk of loneliness above and beyond the individual-specific mental health trajectories). However, mental health has been reported to have little or no effect on the risk of loneliness in previous studies (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). Therefore, it seems unlikely that the results are biased by the violation of the strict exogeneity assumption. Second, the exclusion of observations was selective with regard to some of the covariates, with the result that resilient individuals who had more social and financial resources tended to remain in the sample. Hence, the effect of loneliness on mental health may have been underestimated in this study because these people may have been better able to cope with loneliness. Third, the FEIS model uses only within-individual variation, which allows me to account for all stable confounders, even if they are unobserved. However, as there were only a limited number of observations available for each participant, it was not possible to investigate whether chronic loneliness (i.e., feeling lonely over a longer period of time) had an even greater impact on mental health. Finally, self-reports were used to measure mental health, which provide little information regarding specific mental disorders and clinical diagnoses. Future research should replicate this study by using validated scales and diagnostic interviews for specific disorders.

3.4.1 Conclusion

In conclusion, this study provides more comprehensive and convincing evidence to support the hypothesis that loneliness contributes to mental health problems. A practical implication of this finding is that loneliness not only causes great suffering to those who experience it but is also likely to be costly to health care systems (Meisters et al., 2021; Mihalopoulos et al., 2020). Fortunately, the findings also suggest that developing effective intervention strategies to alleviate feelings of loneliness could be useful with regard to preventing mental disorders in the general population.

3.5 Appendix Study 2

Table 3.2 Within-individual variation in loneliness (UCLA Loneliness Scale)

Loneliness at time t	**Loneliness at time t+1**			
	Hardly ever/ never lonely	Sometimes lonely	Often lonely	**Total**
Hardly ever/ never lonely	31,349	7,231	323	38,903
	80.58	18.59	0.83	100.00
Sometimes lonely	6,039	12,167	1,549	19,755
	30.57	61.59	7.84	100.00
Often lonely	320	1,527	1,403	3,250
	9.85	46.98	43.17	100.00
Total	37,708	20,925	3,275	61,908
	60.91	33.80	5.29	100.00

Notes: Absolute and relative row frequencies are shown.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.3 Within-individual variation in loneliness (Single-item measure)

	Loneliness at time t+1			
Loneliness at time t	Hardly ever/ never lonely	Sometimes lonely	Often lonely	**Total**
Hardly ever/ never lonely	32,351	6,616	501	39,468
	81.97	16.76	1.27	100.00
Sometimes lonely	5,683	10,507	1,828	18,018
	31.54	58.31	10.15	100.00
Often lonely	441	1,842	2,139	4,422
	9.97	41.66	48.37	100.00
Total	38,475	18,965	4,468	61,908
	62.15	30.63	7.22	100.00

Notes: Absolute and relative row frequencies are shown.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.4 Artificial regression test (FEIS vs. FE)

	Loneliness			All variables		
	χ^2	df	p (> χ^2)	χ^2	df	p (> χ^2)
Psychological distress						
M2: UCLA Loneliness scale	25.91	2	0.000	66.58	21	0.000
M4: Single item	26.64	2	0.000	67.41	21	0.000
General mental health						
M6: UCLA Loneliness scale	26.62	2	0.000	74.28	21	0.000
M8: Single item	26.23	2	0.000	74.41	21	0.000

Notes: FE = fixed-effects model, FEIS = fixed-effects individual-slopes model. For the full models, see Table 3.5 and Table 3.6 in the Appendix.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.5 Effect of loneliness on psychological distress by measure of loneliness (corresponds to Figure 3.1)

	UCLA Loneliness Scale		Single-item measure	
	POLS (M1)	FEIS (M2)	POLS (M3)	FEIS (M4)
Loneliness				
Hardly ever/never lonely	Reference	Reference	Reference	Reference
Sometimes lonely	3.672 ***	1.736 ***	3.505 ***	1.814 ***
	(0.044)	(0.062)	(0.045)	(0.063)
Often lonely	8.653 ***	4.640 ***	8.292 ***	4.716 ***
	(0.127)	(0.168)	(0.110)	(0.148)
Age in years	-0.010 ***		-0.004 +	
	(0.002)		(0.002)	
Female	0.889 ***		0.783 ***	
	(0.043)		(0.043)	
Employment status				
Employed	Reference	Reference	Reference	Reference
Unemployed	1.118 ***	1.344 ***	1.035 ***	1.311 ***
	(0.121)	(0.174)	(0.119)	(0.172)
Retired	0.007	0.082	-0.063	0.087
	(0.066)	(0.149)	(0.067)	(0.147)
Sick/disabled	4.203 ***	1.874 ***	4.077 ***	1.748 ***
	(0.181)	(0.322)	(0.182)	(0.319)
Inactive/homemaker	-0.057	0.400 *	-0.139	0.309 +
	(0.107)	(0.168)	(0.105)	(0.169)
Student	0.407 ***	0.933 ***	0.300 *	0.822 ***
	(0.120)	(0.236)	(0.116)	(0.231)
Financial deprivation				
Mild	Reference	Reference	Reference	Reference
Moderate	1.452 ***	0.686 ***	1.445 ***	0.698 ***
	(0.051)	(0.074)	(0.051)	(0.074)
Severe	4.058 ***	2.643 ***	4.037 ***	2.603 ***
	(0.110)	(0.149)	(0.109)	(0.148)
Relationship status				
Single	Reference	Reference	Reference	Reference
Living apart	0.533 ***	-0.403 *	0.575 ***	-0.302 +
	(0.084)	(0.157)	(0.084)	(0.156)
Living together	0.947 ***	-0.982 **	1.066 ***	-0.690 *
	(0.095)	(0.319)	(0.094)	(0.322)
Marital status				
Never married	Reference	Reference	Reference	Reference
Married	-0.131 +	-0.029	-0.171 *	-0.160
	(0.078)	(0.234)	(0.078)	(0.229)
Separated/divorced	0.106	-0.038	0.037	-0.057
	(0.088)	(0.236)	(0.089)	(0.236)
Widowed	0.008	0.536	-0.412 ***	0.258
	(0.112)	(0.341)	(0.115)	(0.332)

Table 3.5 Continued

	UCLA Loneliness Scale				Single-item measure			
	POLS (M1)		FEIS (M2)		POLS (M3)		FEIS (M4)	
Living alone	-0.037		-0.162		-0.065		-0.190	
	(0.091)		(0.253)		(0.091)		(0.254)	
Single parent	0.097		-0.035		0.113		0.055	
	(0.162)		(0.423)		(0.163)		(0.424)	
Interview mode								
Face-to-face	Reference		Reference		Reference		Reference	
Telephone	-0.837	***	-0.868	***	-0.881	***	-0.850	***
	(0.084)		(0.132)		(0.084)		(0.133)	
Web	0.112	*	0.389	***	0.137	**	0.380	***
	(0.046)		(0.090)		(0.047)		(0.090)	
Intercept	8.196	***			7.942	***		
	(0.114)				(0.113)			
Adjusted R^2	0.322				0.326			
Within R^2			0.083				0.090	
Observations	86,896		86,896		86,896		86,896	
Individuals	24,988		24,988		24,988		24,988	

Notes: Significance levels are indicated by the following symbols + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with panel-robust standard errors in parentheses. All models were additionally adjusted for period effects.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.6 Effect of loneliness on general mental health by measure of loneliness (corresponds to Figure 3.2)

	UCLA Loneliness Scale		Single-item measure	
	POLS (M5)	FEIS (M6)	POLS (M7)	FEIS (M8)
Loneliness				
Hardly ever/never lonely	Reference	Reference	Reference	Reference
Sometimes lonely	-7.188 ***	-2.992 ***	-7.047 ***	-3.112 ***
	(0.083)	(0.111)	(0.085)	(0.114)
Often lonely	-15.556 ***	-7.249 ***	-14.980 ***	-7.044 ***
	(0.207)	(0.256)	(0.186)	(0.245)
Age in years	0.096 ***		0.085 ***	
	(0.004)		(0.004)	
Female	-1.475 ***		-1.261 ***	
	(0.083)		(0.083)	
Employment status				
Employed	Reference	Reference	Reference	Reference
Unemployed	-1.768 ***	-1.402 ***	-1.609 ***	-1.359 ***
	(0.211)	(0.285)	(0.207)	(0.285)
Retired	-0.189	-0.025	-0.058	-0.038
	(0.125)	(0.281)	(0.125)	(0.281)
Sick/disabled	-7.782 ***	-1.874 ***	-7.561 ***	-1.711 **
	(0.300)	(0.532)	(0.300)	(0.535)
Inactive/homemaker	-0.237	-0.237	-0.079	-0.091
	(0.204)	(0.300)	(0.201)	(0.300)
Student	-0.339	-0.978 *	-0.153	-0.805 *
	(0.242)	(0.413)	(0.235)	(0.409)
Financial deprivation				
Mild	Reference	Reference	Reference	Reference
Moderate	-2.627 ***	-0.944 ***	-2.609 ***	-0.970 ***
	(0.096)	(0.130)	(0.096)	(0.130)
Severe	-5.703 ***	-3.128 ***	-5.652 ***	-3.076 ***
	(0.181)	(0.237)	(0.181)	(0.238)
Relationship status				
Single	Reference	Reference	Reference	Reference
Living apart	-0.953 ***	0.528 +	-1.031 ***	0.390
	(0.164)	(0.281)	(0.163)	(0.278)
Living together	-1.415 ***	1.720 **	-1.650 ***	1.258 *
	(0.185)	(0.578)	(0.181)	(0.576)
Marital status				
Never married	Reference	Reference	Reference	Reference
Married	0.619 ***	-0.460	0.697 ***	-0.244
	(0.150)	(0.410)	(0.148)	(0.407)
Separated/divorced	0.018	-0.361	0.148	-0.324
	(0.168)	(0.435)	(0.170)	(0.434)
Widowed	0.040	-2.163 **	0.840 ***	-1.726 **
	(0.219)	(0.675)	(0.220)	(0.660)

Table 3.6 Continued

	UCLA Loneliness Scale				Single-item measure			
	POLS (M5)		FEIS (M6)		POLS (M7)		FEIS (M8)	
Living alone	0.013		0.633		0.086		0.691	
	(0.172)		(0.440)		(0.170)		(0.441)	
Single parent	-0.548	+	-0.178		-0.573	+	-0.267	
	(0.302)		(0.719)		(0.305)		(0.714)	
Interview mode								
Face-to-face	Reference		Reference		Reference		Reference	
Telephone	1.941	***	2.022	***	2.004	***	2.006	***
	(0.165)		(0.251)		(0.166)		(0.251)	
Web	-0.117		-0.766	***	-0.163	+	-0.757	***
	(0.088)		(0.164)		(0.088)		(0.164)	
Intercept	49.922	***			50.432	***		
	(0.222)				(0.219)			
Adjusted R^2	0.338				0.343			
Within R^2			0.059				0.062	
Observations	86,896		86,896		86,896		86,896	
Individuals	24,988		24,988		24,988		24,988	

Notes: Significance levels are indicated by the following symbols + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with panel-robust standard errors in parentheses. All models were additionally adjusted for period effects.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.7 Interaction effects between loneliness and the COVID-19 pandemic on psychological distress by measure of loneliness

	UCLA Loneliness Scale	Single-item measure
	FEIS (M9)	FEIS (M10)
Loneliness		
Hardly ever/never lonely	Reference	Reference
Sometimes lonely	1.684 ***	1.785 ***
	(0.068)	(0.069)
Often lonely	4.652 ***	4.674 ***
	(0.189)	(0.165)
Period effects		
COVID-19 pandemic	0.648 ***	0.694 ***
	(0.067)	(0.066)
Interaction effects		
Sometimes lonely × COVID-19 pandemic	0.184 +	0.106
	(0.106)	(0.110)
Often lonely × COVID-19 pandemic	-0.064	0.154
	(0.297)	(0.258)
Within R^2	0.083	0.090
Observations	86,896	86,896
Individuals	24,988	24,988

Notes: Significance levels are indicated by the following symbols + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with panel-robust standard errors in parentheses. All models were additionally adjusted for time-varying covariates.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

Table 3.8 Interaction effects between loneliness and the COVID-19 pandemic on general mental health by measure of loneliness

	UCLA Loneliness Scale	Single-item measure
	FEIS (M11)	FEIS (M12)
Loneliness		
Hardly ever/never lonely	Reference	Reference
Sometimes lonely	-2.898 ***	-3.038 ***
	(0.122)	(0.124)
Often lonely	-7.351 ***	-6.955 ***
	(0.286)	(0.270)
Period effects		
COVID-19 pandemic	-0.223 +	-0.261 *
	(0.127)	(0.124)
Interaction effects		
Sometimes lonely × COVID-19 pandemic	-0.338 +	-0.282
	(0.191)	(0.198)
Often lonely × COVID-19 pandemic	0.409	-0.325
	(0.447)	(0.413)
Within R^2	0.059	0.061
Observations	86,896	86,896
Individuals	24,988	24,988

Notes: Significance levels are indicated by the following symbols + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with panel-robust standard errors in parentheses. All models were additionally adjusted for time-varying covariates.

Source: UK Household Longitudinal Study 2017–2022, own calculations.

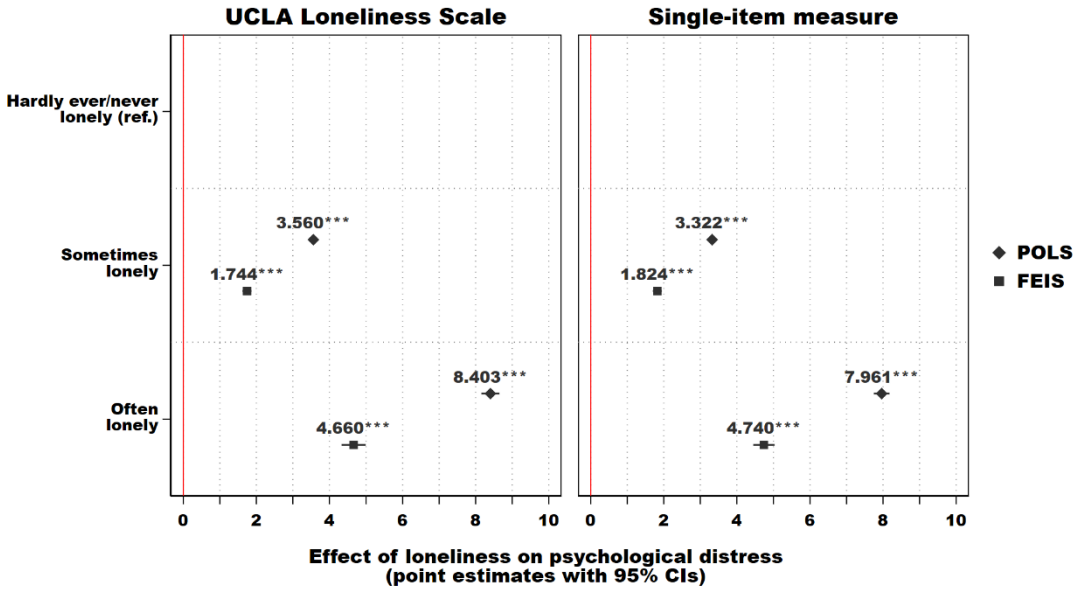

Figure 3.3 Effect of loneliness on psychological distress without accounting for social connectedness by measure of loneliness (N_{obs} = 86,896, N_{ind} = 24,988)

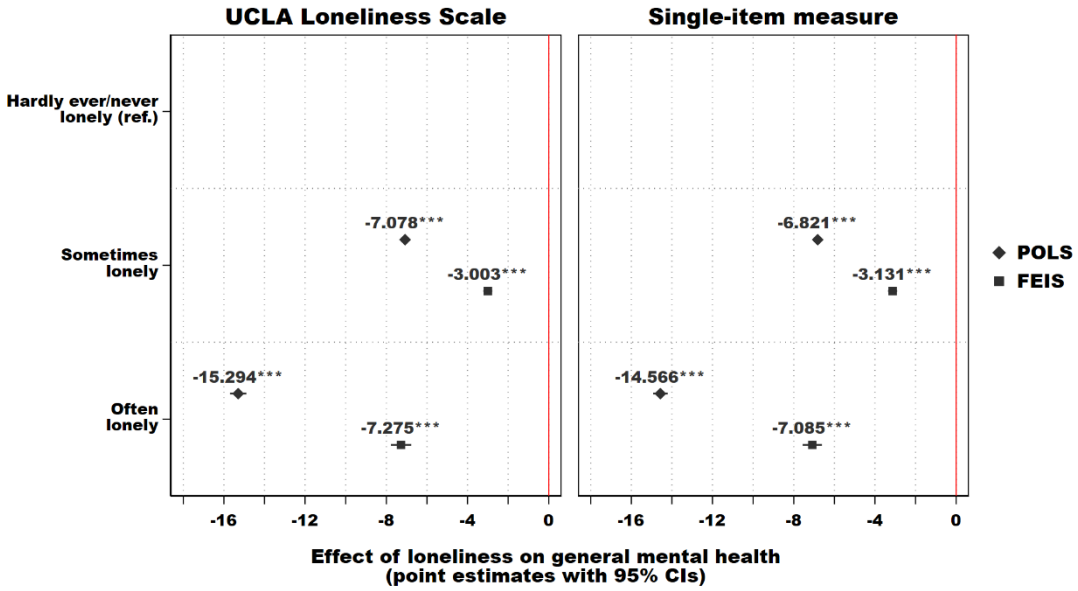

Figure 3.4 Effect of loneliness on general mental health without accounting for social connectedness by measure of loneliness (N_{obs} = 86,896, N_{ind} = 24,988)

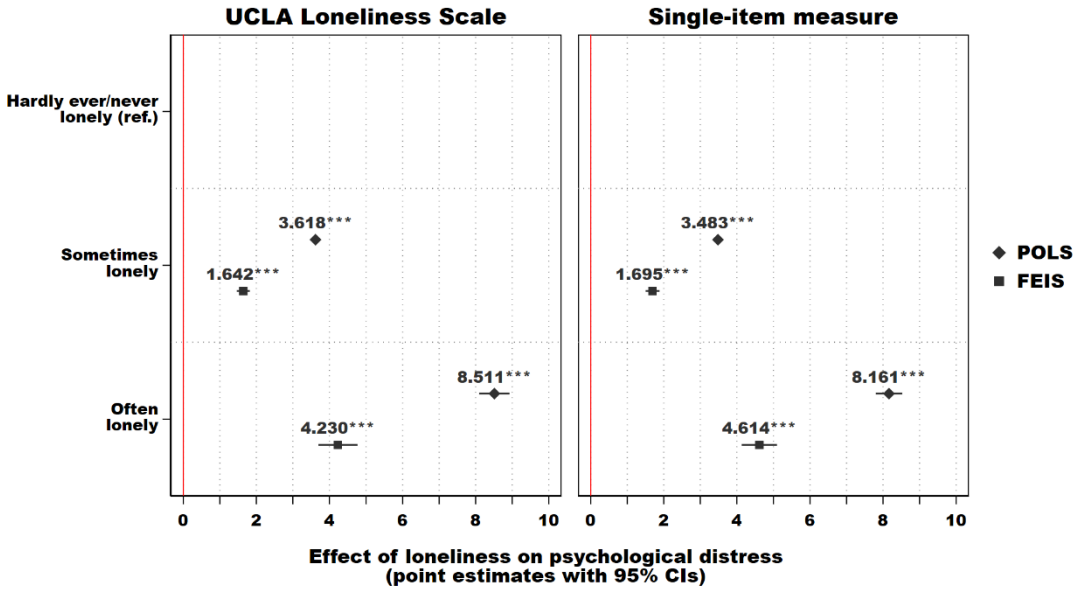

Figure 3.5 Effect of loneliness on psychological distress among men by measure of loneliness (N_{obs} = 38,585, N_{ind} = 11,094)

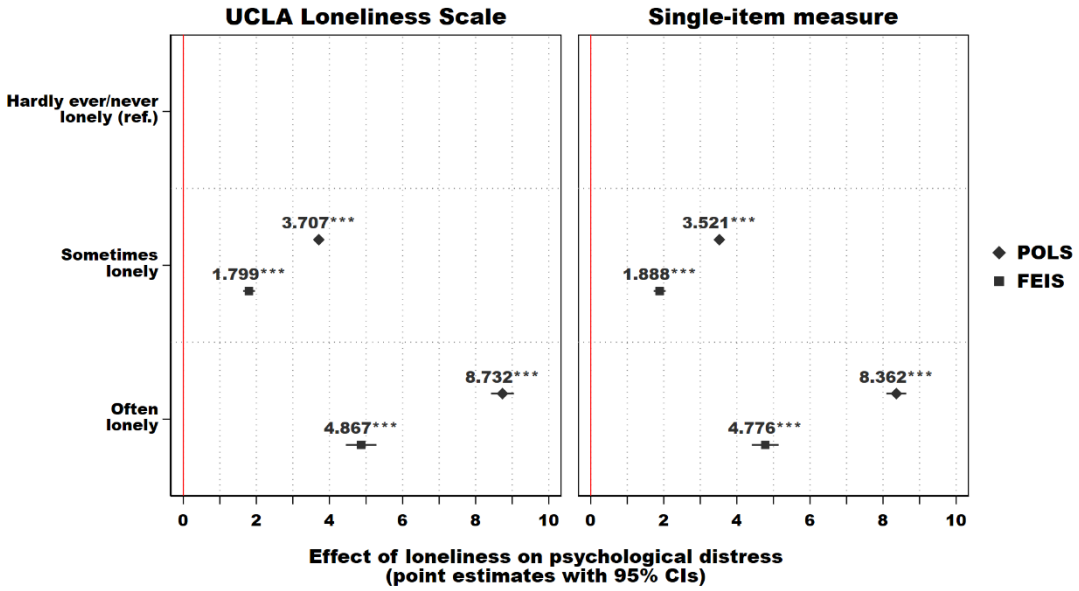

Figure 3.6 Effect of loneliness on psychological distress among women by measure of loneliness (N_{obs} = 48,311, N_{ind} = 13,894)

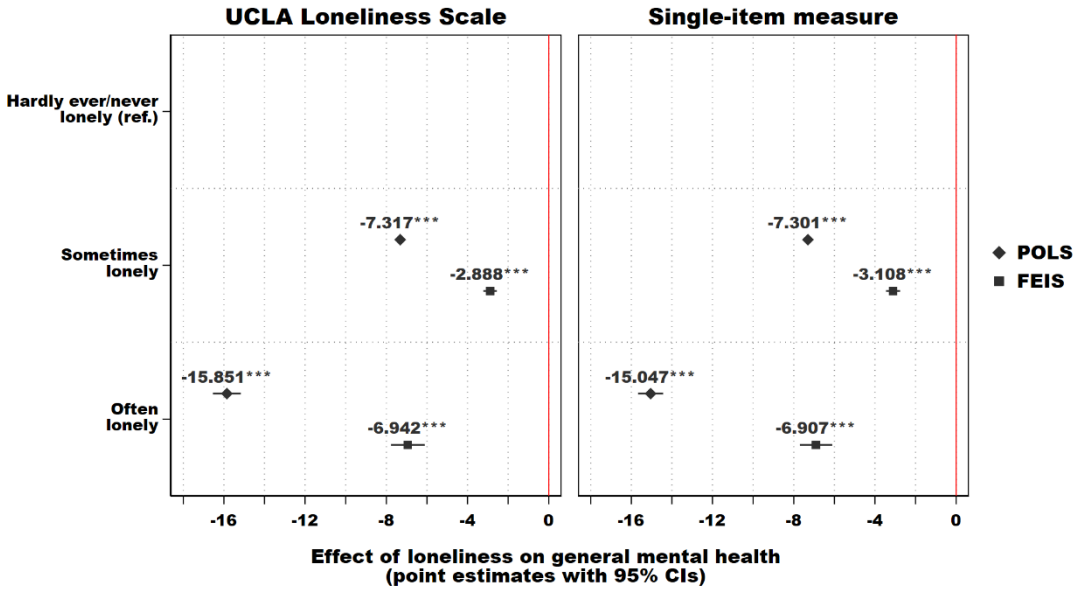

Figure 3.7 Effect of loneliness on general mental health among men by measure of loneliness (N_{obs} = 38,585, N_{ind} = 11,094)

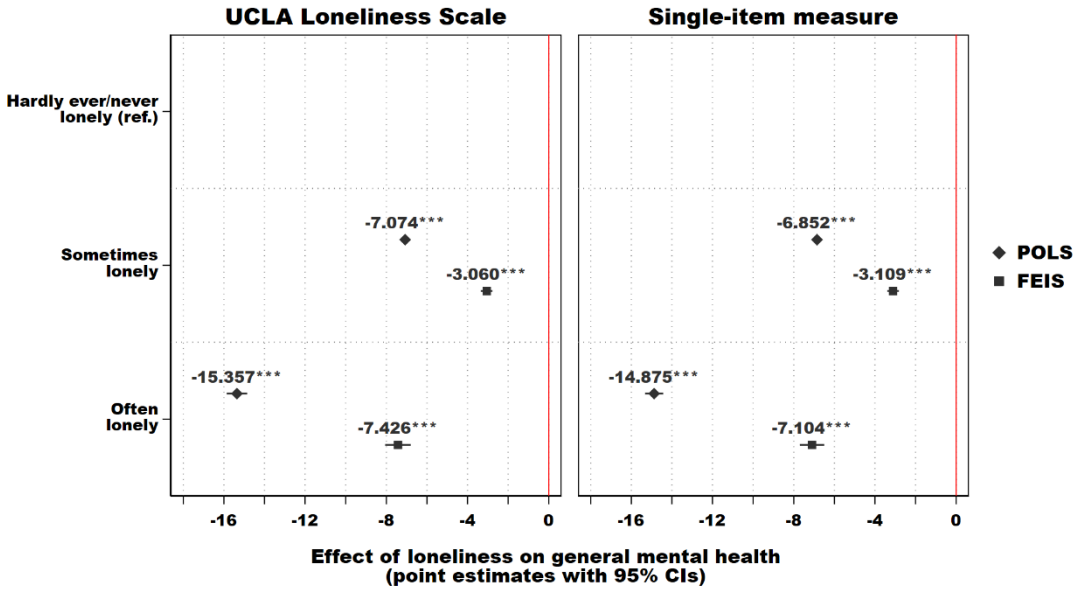

Figure 3.8 Effect of loneliness on general mental health among women by measure of loneliness (N_{obs} = 48,311, N_{ind} = 13,894)

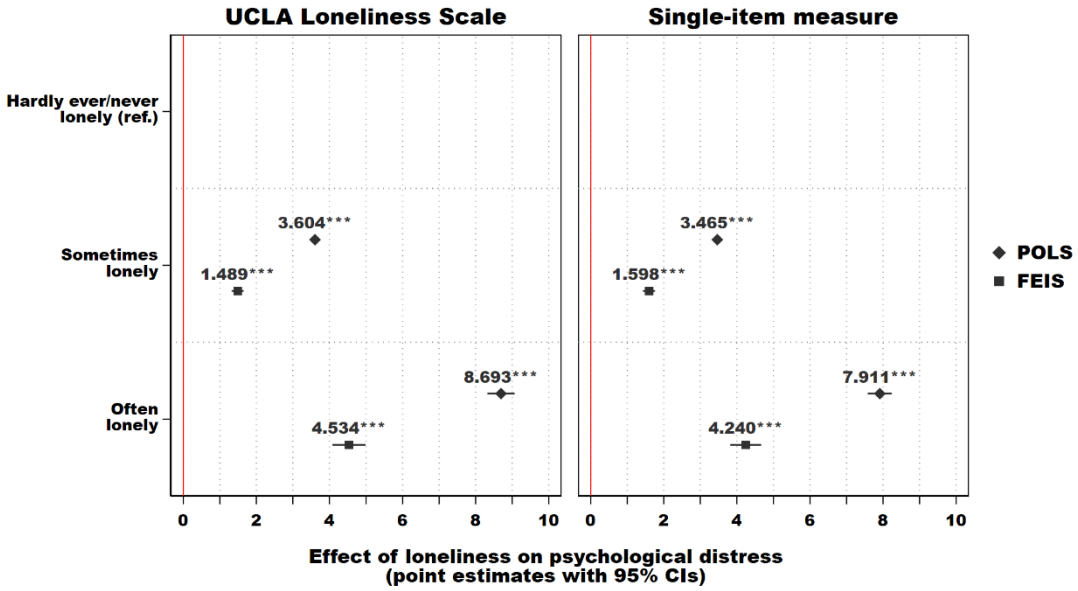

Figure 3.9 Effect of loneliness on psychological distress among individuals aged 50 years or older by measure of loneliness (N_{obs} = 47,356, N_{ind} = 13,533)

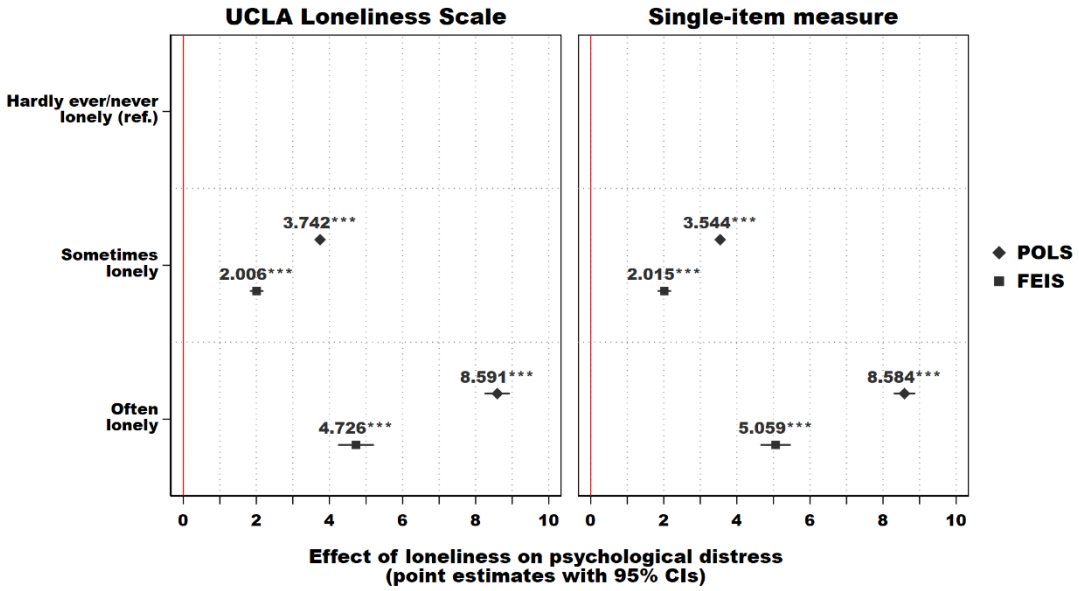

Figure 3.10 Effect of loneliness on psychological distress among individuals aged less than 50 years by measure of loneliness (N_{obs} = 36,574, N_{ind} = 10,706)

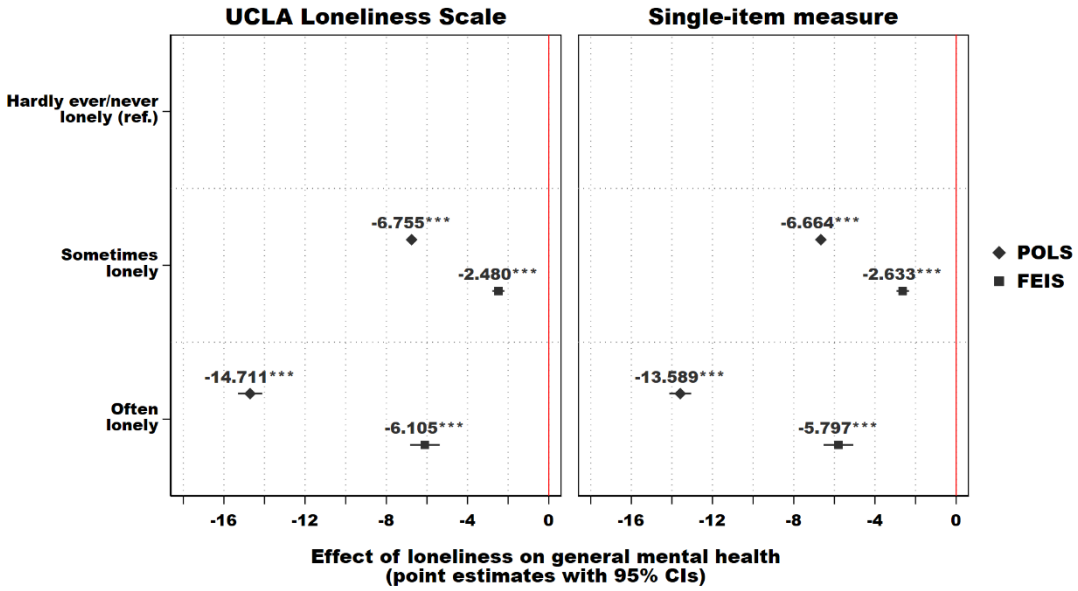

Figure 3.11 Effect of loneliness on general mental health among individuals aged 50 or older by measure of loneliness (N_{obs} = 47,356, N_{ind} = 13,533)

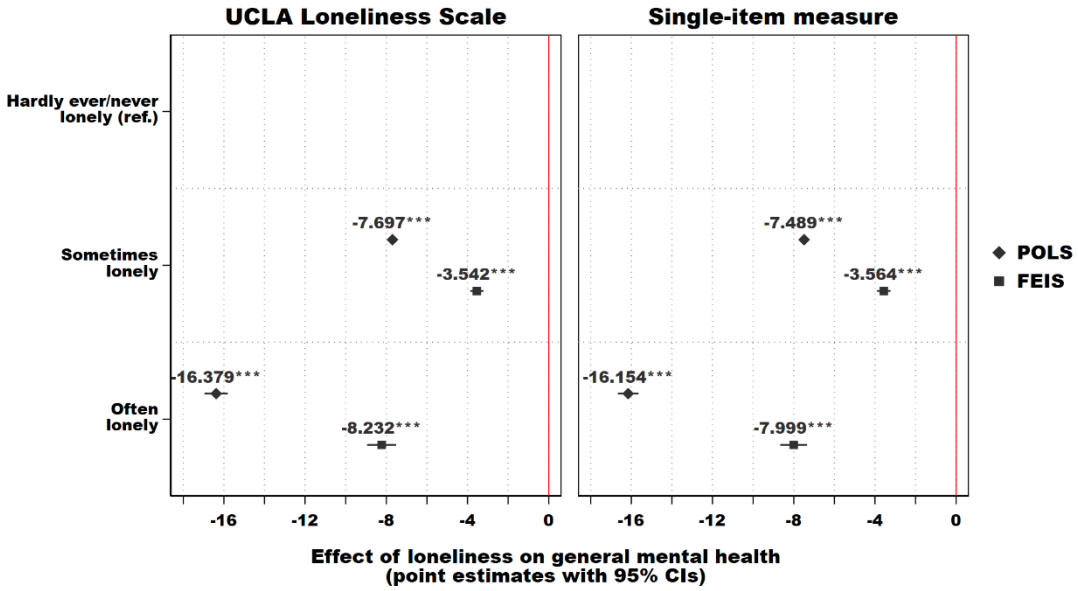

Figure 3.12 Effect of loneliness on general mental health among individuals aged less than 50 years by measure of loneliness (N_{obs} = 36,574, N_{ind} = 10,706)

4 Loneliness and depressive symptoms in early adulthood: Disentangling causation from selection (Study 3)

Abstract

Introduction: It has been widely recognised that loneliness is closely linked to depressive symptoms. However, research on early adulthood, when people are particularly vulnerable to developing depression, is lacking. In addition, whether this association reflects the effect of loneliness on depressive symptoms (causation) or whether people with depression self-select into loneliness (selection) remains unclear. Against this backdrop, the purpose of this study was to investigate whether loneliness contributes to depressive symptoms in young adults and whether this effect differs between young men and young women.

Methods: The statistical analyses were based on data from the German Family Panel (pairfam) 2011–2021 (21,148 observations of 3,386 individuals, 52% from women, aged 18 to 34 years). Loneliness was assessed using a single item, and depressive symptoms were measured using ten items of the State-Trait-Depression Scales. Fixed-effects individual-slopes (FEIS) models were estimated to account for selection effects. Gender-stratified models were estimated to explore possible differences between young men and young women.

Results: The results showed that loneliness was still associated with depressive symptoms in young adults even when selection effects were taken into account in the FEIS model. More specifically, feeling ‘somewhat lonely’ and ‘very lonely’ were associated with increases of 1.472 (95% CI: 1.299, 1.645) and 3.595 (95% CI: 3.327, 3.863) scale points in depressive symptoms, respectively, compared to feeling ‘not lonely’. Because this association cannot be explained by selection, it can be interpreted as evidence for the causation hypothesis. Stratified models revealed a slightly stronger effect in young women, but sizeable effects were evident in both genders.

Conclusions: This study shows that loneliness exacerbates depressive symptoms in young men and young women. One implication of the findings of this study is that loneliness should be addressed by interventions aimed at preventing the onset of depression in this age group.

4.1 Introduction

Depression is one of the most common mental disorders worldwide, affecting approximately 280 million people in 2019 (GBD 2019 Mental Disorders Collaborators, 2022). Globally, half of people with depression first showed symptoms by the age of 26, and half were between 17 and 34 years old when they first developed symptoms (Solmi et al., 2022). Therefore, early adulthood seems to be a period in life during which individuals are highly vulnerable to depression. Moreover, research has shown that an earlier age of onset is a risk factor for a chronic course of depression (Hölzel et al., 2011) and that people with an onset of depression in early adulthood are more likely to be unemployed (Hakulinen et al., 2019a), to have a lower income (Hakulinen et al., 2019b), and to never have entered into a romantic relationship later in life (Leach and Butterworth, 2020). It is thus imperative to identify modifiable risk factors for depression in early adulthood that can be targeted by prevention strategies.

4.1.1 Loneliness as a risk factor for depression in early adulthood

Extensive evidence has suggested that loneliness is closely related to depressive symptoms (for meta-analyses, see Dunn and Sicouri, 2022; Erzen and Çikrikci, 2018; Park et al., 2020). Loneliness is the unpleasant feeling that occurs when one's social connections are perceived as insufficient in terms of quantity and/or quality (Peplau and Perlman, 1979; Perlman and Peplau, 1981). Recently, in the wake of the COVID-19 pandemic, loneliness received a great deal of attention due to concerns that physical distancing and social contact restrictions could have the unintended side effect of increasing the prevalence of mental illness in the general population (Brodeur et al., 2021; Koh and Liew, 2022). Nevertheless, loneliness has been a public health concern for some time (Cacioppo and Cacioppo, 2018b), and a substantial proportion of the world's population suffered from problematic levels of loneliness prior to the pandemic (Surkalim et al., 2022). Although relatively high levels of loneliness have been observed in early adulthood (Hawkley et al., 2022; Luhmann and Hawkley, 2016), few studies have examined its association with depressive symptoms during this period of life.

Despite the wealth of evidence indicating a close link between loneliness and depression, little is known regarding the causal nature of this association, as most studies on this topic have relied on research designs that are poorly suited for elucidating the underlying causal processes. Three hypotheses have been proposed to explain the higher levels of depressive symptoms experienced by lonely people.

The causation hypothesis argues that loneliness exacerbates depressive symptoms. Possible mechanisms include high levels of emotional distress that result when satisfaction of the basic need to belong is threatened (Baumeister and Leary, 1995), deprivation in terms of psychosocial resources (e.g., meaning in life, self-esteem; Thoits, 2011a), unhealthy lifestyles due to impaired self-regulation (e.g., physical inactivity; Hawkley and Cacioppo, 2010), and negative cognitive biases (e.g., negative evaluations of oneself and others; Spithoven et al., 2017). These cognitive biases may further lead to hostile or avoidant behaviour in lonely people, which others may perceive as inappropriate (Segel-Karpas and Ayalon, 2020; Spithoven et al., 2017). In response, others may criticise or reject the lonely person, thereby confirming and reinforcing the cognitive biases, in turn leading to increasingly negative social interactions and ultimately high levels of stress (Cacioppo and Hawkley, 2009). Finally, some evidence has indicated that lonely people exhibit maladaptive biological responses to the high levels of stress they often experience (e.g., increased levels of inflammation or dysregulation of the hypothalamic-pituitary-adrenal axis; Cacioppo et al., 2015; Smith et al., 2020), which are thought to play a role in the onset of depression (LeMoult, 2020).

Another explanation argues that people with depression are at greater risk of loneliness. The direct selection hypothesis states that selection is directly related to depressive symptoms. Potential mechanisms include the observation that social functioning is often impaired by symptoms of depression, especially with regard to the skills people need to navigate the social world (e.g., theory of mind; Cotter et al., 2018). Moreover, people with depression may avoid social situations, for example, because they derive less pleasure from social activities (social anhedonia; Gandhi et al., 2022; Trøstheim et al., 2020), feel ashamed of their illness (Kim et al., 2011), want to conceal their illness to avoid being stigmatised by others (Lasalvia et al., 2013), or abandon their pursuit of major life goals because they begin to stigmatise themselves (Corrigan et al., 2016). Conversely, people with depression may be shunned by others, for example, as a result of the stigma attached to their mental illness (Angermeyer et al., 2013; Lasalvia et al., 2013) or their tendency to engage in problematic social behaviours, such as excessive reassurance-seeking (Joiner et al., 1999; Starr and Davila, 2008). Finally, people with depression may exhibit negative biases in the context of information processing (Everaert et al., 2022; Everaert et al., 2017; Suslow et al., 2020), which can lead them to perceive the social world in an overly negative way.

Alternatively, the indirect selection hypothesis states that such selection is not due to depression itself but rather to stable vulnerabilities that predispose people to depression. In contrast to the causation and direct selection hypotheses, this explanation suggests that the

higher levels of depressive symptoms in lonely people do not reflect causal effects in either direction but rather the confounding effects of shared risk factors. Possible candidates for such stable vulnerabilities include genetic predispositions (Abdellaoui et al., 2019; Matthews et al., 2016; Rødevand et al., 2021), personality traits such as neuroticism and extraversion (Buecker et al., 2020; Jeronimus et al., 2016; Khazanov and Ruscio, 2016), and experiences of maltreatment in childhood (de Heer et al., 2022; Gardner et al., 2019), as well as the psychological traits that emerge from such traumatic experiences, such as rejection sensitivity (Gao et al., 2017b) and insecure attachment styles (Mikulincer and Shaver, 2014; Zhang et al., 2022). However, most studies have not adjusted for these vulnerabilities because they are very difficult to observe and have often not been measured in commonly available datasets. One implication of this hypothesis is that loneliness should not be related to depressive symptoms once these vulnerabilities are taken into account.

4.1.2 Empirical evidence regarding the importance of causation and selection

A few studies have attempted to disentangle the three explanations statistically by using extensions of the cross-lagged panel model. All of these analytical approaches make it possible to test whether loneliness and depression predict each other within individuals over time while taking into account previous changes in the outcomes and unobserved stable confounders. Intriguingly, these studies have found only weak evidence for the causation hypothesis. Analysing non-probability samples of adults, two studies found weak to moderate effects of loneliness on depressive symptoms (Lim et al., 2016; McDowell et al., 2021). Other studies conducted using samples of older people have found either very weak effects (Joshanloo, 2022; Luo, 2022) or nonsignificant effects (Griffin et al., 2022; Joshanloo, 2022; Mayerl et al., 2022). Yet another study also found no effect of loneliness on symptoms of depression and anxiety in adolescents (Kristensen et al., 2022). Furthermore, these studies did not support the direct selection hypothesis, as most found no or very weak effects of depressive symptoms on loneliness. Overall, the lack of convincing evidence for effects in either direction is consistent with the indirect selection hypothesis, which emphasises the role of unobserved confounders. Therefore, these findings challenge the claim that feelings of loneliness play a causal role in the onset of depression, as has been readily assumed by the public and health experts.

However, this research has exhibited important shortcomings. First, none of these studies adjusted for the confounding influence of negative life events and other changing living conditions. As a result, the two studies that supported the causation hypothesis might have overstated the impact of loneliness on depression, which might actually reflect the effects of

such time-varying confounders. Second, the analytical strategies utilised by previous studies have required strong assumptions regarding the time interval over which loneliness and depression can be expected to predict each other. While the prospect of establishing a clear temporal sequence of exposure and outcome is appealing, simulation studies have shown that when analysing within-individual associations, an incorrect specification of the time interval (i.e., any overly long latency of the effect) can lead to highly biased estimates, possibly even yielding a coefficient with the opposite sign (Vaisey and Miles, 2017). Strikingly, only the two studies that assumed short time intervals (i.e., of weeks) found evidence for causation (Lim et al., 2016; McDowell et al., 2021). This finding suggests that other studies that have assumed a time interval of several years may not have found an effect because loneliness affects mental health only over very short periods of time.

Third, previous research has focused on adolescents (Kristensen et al., 2022), adults (Lim et al., 2016; McDowell et al., 2021), and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022), thus neglecting the investigation of loneliness as a risk factor for depression in early adulthood. Finally, previous research may have overlooked gender differences in the roles of causation and selection. On the one hand, it can be argued that women's mental health may be more strongly affected by loneliness, as they are generally at higher risk of depression (Hyde and Mezulis, 2020; Steel et al., 2014) and tend to care more excessively about the cultivation of positive social relationships (Yang and Girgus, 2019). On the other hand, evidence has suggested that depression and related vulnerabilities contribute more strongly to the occurrence of interpersonal problems and negative life events in women than in men (Liu and Alloy, 2010). Supporting this view to some degree, a study of adolescents found that the effect of loneliness on later symptoms of anxiety and depression was weak in girls but completely absent in boys (Kristensen et al., 2022). Possibly due to the small sample size of this study, the effect was not statistically significant with regard to either gender. In addition, symptoms of anxiety and depression affected future loneliness in girls but not in boys. In contrast, two other studies found no gender differences in the effect of loneliness on depression in older people (Joshanloo, 2022; Mayerl et al., 2022). Considering these gaps in the literature, further research is necessary to determine whether loneliness influences the severity of depressive symptoms among young adults and whether the causation hypothesis finds empirical support with respect to both young men and young women.

4.1.3 The present study

This study advances the literature in several ways. First, this study is the first to examine the effect of loneliness on depressive symptoms in early adulthood while attempting to rule out selection as a competing explanation. Second, the study investigates gender differences in the depressive effect of loneliness to determine whether the causation hypothesis can be confirmed in both young men and young women. For this purpose, this study uses an innovative analytical strategy based on a unique German panel dataset and fixed-effects individual-slopes (FEIS) models, thereby addressing some of the shortcomings of prior research. The analytical strategy used in this research builds on the observations that the trajectories of depressive symptoms vary systematically across individuals depending on stable characteristics such as genetic predispositions, early life experiences, and personality traits (Kwong et al., 2021; Nandi et al., 2009; Nanni et al., 2012; Nelson et al., 2017; Rhebergen et al., 2012; Schubert et al., 2017) and that unfavourable courses of depression are associated with weaker social connections and stronger feelings of loneliness (Houtjes et al., 2017; Houtjes et al., 2014; Musliner et al., 2016). In other words, this strategy rules out the possibility that any observed association reflects the selection of young adults with unfavourable courses of symptoms into loneliness. Using this analytical strategy, the study aims to answer the following two research questions: Does loneliness exacerbate depressive symptoms in early adulthood? Can this effect be observed in both young men and young women?

4.2 Data and methods

The statistical analyses were based on data from the German Family Panel (pairfam, release 13; Brüderl et al., 2022),[8] which is a multidisciplinary longitudinal study of intimate relationships and family dynamics in Germany. The study started in 2008/2009 based on a nationwide random sample of 12,402 individuals from three different birth cohorts: 1971–1973, 1981–1983, and 1991–1993. The participants were interviewed on an annual basis using computer-assisted personal interviews (CAPI). With regard to sensitive topics such as loneliness and depression, participants completed computer-assisted self-interviews (CASI).

[8] This study uses data from the German Family Panel (pairfam), coordinated by Josef Brüderl, Sonja Drobnič, Karsten Hank, Johannes Huinink, Bernhard Nauck, Franz J. Neyer, and Sabine Walper. From 2004 to 2022, pairfam was funded as priority programme and long-term project by the German Research Foundation (DFG).

During the COVID-19 pandemic, fieldwork continued through computer-assisted telephone interviews (CATI) and self-administered paper-and-pencil interviews (PAPI). To increase the sample size, the data were augmented by a subsample that initially consisted of 1,489 individuals included in the DemoDiff study, which closely followed the design of pairfam and was fully integrated into its sample in wave 5. Additional information can be found elsewhere (Huinink et al., 2011; Kreyenfeld et al., 2012).

This study analysed pooled data collected during waves 4 (2011/2012), 5 (2012/2013) and 7 to 13 (2014/2015 to 2020/2021), which were the only waves in which measures of loneliness were available in the data. Only observations collected from participants aged 18 to 34 were included in the analyses, as the study focused on early adulthood. In addition, the analytical approach required at least four observations for each individual. Observations with missing values for any of the variables and individuals with fewer than four total observations were excluded. The final sample consisted of 21,148 observations of 3,386 individuals. The proportion of missing values with regard to the variables analysed in this study was generally very low in the pooled data (the highest rate was observed for loneliness at 1.1%). Exclusion of observations was not selective in terms of the main variables of interest, depressive symptoms and loneliness, but it was selective in terms of some of the covariates (see Table 4.1). In the excluded observations, young adults were less often employed full- or part-time, more often single, and less often cohabitating. Furthermore, they lived more often with their parents.

4.2.1 Measures

Depressive symptoms were assessed using ten items of the German version of the State-Trait-Depression Scales (STDS, Krohne et al., 2002). Scores on this scale are highly correlated with scores on other widely used measures of depression in German and US samples, such as the Beck Depression Inventory (r = 0.67 and 0.73) and the Center for Epidemiologic Studies Depression Scale (r = 0.70 and 0.79; Krohne et al., 2002). Consistent with the cardinal features of major depressive disorder (depressed mood and anhedonia), five items focused on the presence of negative affect (dysthymia), and five items focused on the absence of positive affect (euthymia). The euthymic items were reverse scored. If valid information was available for at least 8 of the 10 items, the average score of these items was calculated and multiplied by 10 to obtain a total score on the original scale, which ranged from 10 to 40 points. On this scale, higher scores indicate a higher severity of depressive symptoms. Internal consistency was excellent across waves (Cronbach's alpha coefficients ranged from 0.88 to 0.91).

Loneliness was measured using a single item ('I feel lonely'), which was scored on a five-point scale ranging from 1 (*not at all*) to 5 (*absolutely*). Single-item measures of loneliness may be subject to social desirability bias because they ask respondents about their loneliness directly. However, the item used in this study has shown high convergent validity with multi-item scales (such as the three-item UCLA Loneliness Scale) and features a similar nomological network (Mund et al., 2022). As research has indicated that severe or chronic loneliness is a qualitatively different experience than mild or temporary loneliness (Spithoven et al., 2017), the scores were categorised into three groups: 'not lonely' (scores of 1 and 2), 'somewhat lonely' (3), and 'very lonely' (4 and 5).

To account for the confounding effects of changing living conditions that affect both loneliness and depressive symptoms, all models were adjusted for *time-varying covariates*, including employment status, financial deprivation, relationship status, living alone, being a single parent, and living with parents. The models also included age and age squared, which were used to estimate individual-specific trajectories of depressive symptoms in the FEIS models (see the following section for further details), interview mode (CAPI/CASI vs. CATI/PAPI), region (East vs. West Germany), and period effects. The pooled ordinary least squares (POLS) model also accounted for gender. The FEIS model already accounted for all stable confounders, even if they were unobserved. Thus, there was no need to include these confounders in the models. Table 4.1 shows the summary statistics for both the analysed sample and the excluded observations.

Table 4.1 Summary statistics of the analysed and excluded observations

	Analysed observations		Excluded observations	
	Mean	SD	Mean	SD
Depressive symptoms	17.80	5.05	17.61	5.11
Loneliness				
Not lonely	0.70		0.72	
Somewhat lonely	0.17		0.15	
Very lonely	0.14		0.13	
Age in years	26.48	4.73	25.13	5.32
Female	0.52		0.48	
Employment status				
Full-time	0.44		0.37	
Part-time	0.18		0.13	
Student	0.19		0.21	
In vocational training	0.08		0.14	
Unemployed	0.04		0.06	
Other not working	0.07		0.08	
Financial deprivation	2.42	1.15	2.64	1.19
Relationship status				
Single	0.35		0.41	
Living apart	0.22		0.24	
Cohabiting	0.43		0.35	
Living alone	0.20		0.17	
Single parent	0.02		0.03	
Living with parents	0.31		0.43	
CATI /PAPI mode	0.04		0.03	
East Germany	0.25		0.28	
Observations	21,148		4,434	
Individuals	3,386		2,372	

Source: pairfam 2011–2021, own calculations.

4.2.2 Statistical analyses

The statistical analyses consisted of three steps. First, due to the lack of research on early adulthood, I estimated a POLS model to examine whether loneliness is associated with the severity of depressive symptoms in young adults in Germany. This step was taken to replicate previous research that has shown that loneliness is closely linked to depression in a variety of samples, including adolescents, youths, and students (Dunn and Sicouri, 2022; Erzen and Çikrikci, 2018; Park et al., 2020). Second, I estimated FEIS models to examine the impact of loneliness on depressive symptoms while taking into account the selection of people with depression into loneliness. In particular, the FEIS model accounts for stable vulnerabilities that produce heterogeneous trajectories of depressive symptoms and the possibility that individuals with unfavourable courses of symptoms are more likely to experience loneliness. The model to be estimated can be illustrated by the following equation:

$$y_{it} = x_{it}\beta + \alpha_{1i} + age_{it}\alpha_{2i} + age_{it}^2\alpha_{3i} + \varepsilon_{it} \quad (1)$$

where y is the severity of depressive symptoms experienced by individual i at time t, x contains loneliness and time-varying covariates, ε_{it} is an idiosyncratic error term, α_{1i} is an individual-specific intercept that reflects differences in the baseline level of depressive symptoms, and α_{2i} and α_{3i} are the individual-specific slopes for age and age^2, respectively. These slopes can be understood as interactions between the age variables and unobserved stable characteristics that lead to differences in the course of depressive symptoms across individuals. Importantly, the model assumes that loneliness has a contemporaneous effect on depressive symptoms, which is likely to be accurate, as previous studies have indicated that loneliness is likely to affect mental health over short periods of time (Lim et al., 2016; McDowell et al., 2021).

Third, I stratified the FEIS model by gender to investigate whether the depressive effect of loneliness can be observed in both men and women. Gender-stratified models, as a more exploratory approach, are preferable to the inclusion of interaction effects for two reasons. On the one hand, this subgroup analysis aimed only to determine whether empirical support for the causation hypothesis is evident in both men and women. On the other hand, testing for interaction effects relies on the assumption that gender moderates the effect of loneliness on depressive symptoms but not the effect of the covariates (e.g., the dissolution of a romantic relationship). This assumption seems to be implausible because women are generally more vulnerable to depression. Consequently, any observed interaction effect could be confounded

by interactions between gender and some of the covariates included in the model. While it is possible to include multiple interaction terms in the model, this approach can lead to multicollinearity issues.

An artificial regression test (ART) supported the choice of the FEIS model. The ART test compares the regression coefficients of the FEIS model with those of the conventional fixed effects (FE) model. The test was performed for the multivariate model including loneliness and the time-varying covariates (Model 2a in Table 4.2). The test was highly significant with regard to the subset of loneliness variables ($\chi^2 = 38.49$, df = 2, p ($> \chi^2$) = 0.000) and all variables in the model combined ($\chi^2 = 66.91$, df = 17, p ($> \chi^2$) = 0.000). Thus, the FEIS model is preferable because it provides a more accurate estimate of the effects of loneliness on depressive symptoms by accounting for selection on outcome trajectories. The FEIS model identifies the causal effect of loneliness on the severity of depressive symptoms under the strict exogeneity assumption, which implies that the idiosyncratic error (ε_{it}) must not be correlated with past, contemporaneous, and future values of the independent variables. The FEIS model assumes a weaker form of strict exogeneity, which must hold conditional on the time-varying covariates, the individual-specific intercept (α_{1i}), and the individual-specific slopes for age (α_{2i}) and age^2 (α_{3i}). Additional information on the FEIS model has been provided elsewhere (Brüderl and Ludwig, 2015; Rüttenauer and Ludwig, 2023).

The estimation of the FEIS models is based on the following logic: (1) For each individual i, y and all variables in x are regressed on the individual-specific intercept, age and age^2 to obtain the individual-specific predicted values. (2) The predicted values are then subtracted from the observed values to detrend the data. (3) An OLS regression is applied to the detrended data. In other words, the FEIS model uses only the within-individual variation that is not attributable to individual-specific trajectories to estimate the effect of loneliness on depressive symptoms. The FEIS model requires data including at least $j + 1$ observations per individual, where j is the number of individual-specific parameters. In this study, four observations were required because in addition to the individual-specific intercept, the slopes for age and age^2 were estimated separately for all individuals.

For all models, unstandardised regression coefficients with 95% confidence intervals (CIs) based on panel-robust standard errors were reported. All statistical analyses were performed using Stata 15.1 (StataCorps, Texas). The FEIS models were estimated using xtfeis.ado (Ludwig, 2019).

4.3 Results

Table 4.1 provides the descriptive statistics for the analysed sample. Overall, the sample was relatively balanced in terms of gender, with 52% of observations collected from women. The mean age across all observations was 26.48 years (SD_{age} = 4.73 years). It is also evident that a substantial proportion of young adults reported experiencing loneliness. In 17% of the observations, the respondents reported feeling 'somewhat lonely'. Furthermore, in 14% of the observations, they reported feeling 'very lonely'. In terms of depressive symptoms, young adults reported a mean score of 17.80 points (SD = 5.05) on a scale ranging from 10 to 40 points, indicating a low level of symptom severity.

Table 4.2 presents the results of the statistical analyses. To replicate previous research that has found robust associations between loneliness and depressive symptoms, I first estimated a POLS model. The results, which are shown in Model 1, indicate that young adults who felt 'somewhat lonely' or 'very lonely' reported more severe depressive symptoms of 3.588 (95% CI: 3.390, 3.785) and 6.909 (95% CI: 6.588, 7.229) scale points, respectively, than young adults who felt 'not lonely'. This finding confirms the close link between loneliness and depressive symptoms based on a sample of young adults in Germany. However, the POLS model uses both between- and within-individual variation and is therefore unable to disentangle causation from selection.

To overcome the limitations of the POLS model, I estimated FEIS models to examine whether the observed association persists when selection is considered. It is important to note that the regression coefficients of the FEIS model reflect differences within the same individuals over time rather than differences among individuals. Model 2a shows that when young adults felt 'somewhat lonely' or 'very lonely', they reported significantly more severe depressive symptoms than when they felt 'not lonely', with scores of 1.472 (95% CI: 1.299, 1.645) and 3.595 (95% CI: 3.327, 3.863) points, respectively. Lending support to the causation hypothesis, these differences in depressive symptoms cannot be explained by the selection of young adults with unfavourable trajectories of depressive symptoms into loneliness. To illustrate the magnitude of the association, it was possible to compare the regression coefficients with the within-individual standard deviation of depressive symptoms (SD_w). This comparison revealed that the differences were moderate to large in comparison to the typical degree of within-individual change over time (0.49 and 1.20 SD_w, respectively). Finally, I estimated gender-stratified FEIS models to determine whether the causation hypothesis is supported among both young men and young women. The results, which are shown in Models

2b and 2c in Table 4.2, show that the depressive effect of loneliness was slightly stronger in women, but substantial effects were evident in men and women. Overall, these results support the causation hypothesis, which posits that loneliness exacerbates depressive symptoms, in both young men and young women.

As a robustness check, I examined whether the fact that some observations were collected during the COVID-19 pandemic influenced the results, for example, due to people's adaptations to physical distancing and restrictions on social contact. As shown in Table 4.4 in the Appendix, the results were very similar when only the observations collected before the outbreak of the pandemic were analysed. In addition, I investigated whether the results were altered when no adjustment was made for social connectedness, as it could be argued that loneliness affects mental health by leading to problematic social behaviour that damages the lonely person's social connections (e.g., Cacioppo and Hawkley, 2009). However, the results remained the same (Table 4.5 in the Appendix).

Table 4.2 The association between loneliness and depressive symptoms in young adults

	POLS			FEIS								
	Model 1 (full sample)			**Model 2a (full sample)**			**Model 2b (men)**			**Model 2c (women)**		
Loneliness												
Not lonely	Reference			Reference			Reference			Reference		
Somewhat lonely	3.588	***	[3.390,3.785]	1.472	***	[1.299,1.645]	1.356	***	[1.107,1.606]	1.565	***	[1.326,1.805]
Very lonely	6.909	***	[6.588,7.229]	3.595	***	[3.327,3.863]	3.386	***	[3.011,3.761]	3.764	***	[3.384,4.144]
Adjusted R^2	0.311											
Within R^2				0.118			0.120			0.121		
Observations	21,148			21,148			10,130			11,018		
Individuals	3,386			3,386			1,615			1,771		

Notes: Significance levels are denoted as follows: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with 95% confidence intervals based on panel-robust standard errors in brackets. All models are adjusted for time-varying covariates. Model 1 is additionally adjusted for gender.
The full results are shown in Table 4.3 in the Appendix.

Source: pairfam 2011–2021, own calculations.

4.4 Discussion

Depression remains a major concern and leading cause of disability worldwide. Early adulthood has been recognised as a period when many people with depression first experience symptoms (Solmi et al., 2022). Several meta-analyses have reported that depressive symptoms are more common in lonely people (Dunn and Sicouri, 2022; Erzen and Çikrikci, 2018; Park et al., 2020), and it is known that young adults report relatively high levels of loneliness (Hawkley et al., 2022; Luhmann and Hawkley, 2016). The present study is the first to examine whether loneliness exacerbates depressive symptoms in young adults and whether this effect is evident in both young men and young women. For this purpose, the study used data from a unique German panel study and employed an innovative analytical strategy based on FEIS models to account for the possibility that any observed association reflects the selection of young adults with a less favourable course of depressive symptoms into loneliness.

The POLS model initially confirmed the findings of previous research by indicating that feeling lonely was closely related to depressive symptoms in young adults in Germany. Then, the FEIS model showed that loneliness was still related to the severity of depressive symptoms after considering selection as a competing explanation. The magnitude of the association reflected moderate to large effect sizes, thus providing evidence for the causation hypothesis. Additional analyses revealed that a substantial effect was evident in both young men and young women. However, this effect was slightly stronger in women. Finally, several robustness checks demonstrated that the main findings were robust to the lack of an adjustment for social connections and to the exclusion of observations collected during the COVID-19 pandemic. Thus, the study found robust evidence for the depressive effects of loneliness in young adults. The findings of this study are consistent with those of two studies that have used extensions of the cross-lagged panel model to show weak to moderate effects of loneliness on depressive symptoms in adults (Lim et al., 2016; McDowell et al., 2021). However, the findings of this study contradict the findings of other recent studies that have reported either no or only weak effects in adolescents (Kristensen et al., 2022) and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Very few studies have explored possible gender differences in the depressive effects of loneliness, and these studies have found either no evidence of such differences in older people (Joshanloo, 2022; Mayerl et al., 2022) or only suggestive evidence in adolescents (Kristensen et al., 2022).

A noteworthy aspect of this study is the innovative analytic strategy that was used to test the causation hypothesis empirically. Previous studies have attempted to identify the

depressive effect of loneliness by using within estimator versions of the cross-lagged panel model that account for previous levels of depressive symptoms and unobserved stable confounders. In contrast, the present study was the first to use FEIS models to account for the selection of people with less favourable trajectories of depressive symptoms into loneliness. This analytical strategy builds on the observations that the courses of depressive symptoms differ systematically across individuals depending on stable characteristics such as genetic predispositions, early life experiences, and personality traits (Kwong et al., 2021; Nandi et al., 2009; Nanni et al., 2012; Nelson et al., 2017; Rhebergen et al., 2012; Schubert et al., 2017) and that less favourable symptom courses are associated with weaker social connections and stronger feelings of loneliness (Houtjes et al., 2017; Houtjes et al., 2014; Musliner et al., 2016). Importantly, this study avoided the shortcomings of previous studies. In particular, it avoided making strong assumptions about the latency of the effect of loneliness on depression, accounted for several time-varying covariates, and explored gender differences in the depressive effects of loneliness. It can therefore be concluded that this study provides broader and stronger evidence for the causation hypothesis than previous research.

While the results of this study indicate that loneliness contributes to depressive symptoms, they tell us little about the potential underlying pathways. In general, the reasons why loneliness carries risks for mental health are not yet fully understood. Different lines of research have highlighted high levels of emotional distress caused by the lack of satisfaction of the basic need to belong (Baumeister and Leary, 1995), deprivation in terms of psychosocial resources (Thoits, 2011a), unhealthy behaviour resulting from impaired self-regulation (Hawkley and Cacioppo, 2010), negative cognitive biases (Spithoven et al., 2017), and maladaptive biological stress responses as potential pathways (Cacioppo et al., 2015). An investigation of the relative importance of these pathways was beyond the scope of this study. Nevertheless, such an investigation would significantly advance the theoretical literature. In addition, this study did not test the selection hypotheses because selection was viewed as a source of bias that should be eliminated. Previous studies have provided little support for the direct selection hypothesis (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021), according to which depressive symptoms exacerbate feelings of loneliness. Therefore, prior to the present study, with few exceptions that have supported the causation hypothesis (Lim et al., 2016; McDowell et al., 2021), evidence for effects in either direction has been very limited. Thus, the previously available evidence has been most consistent with the indirect selection hypothesis, which implies that the association between loneliness and depressive symptoms is not causal but

instead confounded by shared vulnerabilities. Nonetheless, more research is needed to investigate the roles of selection processes in this context and the possible underlying mechanisms.

This study has several limitations that could affect its substantive conclusions. First, the data include only the STDS as a measure of depressive symptoms. Although STDS scores are highly correlated with scores on more established scales, such as the Beck Depression Inventory (Krohne et al., 2002), the STDS have rarely been used in previous research. Moreover, the STDS capture only the cardinal symptoms of depression (i.e., the presence of negative affect and the absence of positive affect) and do not allow any conclusions to be drawn regarding a clinical diagnosis of major depressive disorder. Thus, future studies should replicate this study by using more established scales of depressive symptoms and diagnostic interviews for major depression. Second, loneliness was measured using a single item that asked about loneliness directly, which could lead to social desirability bias due to the stigma and shame associated with loneliness. However, the performance of single-item measures is typically equal to that of multi-item scales (Mund et al., 2022). Third, the FEIS model required the exclusion of young adults for whom fewer than four observations were available in total. The exclusion of observations was not selective in terms of loneliness and depressive symptoms but was selective with regard to having a full-time or part-time job, not being in a romantic relationship and cohabiting with a partner, and living with parents (see also Table 4.1). Therefore, young adults who were less socially and occupationally integrated tended to be excluded from the sample, which may have led to an underestimation of the depressive effects of loneliness because those young adults may have had fewer resources available to enable them to cope with this aversive state. Finally, the FEIS model is based on a strict exogeneity assumption, which is violated in the presence of unobserved time-varying heterogeneity (i.e., changes in other aspects of life that influence loneliness and depressive symptoms). However, any potential bias is likely to be small, as the models were adjusted for the most important time-varying covariates. Moreover, strict exogeneity does not hold when reverse causality is present (i.e., when depressive symptoms increase the risk of loneliness over and above the individual's symptom trajectories). Nevertheless, limited evidence has indicated that depressive symptoms affect feelings of loneliness regardless of the assumed time interval (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021).

In conclusion, this study demonstrated that loneliness is still positively associated with depressive symptoms in young adults when the possibility that young adults with depression

select themselves into loneliness is taken into account. This result is consistent with the causation hypothesis, which posits that these two conditions are related because loneliness has a causal effect on depression. One implication of this finding is that loneliness should be routinely addressed to prevent the onset of depressive disorder in young adults. Moreover, intervention strategies aimed at reducing loneliness in young adults, such as social skills training and cognitive bias modification, might be effective in preventing depressive disorders. Nevertheless, these findings must be replicated using other samples of young adults and by using established scales of loneliness and depressive symptoms.

4.5 Appendix Study 3

Table 4.3 The association between loneliness and depressive symptoms in young adults (full results)

	POLS			FEIS								
	Model 1 (full sample)			**Model 2a (full sample)**			**Model 2b (men)**			**Model 2c (women)**		
Loneliness												
Not lonely	Reference			Reference			Reference			Reference		
Somewhat lonely	3.588	***	[3.390,3.785]	1.472	***	[1.299,1.645]	1.356	***	[1.107,1.606]	1.565	***	[1.326,1.805]
Very lonely	6.909	***	[6.588,7.229]	3.595	***	[3.327,3.863]	3.386	***	[3.011,3.761]	3.764	***	[3.384,4.144]
Age in years	0.212	*	[0.033,0.392]									
Age²	-0.004	*	[-0.007,-0.001]									
Female	0.623	***	[0.402,0.844]									
Employment status												
Full-time	Reference			Reference			Reference			Reference		
Part-time	0.008		[-0.227,0.243]	0.067		[-0.197,0.331]	-0.097		[-0.469,0.274]	0.124		[-0.238,0.486]
Student	-0.021		[-0.288,0.246]	-0.163		[-0.419,0.094]	-0.073		[-0.422,0.277]	-0.235		[-0.607,0.136]
In vocational training	-0.043		[-0.340,0.255]	-0.328	*	[-0.639,-0.017]	-0.606	**	[-0.982,-0.229]	0.031		[-0.478,0.539]
Unemployed	1.437	***	[0.966,1.908]	0.481	*	[0.083,0.880]	0.757	**	[0.252,1.262]	0.187		[-0.436,0.809]
Other not working	-0.220		[-0.553,0.114]	-0.061		[-0.404,0.281]	0.583	+	[-0.097,1.263]	-0.229		[-0.641,0.183]
Financial deprivation	0.753	***	[0.668,0.837]	0.204	***	[0.122,0.287]	0.179	**	[0.069,0.289]	0.238	***	[0.117,0.359]
Relationship status												
Single	Reference			Reference			Reference			Reference		
Living apart	0.353	**	[0.138,0.569]	-0.215	+	[-0.430,-0.000]	-0.329	*	[-0.608,-0.049]	-0.101		[-0.428,0.226]
Cohabiting	0.500	**	[0.136,0.864]	-0.343	+	[-0.714,0.028]	-0.629	*	[-1.139,-0.120]	-0.078		[-0.617,0.462]

Table 4.3 Continued

	POLS			FEIS							
	Model 1 (full sample)			Model 2a (full sample)			Model 2b (men)			Model 2c (women)	
Living alone	0.048		[-0.313,0.409]	-0.301	+	[-0.616,0.014]	-0.335	[-0.786,0.115]	-0.268	[-0.712,0.176]
Single parent	0.361		[-0.371,1.094]	-0.054		[-0.998,0.889]	-0.532	[-2.737,1.672]	0.172	[-0.887,1.232]
Living with parents	0.341	+	[-0.015,0.698]	0.161		[-0.197,0.519]	0.017	[-0.473,0.508]	0.261	[-0.260,0.782]
CATI /PAPI	0.542	*	[0.040,1.044]	0.454	+	[-0.049,0.956]	0.399	[-0.268,1.065]	0.504	[-0.246,1.253]
East Germany	-0.312	*	[-0.562,-0.062]	-0.104		[-0.780,0.573]	0.155	[-0.808,1.118]	-0.236	[-1.138,0.666]
Intercept	11.234	***	[8.757,13.710]							
Adjusted R^2	0.311									
Within R^2				0.118			0.120		0.121	
Observations	21,148			21,148			10,130		11,018	
Individuals	3,386			3,386			1,615		1,771	

Notes: Significance levels are denoted as follows: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with 95% confidence intervals based on panel-robust standard errors in brackets.

Source: pairfam 2011–2021, own calculations.

Table 4.4 The association between loneliness and depressive symptoms in young adults (observations collected before the COVID-19 pandemic)

	POLS			**FEIS**								
	Model 1 (full sample)			**Model 2a (full sample)**			**Model 2b (men)**			**Model 2c (women)**		
Loneliness												
Not lonely	Reference			Reference			Reference			Reference		
Somewhat lonely	3.599	***	[3.398,3.800]	1.496	***	[1.311,1.681]	1.378	***	[1.111,1.646]	1.596	***	[1.340,1.852]
Very lonely	6.857	***	[6.534,7.180]	3.557	***	[3.273,3.841]	3.380	***	[2.982,3.777]	3.703	***	[3.302,4.105]
Adjusted R^2	0.310											
Within R^2				0.115			0.118			0.116		
Observations	19,900			19,900			9,540			10,360		
Individuals	3,385			3,385			1,614			1,771		

Notes: Significance levels are denoted as follows: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with 95% confidence intervals based on panel-robust standard errors in brackets. All models are adjusted for time-varying covariates. Model 1 is additionally adjusted for gender.

Source: pairfam 2011–2021, own calculations.

Table 4.5 The association between loneliness and depressive symptoms in young adults (no adjustment for social connections)

	POLS			**FEIS**							
	Model 1 (full sample)			**Model 2a (full sample)**			**Model 2b (men)**			**Model 2c (women)**		
Loneliness											
Not lonely	Reference			Reference			Reference			Reference		
Somewhat lonely	3.496	***	[3.301,3.690]	1.495	***	[1.323,1.666]	1.406	***	[1.160,1.652]	1.572	***	[1.334,1.811]
Very lonely	6.765	***	[6.449,7.081]	3.633	***	[3.369,3.898]	3.449	***	[3.075,3.823]	3.783	***	[3.411,4.154]
Adjusted R^2	0.310											
Within R^2				0.117			0.118			0.120		
Observations	21,148			21,148			10,130			11,018		
Individuals	3,386			3,386			1,615			1,771		

Notes: Significance levels are denoted as follows: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with 95% confidence intervals based on panel-robust standard errors in brackets. All models are adjusted for time-varying covariates. Model 1 is additionally adjusted for gender.

Source: pairfam 2011–2021, own calculations.

5 The effect of loneliness on subjective well-being: Evidence from the UK Household Longitudinal Study 2017–2021 (Study 4)

Abstract

Although loneliness is associated with lower levels of subjective well-being, little is known about the precise nature of this association. Theoretical arguments have indicated a negative effect of loneliness on well-being, but there are alternative explanations, such as the possibility that chronically unhappy people select themselves into loneliness. This study investigates whether loneliness is detrimental to subjective well-being by considering selection as a competing explanation. The analyses were based on three waves of panel data from Understanding Society, the UK Household Longitudinal Study (2017–2021, containing 85,083 observations from 31,223 individuals aged 16 to 103 years). Subjective well-being was measured using a single item capturing life satisfaction. Loneliness was measured both directly using a single item and indirectly using the three-item UCLA Loneliness Scale. First, pooled ordinary least squares (POLS) models were estimated to confirm previous cross-sectional findings. Subsequently, fixed-effects (FE) models were used to account for the possibility that chronically unhappy people select themselves into loneliness. The results of the POLS models showed that lonely people report significantly lower levels of life satisfaction. This association persisted in the FE model, and the remaining association can be interpreted as evidence of the negative effect of loneliness on well-being. Further analyses showed that the results were similar for men and women and for younger and older people. Moreover, the results were remarkably robust across the two measures of loneliness and model specifications. Overall, the results support the claim that loneliness is detrimental to well-being. Thus, intervention strategies aimed at reducing loneliness might also be effective in improving well-being in the general population.

5.1 Introduction

Social connections are widely regarded as key elements of a good life (Caunt et al., 2013; Diener and Seligman, 2002), and as such, they are thought to have significant effects on subjective well-being (e.g., Pinquart and Sörensen, 2000; Proulx et al., 2007). Nevertheless, not all individuals succeed in establishing satisfying social relationships (Qualter et al., 2015). Loneliness is defined as the unpleasant feeling that is experienced when one's social relationships are perceived as deficient relative to one's social needs and desires (Peplau and Perlman, 1979; Perlman and Peplau, 1981). As a subjective feeling, loneliness is empirically different from social isolation, which is an objective state of social disconnection (De Jong Gierveld et al., 2012; Eckhard, 2018b). Recently, a large meta-analysis of 114 studies on the health effects of loneliness concluded that feeling lonely is related to significantly lower levels of well-being. This association exhibited a moderate to large effect size and emerged as one of the strongest of all the health outcomes analysed in the study (Park et al., 2020).

Accordingly, loneliness could be detrimental to well-being. However, other explanations are also conceivable. Most notably, selection effects might occur because loneliness is not randomly distributed, and certain people are more likely to feel lonely because of characteristics that could also influence their well-being (e.g., genetic factors or personality traits). Consequently, it is equally plausible that the observed association reflects the selection of unhappy people into loneliness. As loneliness is highly prevalent worldwide (Surkalim et al., 2022), it is essential to explain the association between loneliness and well-being that has been observed in previous research. The present study seeks to address this research problem by investigating whether loneliness is still associated with well-being when selection is considered as an alternative explanation. If the association persists, such a finding would support the claim that loneliness is detrimental to well-being.

5.1.1 Explanations of the association between loneliness and subjective well-being

Scholars have proposed various mechanisms to explain the lower subjective well-being reported by people who feel lonely, which are directly related to the broader debate in well-being research regarding the importance of bottom-up and top-down influences on well-being (Diener, 1984; Lucas, 2004).

One explanation for the lower well-being of lonely people is that loneliness has a negative effect on subjective well-being. This hypothesis, referred to here as the causation hypothesis, follows the theoretical reasoning underlying bottom-up theories of well-being, which describe

people's subjective well-being as a subjective average of how satisfied they are with various aspects of their lives (Diener, 1984). Following this reasoning, loneliness might affect subjective well-being in several ways. First, needs theorists have emphasised that well-being depends on the extent to which people's living conditions satisfy their basic physiological and psychological needs (Ryan and Deci, 2000; Tay and Diener, 2011). In particular, needs theorists have highlighted the importance of satisfying the basic human need to belong to achieve high levels of well-being (Baumeister and Leary, 1995; Ryan and Deci, 2000). From this perspective, loneliness is detrimental to well-being because it is an emotionally distressing experience that results from inadequate satisfaction of a basic human need (Baumeister and Leary, 1995). Second, social support and stress buffering theory argues that positive and meaningful social relationships provide several psychosocial benefits, such as a sense of purpose, self-esteem, and the perceived availability of social support (Cohen and Wills, 1985; Thoits, 2011a). Accordingly, loneliness may affect well-being by depriving people of these psychosocial resources, leading to feelings of worthlessness and emptiness. Third, sociocognitive models of loneliness argue that lonely people become hypervigilant towards social threats, which in turn produces negative biases at all stages of social information processing. For example, lonely people tend to exhibit negative beliefs about themselves and others, blame themselves for negative social events, and anticipate social rejection (for a review, see Spithoven et al., 2017). These models further argue that such cognitive biases may lead to problematic social behaviours in lonely people, which can elicit negative reactions from others, thus confirming and reinforcing these negative thoughts (Spithoven et al., 2017). In this way, initial feelings of loneliness are the starting point for a self-reinforcing vicious circle of continually increasing loneliness, negative thoughts, and interpersonal problems (Cacioppo and Hawkley, 2009). The high level of emotional distress caused by this downward spiral increases the risk of a variety of health problems (Leigh-Hunt et al., 2017; Park et al., 2020), which can negatively affect life evaluations.

An alternative explanation, the selection hypothesis, argues that people who are chronically unhappy are more likely to experience loneliness and that such people are less likely to escape loneliness by establishing new satisfying social relationships. This hypothesis is based on top-down theories of well-being, which posit that stable dispositions determine people's overall outlooks on their lives, which in turn trickle down to affect how people evaluate aspects of their lives. Top-down influences may occur for two reasons (Lucas, 2004). First, a large body of research has revealed that happy people are objectively more successful in establishing stable, supportive, and positive relationships (Kansky and Diener, 2017;

Lyubomirsky et al., 2005; Moore et al., 2018). In contrast, chronically unhappy people may miss out on the objective social benefits of happiness and be more likely to have deficient social relationships that exacerbate their feelings of loneliness. Second, chronically happy people tend to exhibit positivity bias when evaluating various aspects of their lives (Diener et al., 2018; Diener et al., 2000; Lauriola and Iani, 2015). For example, they are more attentive to positive social stimuli, interpret ambiguous and positive social interactions more positively, and recall more positive life events (Heintzelman and Diener, 2019; Raila et al., 2015; Seidlitz and Diener, 1993; Tamir and Robinson, 2007). In contrast, unhappy people may lack this positivity bias, due to which they may be more likely to perceive their social connections to be inadequate.

The selection of chronically unhappy people into loneliness can be understood in statistical terms as a confounding effect of unobserved stable characteristics. From this perspective, some people are more likely to feel lonely because of stable dispositions that also contribute to chronically lower levels of subjective well-being. Perhaps the most likely candidates for such stable characteristics are genetic predispositions (Bartels, 2015; Spithoven et al., 2019), traumatic experiences of neglect and abuse in childhood (Cao et al., 2022; de Heer et al., 2022; Reinhard et al., 2022), and personality traits (Buecker et al., 2020; DeNeve and Cooper, 1998). According to this hypothesis, previous research has likely overestimated the effect of loneliness on well-being because it has considered few, if any, of these potential confounders. Thus, taking these stable characteristics into account should reduce the association between loneliness and well-being.

5.1.2 Previous attempts to disentangle causation and selection

To my knowledge, no study has attempted to disentangle these two hypotheses by using panel data and appropriate panel regression models to examine the association between loneliness and well-being within individuals over time. The previous studies most closely related to this research question have used within estimator versions of the cross-lagged panel model to investigate whether loneliness contributes to mental health problems (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). Adjusting for previous mental health and unobserved stable confounders, these studies have found limited empirical support for the causation hypothesis. More specifically, two studies based on non-probability samples of adults from the USA reported weak to moderate effects of loneliness on depression, (social) anxiety, and paranoia (Lim et al., 2016; McDowell et al., 2021). In contrast, many other studies have reported either

very weak or nonsignificant effects on symptoms of depression and anxiety in adolescents (Kristensen et al., 2022) and on depressive symptoms in older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). Collectively, these findings seriously challenge the widespread belief that loneliness entails significant risks to mental health. Similarly, the idea that loneliness negatively affects subjective well-being is highly plausible, but it has never been tested empirically using appropriate analytical approaches.

5.1.3 The present study

This study is the first to test the causation hypothesis empirically. Specifically, the study seeks to investigate whether loneliness is detrimental to subjective well-being while taking into account the selection of chronically unhappy people into loneliness as a competing explanation. For this purpose, I applied fixed-effects (FE) models to three-wave panel data from Understanding Society, the UK Household Longitudinal Study (UKHLS), 2017–2021. Several additional analyses were conducted to investigate whether the substantive conclusions are robust across various sociodemographic groups, measures of loneliness, and model specifications.

5.2 Data and methods

The statistical analyses were based on data from waves 9 to 11 of the UKHLS (Institute for Social and Economic Research, 2022b).[9] Since the study began in 2009, participants aged 16 or older have been surveyed on a wide range of topics, including their socioeconomic status, health, and social relationships. The study employed a mixed-mode design involving face-to-face, telephone, and web interviews (Institute for Social and Economic Research, 2022c). When face-to-face interviews were suspended due to the COVID-19 pandemic, participants were asked to participate either online or by telephone (Institute for Social and Economic Research, 2022a). Although the fieldwork performed in each wave covered a period of 24 months or more, participants were interviewed at approximately 12-month intervals. Therefore, the observation period for each participant was three years in length. Further

[9] Understanding Society is an initiative funded by the Economic and Social Research Council and various Government Departments, with scientific leadership by the Institute for Social and Economic Research, University of Essex, and survey delivery by NatCen Social Research and Kantar Public. The research data are distributed by the UK Data Service. Fieldwork for the web survey was carried out by Ipsos MORI and for the telephone survey by Kantar.

information on data collection is available elsewhere (Institute for Social and Economic Research, 2022c).

5.2.1 Sample selection

The initial sample consisted of 100,068 observations from 40,521 individuals. The analytical approach used in this study required at least two observations per individual. After excluding observations that featured missing values for any of the variables analysed and individuals for whom fewer than two observations were available in total, the final sample comprised 85,083 observations from 31,223 individuals (55.57% from women, aged 16 to 103 years; $mean_{age}$ = 50.79 and SD_{age} = 18.18). In general, the amount of missing data in the pooled data was very low and highest for the UCLA Loneliness Scale with 6.3%. Additional analyses revealed that in the excluded observations, individuals were slightly less satisfied with their lives, slightly more often lonely, younger, less often married, and more often affected by financial deprivation and unemployment (see Table 5.1).

5.2.2 Measures

Subjective well-being was measured in terms of life satisfaction, which is the cognitive evaluation that one's life is going well. Life satisfaction was assessed using a single item that asked how satisfied the respondents were with their lives overall. The response options ranged from 1 (*completely dissatisfied*) to 7 (*completely satisfied*). Single-item measures are widely used in well-being research and perform as well as multi-item scales, such as the Satisfaction with Life Scale (Cheung and Lucas, 2014).

Loneliness was captured using both direct and indirect measures to ensure the robustness of the analyses, as recommended by the Office for National Statistics (2018). The direct measure involved a single item ('How often do you feel lonely?'). The indirect measure was based on the three-item version of the UCLA Loneliness Scale ('How often do you feel a) you lack companionship, b) left out, and c) isolated from others?', Hughes et al., 2004). The response options for all items were 1 (*hardly ever or never*), 2 (*some of the time*), and 3 (*often*). To ensure the comparability of the two measures, the scores of the three items on the UCLA Loneliness Scale were summed and then categorised as 'hardly ever or never' (scores of 3 and 4), 'sometimes' (5, 6, and 7), or 'often' lonely (8 and 9).

The models were adjusted for several *time-varying covariates* that affect both loneliness and life satisfaction. These time-varying covariates included age (in years), employment status (employed, unemployed, retired, sick/disabled, inactive/homemaker, or student), financial

deprivation (mild, moderate, or severe), relationship status (single, living apart or with a partner), marital status (never married, married, separated/divorced, or widowed), living alone, and single parenthood. In addition, to account for the potential impact of the COVID-19 pandemic, interview mode (face-to-face, telephone, or web) and period (2017, 2018–2019, January–February 2020, or March 2020–May 2021) were included as control variables in all models. Controlling for time-invariant covariates was not necessary in the FE model, as it already accounts for all time-invariant confounders, even if they are unrecognised or not observed in the data. The pooled ordinary least squares (POLS) model was additionally adjusted for gender.

5.2.3 Statistical analyses

To investigate the association between loneliness and life satisfaction, I started by using POLS models to replicate the findings of previous cross-sectional studies that did not attempt to disentangle causation from selection. The POLS estimator is obtained by pooling the data collected from all individuals over as many as three waves and applying OLS estimation to the pooled data. The POLS model can be illustrated as follows:

$$y_{it} = x_{it}\beta + \alpha_i + \varepsilon_{it} \quad (1)$$

where y is the life satisfaction of individual i at time point t, x is a vector of independent variables, including loneliness and the time-varying covariates, and ε_{it} is an idiosyncratic error. In addition, α_i is an individual-specific intercept that captures the joint influence of all unobserved stable characteristics (e.g., genetic factors) on life satisfaction. In other words, α_i captures stable differences in people's tendencies to be (un)happy. For the POLS model to be unbiased, both error terms (α_i and ε_{it}) must be uncorrelated with the independent variables. Crucially, the POLS model is based on the random-effects assumption, which is violated if α_i is correlated with the risk of loneliness (i.e., if chronically unhappy people select themselves into loneliness).

Subsequently, I applied standard FE models to the pooled data to account for the selection of chronically unhappy people into loneliness. In general, the FE model accounts for all stable characteristics by using only the variation within individuals over time (Brüderl and Ludwig, 2015). As shown in Table 5.2 and Table 5.3 in the Appendix, sufficient within-individual variation is observed in both measures of loneliness to estimate FE models. To account for the selection of chronically unhappy people into loneliness, this approach eliminates α_i from the

equation by subtracting the individual-specific mean of all variables from their observed values:

$$(y_{it} - \bar{y}_i) = (x_{it} - \bar{x}_i)\beta + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad (2)$$

The FE model identifies the causal effect of loneliness on subjective well-being under the strict exogeneity assumption, according to which the idiosyncratic error ε must not be correlated with past, contemporaneous, and future values of the independent variables. Additional information can be found elsewhere (Brüderl and Ludwig, 2015). Unstandardised regression coefficients with 95% confidence intervals based on panel-robust standard errors are reported for both the POLS and FE models in all figures. The statistical analyses were conducted using Stata 15.1 (StataCorps, Texas).

5.3 Results

5.3.1 Descriptive statistics

Table 5.1 provides an overview of the summary statistics of all relevant variables for both the analysed sample and the sample of excluded observations. In the analysed sample, the indirect and direct measures of loneliness yielded similar results regarding the frequency of loneliness. In 33% and 30% of the observations, the respondents reported feeling lonely ‘sometimes’, and in 5% and 8% of the observations, they reported feeling lonely ‘often’. In addition, the respondents were generally satisfied with their lives (mean = 5.16 on a scale ranging from 1, ‘completely dissatisfied’, to 7, ‘completely satisfied’).

Table 5.1 Summary statistics of the analysed sample and excluded observations

	Analysed observations		Excluded observations	
	Mean	SD	Mean	SD
Life satisfaction	5.16	1.43	4.99	1.54
UCLA Loneliness Scale				
Hardly ever/never lonely	0.62		0.58	
Sometimes lonely	0.33		0.35	
Often lonely	0.05		0.07	
Single-item measure of loneliness				
Hardly ever/never lonely	0.63		0.57	
Sometimes lonely	0.30		0.32	
Often lonely	0.08		0.10	
Age in years	50.79	18.18	45.56	21.40
Female	0.56		0.51	
Employment status				
Employed	0.57		0.49	
Unemployed	0.04		0.07	
Retired	0.27		0.21	
Sick/disabled	0.03		0.05	
Inactive/homemaker	0.05		0.07	
Student	0.05		0.11	
Financial deprivation				
Mild	0.73		0.63	
Moderate	0.20		0.25	
Severe	0.07		0.12	
Relationship status				
Single	0.28		0.29	
Living apart	0.08		0.09	
Living together	0.65		0.63	
Marital status				
Never married	0.27		0.41	
Married	0.56		0.43	
Separated/divorced	0.11		0.08	
Widowed	0.06		0.07	
Living alone	0.16		0.12	
Single parent	0.03		0.04	
Interview mode				
Face-to-face	0.35		0.62	
Telephone	0.03		0.04	
Web	0.63		0.34	
Observations	85,083		14,984	
Individuals	31,223		11,426	

Notes: A small proportion of the respondents contributed observations to both subsamples, which occurred when only one observation was excluded from the analysed sample due to missing values.

Source: UK Household Longitudinal Study 2017–2021, own calculations.

5.3.2 Multivariate analyses

Figure 5.1 shows the results regarding the association between loneliness and life satisfaction. The full models including the regression coefficients for all covariates are presented in Table 5.4 in the Appendix. First, I estimated POLS models to replicate the findings of previous research that reported a substantial association between loneliness and well-being (Park et al., 2020). Comparing individuals who felt lonely 'often' with those who were 'hardly ever/never' lonely, I found differences in life satisfaction of -1.777 and -1.644 scale points for indirect and direct measures of loneliness, respectively. For people who felt lonely 'sometimes', the differences were -0.777 and -0.702 scale points, respectively. Thus, the magnitude of the association was similar for both measures of loneliness. This result provides further evidence indicating that loneliness is negatively linked to well-being. However, the significantly lower well-being observed in lonely people may not reflect a negative effect of loneliness on well-being, as estimates from POLS models are potentially biased by the selection of chronically unhappy individuals into loneliness.

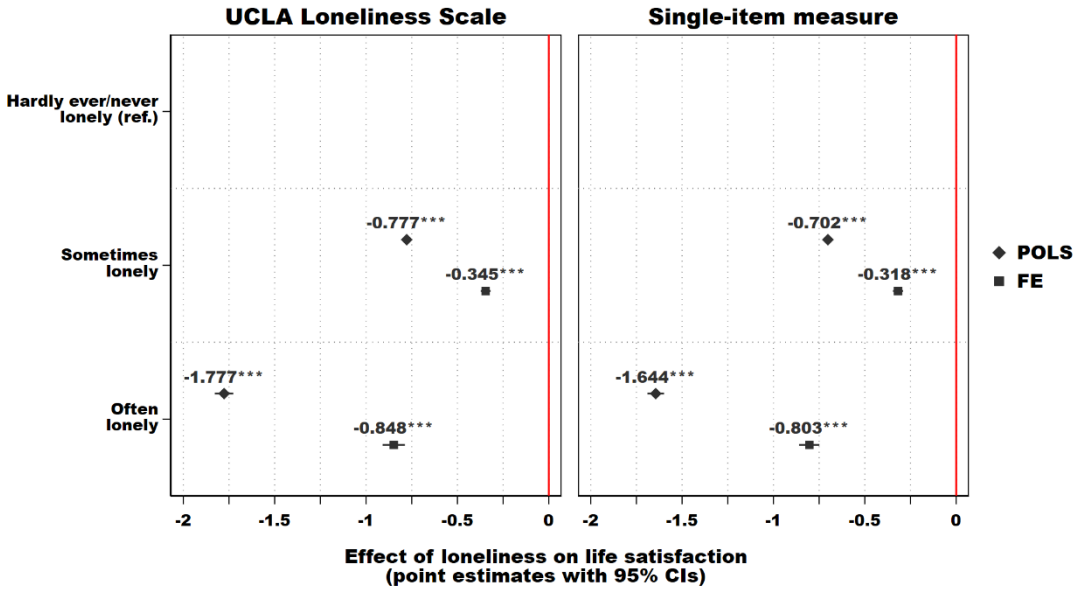

Figure 5.1 Effect of loneliness on life satisfaction by measure of loneliness (N_{obs} = 85,083, N_{ind} = 31,223)

Second, I explored whether the association reflects a negative effect of loneliness on well-being by estimating FE models, which use only within-individual variation and thus account

for selection based on stable characteristics. The results of the FE models are also shown in Figure 5.1. Notably, the regression coefficients of the FE models do not reflect differences in well-being among individuals but rather differences within individuals over time. The results showed that loneliness was still associated with significantly lower levels of life satisfaction after accounting for the selection of chronically unhappy individuals into loneliness. Compared to feeling lonely 'hardly ever/never', feeling lonely 'often' was associated with decreases in life satisfaction of -0.848 and -0.803 scale points, respectively. Feeling lonely 'sometimes' was also associated with lower life satisfaction, but these differences were only -0.345 and -0.318 scale points, respectively. Overall, the differences in well-being corresponded to approximately 0.4 to 1.0 within-individual standard deviations of life satisfaction, reflecting moderate to large changes in well-being compared to the typical levels of variation observed within individuals over time. Again, the results were remarkably consistent across direct and indirect measures of loneliness.

5.3.3 Robustness checks

I also performed several additional analyses to ensure the robustness of the results. First, I re-estimated the models without using the observations made during the COVID-19 pandemic to investigate whether the results were influenced by adaptation to social and physical distancing (see Figure 5.2 in the Appendix). However, the results were almost identical. Second, I stratified the models by gender to investigate whether evidence for the causation hypothesis was evident in both women and men. In particular, women's well-being may be more strongly affected by loneliness than men's well-being, for example, because women's self-construal may be more interdependent in Western societies (Cross and Madson, 1997) and because women tend to overvalue the cultivation of positive social relationships, especially in more individualistic societies (Yang and Girgus, 2019). However, only small differences in the regression coefficients emerged between men and women (see Figure 5.3 and Figure 5.4 in the Appendix). Third, I stratified the models by age group to explore possible differences between younger (< 50 years) and older people (≥ 50 years). This step was taken because previous studies using within estimators on panel data have found very little evidence to support the causation hypothesis among older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022), while studies covering the entire adult life span have reported such evidence (Lim et al., 2016; McDowell et al., 2021). It is therefore important to rule out the possibility that such age differences also exist in the effect of loneliness on well-being. The results did not show any systematic differences between the age groups (see Figure 5.5

and Figure 5.6 in the Appendix). Fourth, I re-estimated the models without adjusting for variables that capture a person's actual social connections to rule out potential overcontrol bias. More specifically, it could be argued that loneliness affects subjective well-being by encouraging problematic behaviours that damage existing social connections (Cacioppo and Hawkley, 2009). However, the results were again almost identical (see Figure 5.7 in the Appendix).

Finally, I explored the possibility that selection may operate not on people's stable levels of well-being but rather on age-related trajectories of well-being. I tested this possibility using fixed-effects individual-slopes (FEIS) regression, which allows both the intercept and the slope pertaining to the effect of age on life satisfaction to differ across individuals and to be correlated with the risk of loneliness (for more details, see Brüderl and Ludwig, 2015). When selection operates on the trajectories of well-being (i.e., on both the intercept and the slope for age), the standard FE model yields biased estimates. In the present study, the FEIS model required at least three observations for each individual. I therefore re-estimated the FE models using the reduced sample (i.e., the sample used for the FEIS models) to make a valid comparison. The results showed only negligible differences between the FE and FEIS models (see Figure 5.8 in the Appendix). An artificial regression test (ART), which tests the null hypothesis that there are no systematic differences in the regression coefficients between a standard FE and an FEIS model, generally supported this conclusion. Specifically, the ART indicated that the differences between the models were either not statistically significant or significant only at a level very close to the threshold of 5% (see Table 5.5 in the Appendix). Overall, these results show that selection seems to operate mostly on people's stable levels of well-being (in the sample used for the FEIS models).

5.4 Discussion

Loneliness is a major challenge for contemporary society, and it affects a significant proportion of the population (Surkalim et al., 2022). Previous research has demonstrated that lonely people report significantly lower levels of well-being (Park et al., 2020), but much of this research has been based on cross-sectional data and research designs that are poorly suited to the task of clarifying whether loneliness is detrimental to well-being. Moreover, the few longitudinal studies using within estimators have analysed only psychiatric outcomes, and they have found surprisingly little support for the hypothesis that loneliness contributes to mental health problems (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Luo,

2022; Mayerl et al., 2022; McDowell et al., 2021). Against this backdrop, it was necessary to investigate whether loneliness has a negative effect on subjective well-being (the causation hypothesis) or whether chronically unhappy people are more likely to feel lonely (the selection hypothesis). The present study aimed to examine the effect of loneliness on subjective well-being while ruling out the selection of chronically unhappy people into loneliness as a competing explanation. For this purpose, I used FE models and panel data from the UKHLS 2017–2021.

Initially, I estimated POLS models, which showed that lonely people reported lower levels of life satisfaction. This result confirmed the findings of a large meta-analysis, which showed that the link between loneliness and well-being is one of the strongest links across all health outcomes analysed (Park et al., 2020). Subsequently, I proceeded to use FE models to test the causation hypothesis empirically, according to which the observed association reflects a negative effect of loneliness on well-being. The results revealed that a substantial association between loneliness and life satisfaction persisted even after accounting for the selection of chronically unhappy people into loneliness. The remaining association supports the causation hypothesis because it cannot be explained by the type of selection mentioned above. Furthermore, the present study demonstrated that loneliness is detrimental to subjective well-being in both men and women and in both younger (< 50 years) and older people (≥ 50 years). Thus, robust support for the causation hypothesis can be found in all the sociodemographic groups analysed. Although this finding may not be particularly surprising, as few would doubt that lacking satisfying social relationships is detrimental to subjective well-being, this study is the first to test this view empirically using appropriate methods of panel data analysis. This finding is in line with those of two previous studies using within estimators on panel data, which reported weak to moderate effects on depressive symptoms, (social) anxiety, and paranoia (Lim et al., 2016; McDowell et al., 2021). However, this finding contrasts with other findings of no or very weak effects on symptoms of depression and anxiety in adolescents (Kristensen et al., 2022) and on depressive symptoms in older adults (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022).

The results are remarkably robust to the measurement of loneliness used. This finding is important because direct and indirect measures of loneliness, which have been widely used in loneliness research, have different strengths and weaknesses that could have affected the substantive conclusions of this study (Office for National Statistics, 2018). On the one hand, direct measures ask respondents about their feelings of loneliness directly, but they can lead to social desirability bias because people may be reluctant to discuss their feelings of

loneliness openly due to stigma and feelings of shame. On the other hand, indirect measures try to avoid this problem by avoiding the use of the term 'lonely'. However, as respondents are not asked about loneliness directly, it is uncertain whether they interpret items such as 'feeling left out' as reflecting experiences of loneliness. Encouragingly, the results of this study revealed that both measures yielded highly consistent results. In fact, this study is the first to show that both measures can be used reliably to investigate the impact of loneliness on well-being.

The negative effect of loneliness on well-being can be explained by several factors, such as a lack of satisfaction of the basic need to belong (Baumeister and Leary, 1995), deprivation of psychosocial resources, such as meaning in life and self-esteem (Thoits, 2011a), and cognitive biases leading to problematic social behaviour and thus ultimately to interpersonal problems (Cacioppo and Hawkley, 2009; Spithoven et al., 2017). As a result, lonely people are often trapped in a vicious cycle of increasing feelings of loneliness, cognitive biases, and negative social interactions, which results in high levels of emotional distress (Cacioppo and Hawkley, 2009). In contrast, one can only speculate about the stable characteristics that drive the selection of chronically unhappy people into loneliness. Evidence from different fields of research has indicated that early traumatic experiences, genetic predispositions, and personality traits could be key drivers of selection (Bartels, 2015; Buecker et al., 2020; de Heer et al., 2022; DeNeve and Cooper, 1998; Spithoven et al., 2019). However, further research is needed to clarify the processes underlying the selection of chronically unhappy people into loneliness.

The main conclusions of this study may be affected by a number of limitations. First, the FE model uses only the variation within individuals over time, which is intended to account for stable confounders that are difficult to observe. Nevertheless, loneliness may have a stronger effect on people who often feel lonely over longer periods. Due to the limited number of observations that were available for the present study, it was not possible to determine whether the duration of exposure moderates the effect of loneliness on well-being. Second, the FE model is based on a strict exogeneity assumption, which is violated, for example, when unobserved time-varying confounders (i.e., changes in other characteristics that influence both loneliness and well-being) are present. Although I accounted for social connections, employment status, and financial difficulties as a standard set of time-varying covariates, unobserved changes in other life circumstances and psychological states may be present and could thus still confound the association between loneliness and well-being. Furthermore, strict exogeneity does not hold in the case of reverse causality (i.e., when well-being increases

the risk of loneliness above and beyond a person's disposition to be (un)happy). Although this possibility certainly exists, it seems plausible to assume that a general disposition towards (un)happiness is more important for the cultivation of satisfying social connections than are short-term fluctuations in well-being. Research on psychiatric outcomes has also suggested that this is likely to be the case, as it has found limited evidence indicating that mental health problems contribute to feelings of loneliness (Griffin et al., 2022; Joshanloo, 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). It is also important to note that the FEIS model relaxes the strict exogeneity assumption, as it must hold only conditional on the time-varying covariates and the individual-specific trajectories. Taken together, these arguments suggest that any bias resulting from a violation of the strict exogeneity assumption, if such a violation exists, is likely to be small. Finally, the exclusion of observations was slightly selective in terms of social connections and financial resources. This may have led to an underestimation of the impact of loneliness on subjective well-being, as more resilient individuals with more social and financial resources tended to remain in the sample.

Overall, the present study provides further support for the claim that social connections are a key element of happiness. The results show that when people fail to establish satisfying social connections and thus develop feelings of loneliness, this situation has a negative effect on their levels of subjective well-being. Considering the fact that hundreds of millions of people worldwide report problematic levels of loneliness (Surkalim et al., 2022), this finding is highly relevant to policymakers. In particular, replication of this finding in future studies would suggest that policies and interventions aimed at fostering social connections and reducing feelings of loneliness might also be effective in improving the overall well-being of the general population.

5.5 Appendix Study 4

Table 5.2 Within-individual variation in loneliness (UCLA Loneliness Scale)

Loneliness at time t	**Loneliness at time t+1**			
	Hardly ever/ never lonely	Sometimes lonely	Often lonely	**Total**
Hardly ever/ never lonely	27,445	6,228	316	33,989
	80.75	18.32	0.93	100.00
Sometimes lonely	5,187	10,430	1,383	17,000
	30.51	61.35	8.14	100.00
Often lonely	303	1,373	1,195	2,871
	10.55	47.82	41.62	100.00
Total	32,935	18,031	2,894	53,860
	61.15	33.48	5.37	100.00

Notes: Absolute and relative row frequencies are shown.

Source: UK Household Longitudinal Study 2017–2021, own calculations.

Table 5.3 Within-individual variation in loneliness (Single-item measure)

	Loneliness at time t+1			
Loneliness at time t	Hardly ever/ never lonely	Sometimes lonely	Often lonely	**Total**
Hardly ever/ never lonely	28,128	5,679	493	34,300
	82.01	16.56	1.44	100.00
Sometimes lonely	4,950	9,039	1,603	15,592
	31.75	57.97	10.28	100.00
Often lonely	434	1,630	1,904	3,968
	10.94	41.08	47.98	100.00
Total	33,512	16,348	4,000	53,860
	62.22	30.35	7.43	100.00

Notes: Absolute and relative row frequencies are shown.

Source: UK Household Longitudinal Study 2017–2021, own calculations.

Table 5.4 Effect of loneliness on life satisfaction by measure of loneliness (corresponds to Figure 5.1)

	UCLA Loneliness Scale		Single-item measure	
	POLS (M1)	FE (M2)	POLS (M3)	FE (M4)
Loneliness				
Hardly ever/never lonely	Reference	Reference	Reference	Reference
Sometimes lonely	-0.777 ***	-0.345 ***	-0.702 ***	-0.318 ***
	(0.011)	(0.014)	(0.011)	(0.014)
Often lonely	-1.777 ***	-0.848 ***	-1.644 ***	-0.803 ***
	(0.026)	(0.031)	(0.023)	(0.028)
Age in years	-0.004 ***	-0.019 *	-0.005 ***	-0.019 *
	(0.001)	(0.008)	(0.001)	(0.008)
Female	0.056 ***		0.075 ***	
	(0.010)		(0.011)	
Employment status				
Employed	Reference	Reference	Reference	Reference
Unemployed	-0.218 ***	-0.114 **	-0.206 ***	-0.115 ***
	(0.029)	(0.035)	(0.029)	(0.035)
Retired	0.280 ***	0.087 *	0.298 ***	0.090 *
	(0.017)	(0.038)	(0.017)	(0.038)
Sick/disabled	-0.927 ***	-0.281 ***	-0.920 ***	-0.281 ***
	(0.034)	(0.063)	(0.035)	(0.062)
Inactive/homemaker	0.053 *	0.050	0.068 **	0.055
	(0.025)	(0.035)	(0.025)	(0.035)
Student	0.184 ***	0.078 *	0.204 ***	0.080 *
	(0.027)	(0.039)	(0.026)	(0.039)
Financial deprivation				
Mild	Reference	Reference	Reference	Reference
Moderate	-0.561 ***	-0.206 ***	-0.566 ***	-0.210 ***
	(0.012)	(0.016)	(0.012)	(0.016)
Severe	-1.141 ***	-0.579 ***	-1.153 ***	-0.581 ***
	(0.022)	(0.027)	(0.022)	(0.027)
Relationship status				
Single	Reference	Reference	Reference	Reference
Living apart	0.068 ***	0.073 *	0.059 **	0.049 +
	(0.020)	(0.030)	(0.020)	(0.030)
Living together	0.077 ***	0.167 **	0.054 *	0.133 *
	(0.022)	(0.056)	(0.022)	(0.056)
Marital status				
Never married	Reference	Reference	Reference	Reference
Married	0.067 ***	-0.062	0.072 ***	-0.054
	(0.018)	(0.042)	(0.019)	(0.042)
Separated/divorced	0.011	-0.018	0.020	-0.014
	(0.021)	(0.050)	(0.021)	(0.050)
Widowed	0.120 ***	0.006	0.194 ***	0.042
	(0.028)	(0.072)	(0.029)	(0.072)

Table 5.4 Continued

	UCLA Loneliness Scale				Single-item measure			
	POLS (M1)		FE (M2)		POLS (M3)		FE (M4)	
Living alone	0.093	***	-0.011		0.091	***	-0.014	
	(0.021)		(0.046)		(0.021)		(0.046)	
Single parent	-0.037		-0.047		-0.031		-0.068	
	(0.034)		(0.065)		(0.035)		(0.064)	
Interview mode								
Face-to-face	Reference		Reference		Reference		Reference	
Telephone	0.339	***	0.379	***	0.353	***	0.383	***
	(0.027)		(0.032)		(0.027)		(0.031)	
Web	-0.080	***	-0.162	***	-0.088	***	-0.167	***
	(0.011)		(0.018)		(0.011)		(0.018)	
Intercept	5.775	***			5.807	***		
	(0.027)				(0.027)			
Adjusted R^2	0.281				0.275			
Within R^2			0.047				0.046	
Observations	85,083		85,083		85,083		85,083	
Individuals	31,223		31,223		31,223		31,223	

Notes: Significance levels are + p<0.1, * p<0.05, ** p<0.01, *** p<0.001. Unstandardised regression coefficients are shown with panel-robust standard errors in parentheses. All models were additionally adjusted for period effects, and the POLS models were adjusted for gender.

Source: UK Household Longitudinal Study 2017–2021, own calculations.

Table 5.5 Artificial regression test (FEIS vs. FE)

	Loneliness only			All variables		
	Chi^2	df	p (> Chi^2)	Chi^2	df	p (> Chi^2)
UCLA Loneliness Scale	3.89	2	0.143	21.91	21	0.405
Single-item measure	6.98	2	0.031	25.58	21	0.223

Notes: FE = fixed-effects model, FEIS = fixed-effects individual-slopes model.

Source: UK Household Longitudinal Study 2017–2021, own calculations.

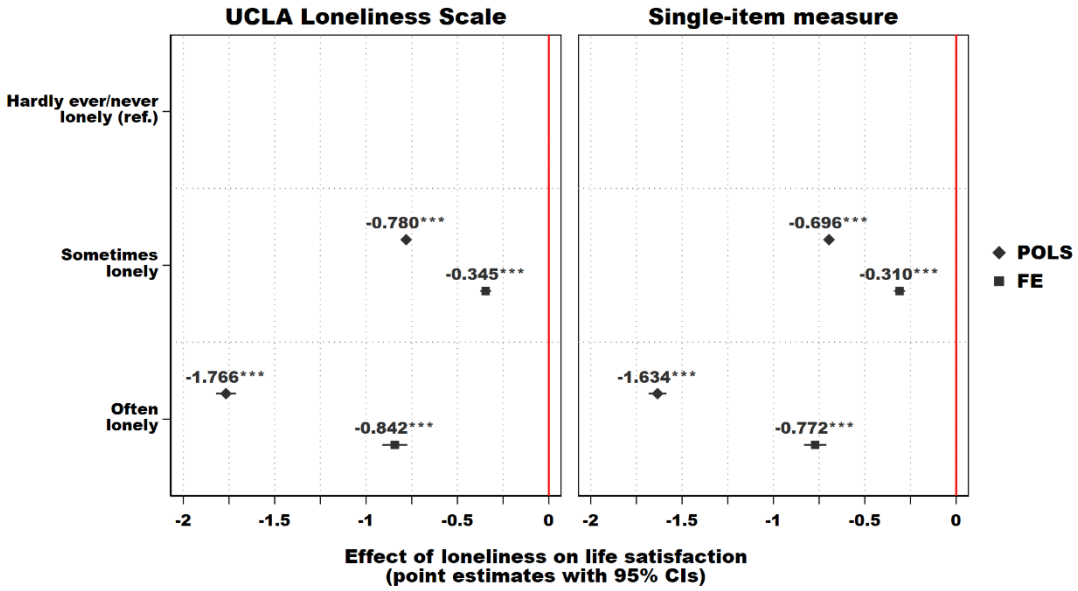

Figure 5.2 Effect of loneliness on life satisfaction by measure of loneliness (excluding observations collected during the COVID-19 pandemic (N_{obs} = 73,314, N_{ind} = 29,235)

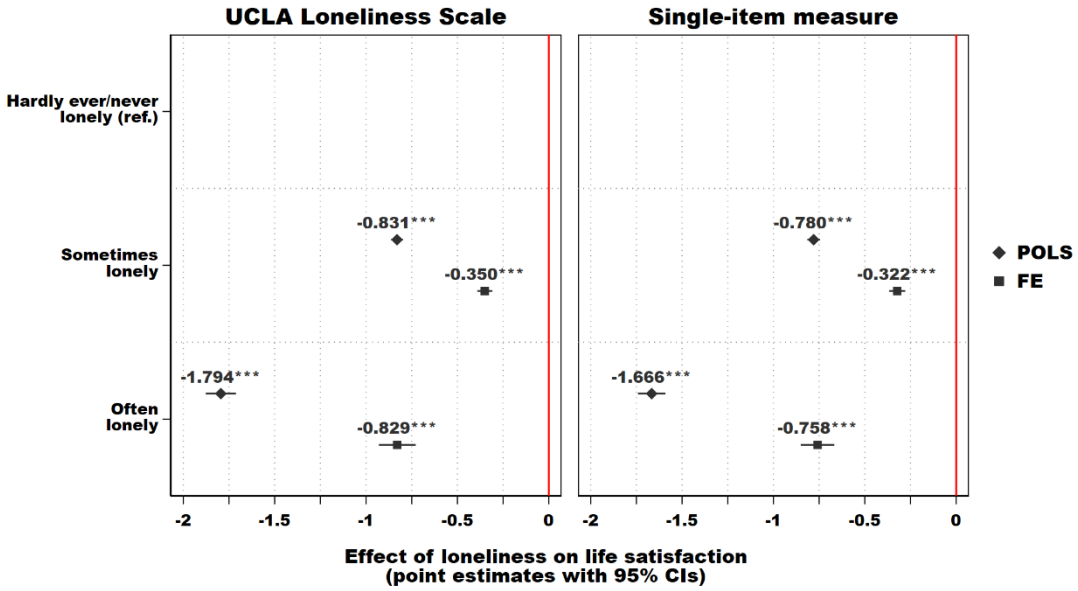

Figure 5.3 Effect of loneliness on life satisfaction among men by measure of loneliness (N_{obs} = 37,802, N_{ind} = 13,867)

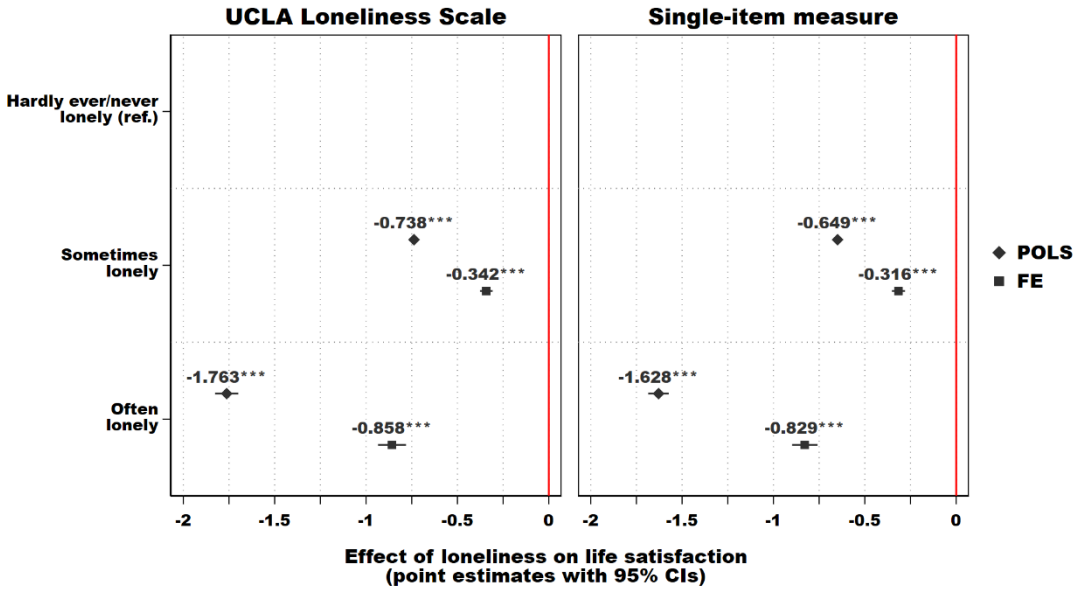

Figure 5.4 Effect of loneliness on life satisfaction among women by measure of loneliness (N_{obs} = 47,281, N_{ind} = 17,356)

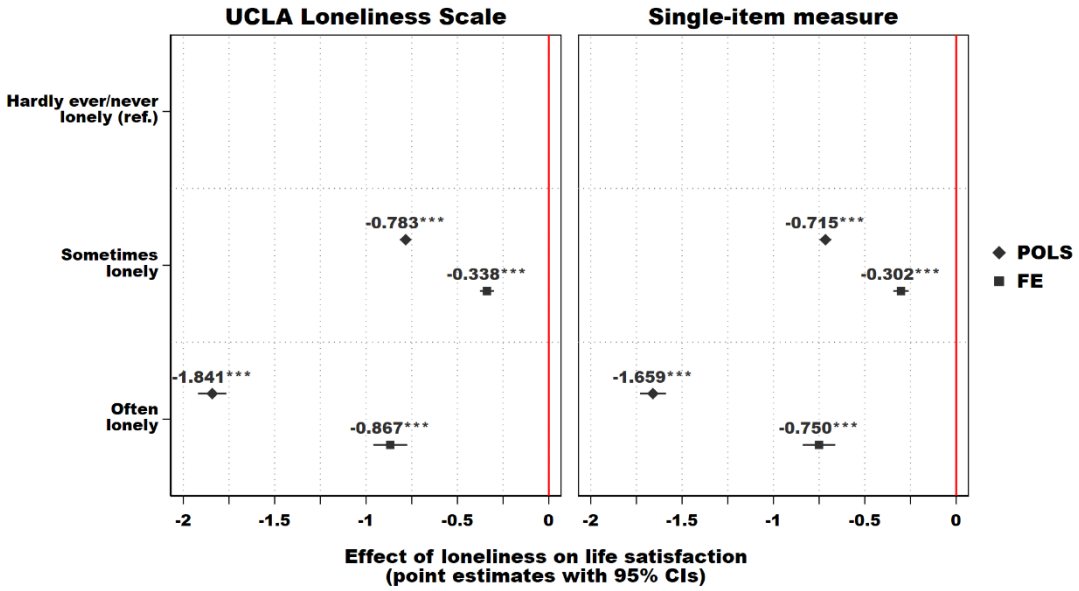

Figure 5.5 Effect of loneliness on life satisfaction among individuals 50 years of age or older by measure of loneliness (N_{obs} = 45,108, N_{ind} = 16,330)

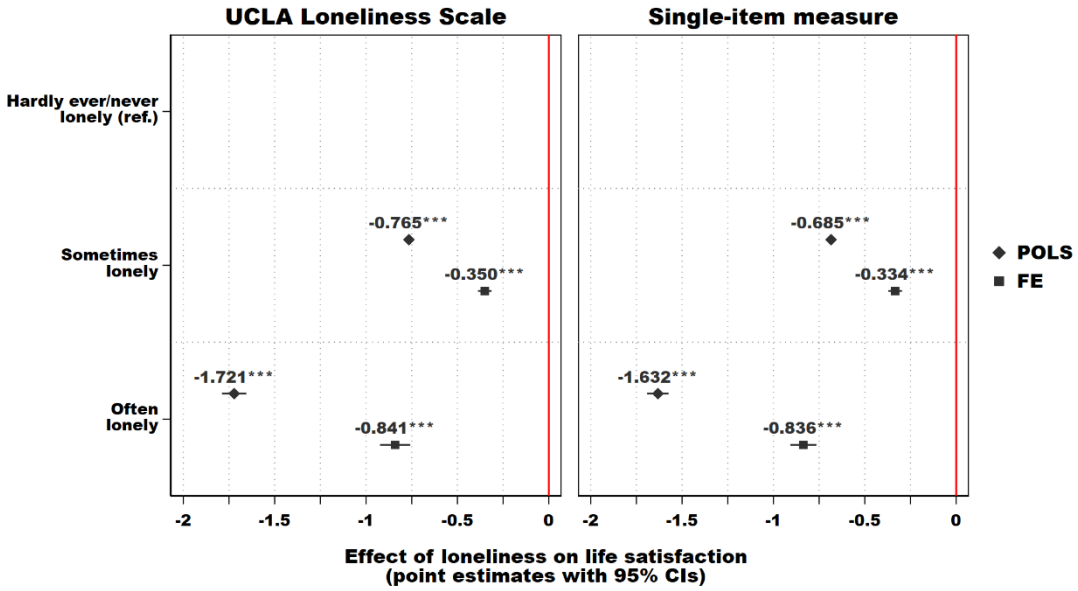

Figure 5.6 Effect of loneliness on life satisfaction among individuals under 50 years of age by measure of loneliness (N_{obs} = 38,690, N_{ind} = 14,673)

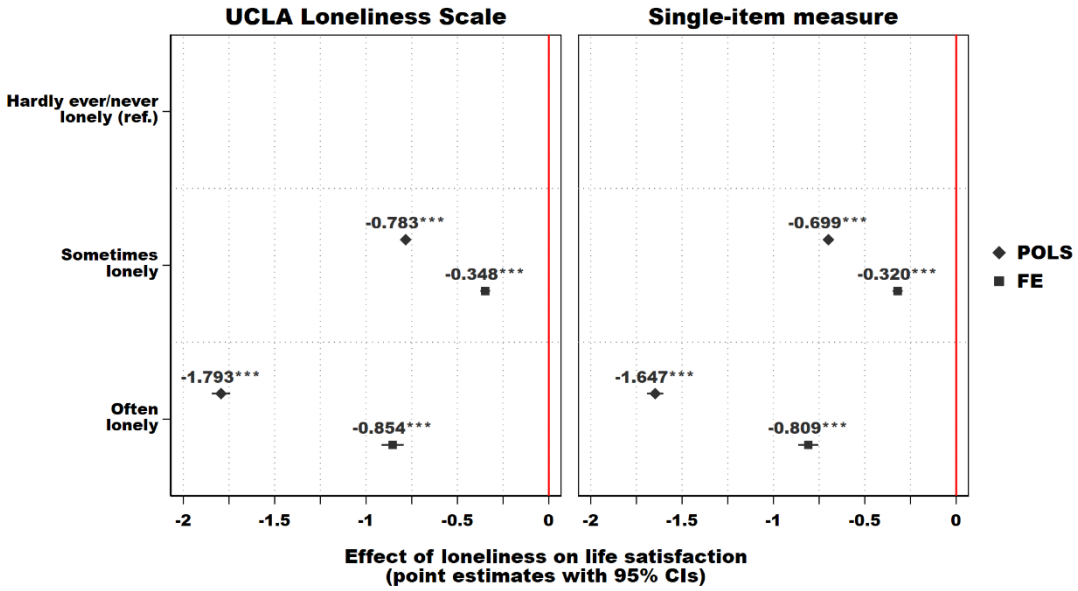

Figure 5.7 Effect of loneliness on life satisfaction without adjusting for social connections by measure of loneliness (N_{obs} = 85,083, N_{ind} = 31,223)

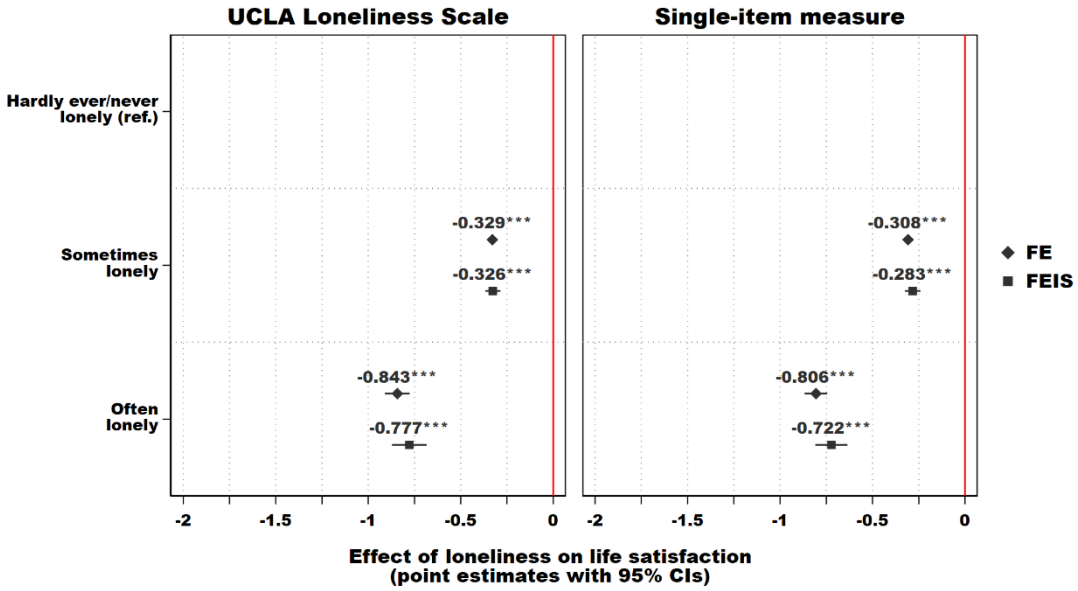

Figure 5.8 Effect of loneliness on life satisfaction in the FEIS and FE models by measure of loneliness (N_{obs} = 67,911, N_{ind} = 22,637)

6 Conclusion

Social isolation and loneliness have received considerable attention from both the public and researchers, which increased sharply following the outbreak of the COVID-19 pandemic due to concerns that the potentially increased prevalence of social isolation and loneliness could result in a mental health crisis. While the close link between social disconnection and mental health has been well established, researchers have yet to explore the importance of different explanations for this association. The common view has been that social disconnection is harmful to mental health, but prior research has failed to rule out selection as an alternative explanation. Thus, the main objective of this thesis was to elucidate the causal nature of the associations between social isolation, loneliness, and mental health. Clarifying the causal roles of social isolation and loneliness in mental illness is essential, as robust evidence regarding causation would indicate that both conditions not only lead to great human suffering but also entail significant costs for health care systems. Moreover, scientific research can provide a major frame of reference for the development of effective interventions. Accordingly, the thesis sought to answer the following research questions:

(1) What are the theoretical arguments underlying different explanations for the associations between social isolation, loneliness, and mental health?
(2) Do social isolation and loneliness contribute to mental health problems, as predicted by the causation hypothesis?
(3) Are conclusions regarding the causation hypothesis robust across measurement approaches and broader sociodemographic groups?

To address these questions, this thesis conducted a literature review of the theoretical arguments underlying the causation hypothesis and the two selection hypotheses (Section 1.3). In particular, this thesis advanced the literature by identifying possible mechanisms by which people with mental health problems may self-select into experiences of social disconnection. Next, the thesis reviewed the empirical literature to determine whether previous research has been able to differentiate among these three explanations (Section 1.4). As previous research has exhibited major methodological limitations, four empirical studies were conducted, which drew on different sources of panel data and advanced methods of panel data analysis to provide a more rigorous empirical test of the causation hypothesis (Chapters 2 to 5). By analysing several mental health outcomes, measures of social isolation and loneliness, and population groups, these studies ensured the robustness of the findings and provided insights into the

inconsistent results of previous research. Overall, these empirical studies offered robust support for the causation hypothesis, thus further supporting the claim that both social isolation and loneliness are detrimental to mental health. The following section summarises the main findings of each study before it synthesises them to highlight three key contributions to the literature. Finally, the chapter discusses the practical implications of the substantive findings and the limitations of the empirical studies.

6.1 Summary of the main findings

6.1.1 Study 1

The aim of this study was to investigate whether social isolation affects the physical and mental health of older people in Germany. Although it is well known that socially isolated people report poorer mental and physical health (Holt-Lunstad et al., 2015; Leigh-Hunt et al., 2017; Santini et al., 2015), prior to the current research, the causation hypothesis had yet to be tested using analytical strategies that account for indirect and direct selection simultaneously. To address this research gap, the study used panel data from the GSOEP 2004–2012 to estimate dynamic panel models with fixed effects within a novel structural equation modelling framework (Allison et al., 2017; Moral-Benito et al., 2019). In a first step that focused on random-effects models, the results confirmed the findings of prior research that has indicated that socially isolated people report significantly worse mental and physical health than people who are (better) socially integrated, but the association between one of the measures of social isolation and physical health was already weak or nonsignificant. Next, in the conventional FE model, the association with mental and physical health was much weaker and nonsignificant, thus suggesting that prior research has likely overestimated the health effects of social isolation by failing to account for indirect selection. Interestingly, substantial associations with mental health were again observed for both measures of social isolation using the FE model in which social isolation was assumed to be sequentially exogenous. Thus, failing to account for direct selection (i.e., the isolating effect of poor mental health) would have caused the impact of social isolation on mental health to be underestimated. In contrast, social isolation was still not related to physical health. Finally, in the dynamic panel model with fixed effects, becoming socially isolated was associated with a decline in mental health one year later but was unrelated to physical health. The results were similar for men and women and, with the single exception discussed previously, robust across different measures of social isolation. The magnitude of the association suggested that social isolation affected

mental health to an extent that is of practical (and probably even clinical) relevance. The lack of evidence for a negative effect on physical health may be due to the fact that physical health in old age is strongly influenced by the accumulation of adversity and the resulting wear and tear on the body throughout the life course. Thus, individual risk factors may have only a minor effect on physical health in old age. Altogether, these findings suggest that social isolation negatively affects mental health. However, they challenge the claim that social isolation is also relevant to physical health.

6.1.2 Study 2

This study shifted the focus of the thesis to the subjective experience of loneliness. Although it has been recognised that loneliness is associated with mental health problems (Park et al., 2020), evidence indicating that this association reflects a negative effect of loneliness on mental health is surprisingly weak (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). However, previous research that has tested the causation hypothesis has suffered from serious shortcomings. Using panel data from the UKHLS 2017–2022, this study investigated whether loneliness affects psychological distress and general mental health while attempting to avoid these shortcomings. As a first step, POLS models were estimated to replicate previous findings that have indicated moderate to strong associations between loneliness and a variety of mental health outcomes (Park et al., 2020). Consistent with this research, the results showed that people who felt (more often) lonely reported significantly higher levels of psychological distress and poorer general mental health. As a second step, FEIS models were estimated to account for selection into loneliness based on outcome trajectories. The results showed that loneliness was still related to both mental health outcomes. The remaining associations corresponded to moderate to large changes relative to the typical degree of within-individual variation in outcomes. The results were remarkably robust across direct and indirect measures of loneliness, to the inclusion of observations collected during the COVID-19 pandemic, and to the lack of an adjustment for social connections to avoid overcontrol bias. Furthermore, despite the fact that some smaller differences were observed across the sociodemographic groups analysed, the causation hypothesis was supported for both men and women as well as for both younger and older people. Overall, the results provide broad and compelling evidence for the effect of loneliness on mental health, and this evidence was consistent across population groups.

6.1.3 Study 3

This study investigated whether loneliness affects the severity of depressive symptoms in young adults in Germany. This study was the first to analyse the depressive effects of loneliness in early adulthood, whereas previous research has focused on adolescents (Kristensen et al., 2022), adults (Lim et al., 2016; McDowell et al., 2021), and older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). This lack of research was surprising given that early adulthood has been identified as a period in life when people often first develop depressive symptoms (Solmi et al., 2022) and when levels of loneliness are relatively high (Hawkley et al., 2022; Luhmann and Hawkley, 2016). Using panel data from the German Family Panel (pairfam) 2011–2021, the study addressed the question of whether loneliness affects depressive symptoms in early adulthood. The study first presented the results of POLS models to show that loneliness is associated with higher levels of depressive symptoms in young adults. This result confirms several meta-analyses that have indicated that loneliness is closely linked to depression in adolescents, youths, and students (Dunn and Sicouri, 2022; Erzen and Çikrikci, 2018; Park et al., 2020). Then, FEIS models were estimated to examine whether this link reflects an effect of loneliness on depressive symptoms by accounting for the possibility that young adults with less favourable symptom courses are at greater risk of loneliness. The results showed that loneliness was still positively associated with depressive symptoms even when accounting for selection based on outcome trajectories. The association was still substantial and indicated moderate to large changes compared to the typical degree of within-individual variation in depressive symptoms. The results also showed a slightly stronger effect in young women than in young men. Nevertheless, evidence of causation could be found in both genders. Similar to Study 2, the findings were robust to the exclusion of observations collected during the COVID-19 pandemic and to the lack of an adjustment pertaining to young adults' actual social connections to avoid overcontrol bias. Altogether, it can be concluded that this study provided strong evidence of the depressive effects of loneliness in young adults.

6.1.4 Study 4

This study investigated the causal role of loneliness in subjective well-being. Because previous studies using within estimators have analysed only psychiatric outcomes (Griffin et al., 2022; Joshanloo, 2022; Kristensen et al., 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021), it was necessary to test the causation hypothesis with respect to positive aspects of mental health. The study was situated in the context of well-being research

and derived the causation and selection hypotheses from theoretical arguments regarding the bottom-up and top-down influences on subjective well-being. Using panel data from the UKHLS 2017–2021 and conventional FE models, the study investigated whether loneliness is detrimental to well-being by ruling out the possibility that chronically unhappy people are more likely to feel lonely. As a first step, the study sought to replicate the findings of a meta-analysis that indicated that lonely people report significantly lower levels of well-being (Park et al., 2020). The results confirmed that loneliness is associated with lower life satisfaction. As a second step, the study then used FE models to investigate whether this association reflects an effect of loneliness on well-being. The results again showed that the association remained substantial when taking selection into account. Therefore, the results of this study support the claim that feeling lonely is detrimental to well-being. The results were very similar in the FEIS model, indicating that selection operates mostly on the stable level of well-being. Furthermore, this evidence was robust to the exclusion of observations collected during the COVID-19 pandemic and to the lack of an adjustment for actual social connections as well as across both direct and indirect measures of loneliness. Furthermore, the results were remarkably consistent across both men and women as well as both younger and older people. Although differences among these subgroups emerged, they were negligible in magnitude. Overall, this study revealed that empirical support for the causation hypothesis can also be found for positive aspects of mental health, and this finding was robust across sociodemographic groups.

6.2 Synthesis of evidence and practical implications

The studies presented in this thesis make several contributions to the literature that are directly relevant to the research questions. This section synthesises the evidence provided by these studies before it discusses the practical implications of the substantive findings of this thesis.

6.2.1 Evidence for the causation hypothesis

The results highlight the importance of social disconnection for mental health. Across a range of outcomes, the results consistently indicate that social isolation and loneliness are associated with poorer mental health even when taking into account a wide range of time-varying covariates and the two types of selection by using suitable methods of panel data analysis. Strikingly, all four studies found associations of substantial magnitude and offered robust empirical support for the causation hypothesis. However, each study empirically tested this hypothesis from a slightly different perspective.

Study 1 showed that social isolation affects mental health (but not physical health) in older people in Germany even when accounting for the two types of selection using dynamic panel models with fixed effects. Notably, this study was the first to perform an empirical test of the causation hypothesis for social isolation, which had not previously been studied using appropriate methods of panel data analysis. The results are partially consistent with those of a previous study that used Australian panel data to explore the reciprocal relationships between three aspects of social relationships and mental health. This study showed that informal social contact improved mental health in older people over a four-year period but yielded only weak evidence for the effects of civic engagement and political participation (Kiely et al., 2021). Since the publication of **Study 1**, two further studies have reported that social disconnection did not influence depressive symptoms and emotional well-being over a four-year period (Luo, 2022; Vella-Brodrick et al., 2023). Given the similar methodological approaches used by these studies, which were based on extensions of the cross-lagged panel model, it seems likely that the conflicting results can be explained by the incorrectly specified latency of the isolation effect in these studies. In particular, theoretical arguments regarding why social isolation affects mental health as long as four years later are lacking. Furthermore, simulation studies have indicated that within estimators can be heavily biased if the time interval is specified incorrectly (Leszczensky and Wolbring, 2022; Vaisey and Miles, 2017). Indeed, **Study 1** showed that the causation hypothesis can be confirmed when a shorter latency period of only one year rather than four years is assumed.

Study 2 also supported the causation hypothesis by showing that loneliness influenced two mental health outcomes—psychological distress and general mental health—in adults from the UK. This finding is consistent with the results of two studies from the USA that found weak to moderate effects of loneliness on depression, (social) anxiety, and paranoia in adults (Lim et al., 2016; McDowell et al., 2021). While these two studies analysed non-probability samples, **Study 2** was the first to support the causation hypothesis by analysing a nationally representative sample of the general adult population in the UK. However, the results challenge those of previous research that has reported limited evidence for causation among both an adolescent sample recruited from selected Norwegian schools (Kristensen et al., 2022) and nationally representative samples of older people (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). **Study 4** built on the findings of **Study 2** by showing that the causation hypothesis can also be supported for subjective well-being as a positive aspect of mental health. Notably, this study was the first to use suitable methods of panel data analysis to examine the causal role of loneliness in well-being in adults, whereas prior studies have

analysed only psychiatric conditions (e.g., depressive symptoms). Furthermore, **Study 3** was the first to test the causation hypothesis in early adulthood, which represents a period in which people are at particularly high risk of depression. This study therefore complemented an early study based on a German sample that focused on older people (Joshanloo, 2022). Although the causation hypothesis could not be confirmed in that previous study, the results of **Study 3** provided evidence for the influence of loneliness on the severity of depressive symptoms in young adults.

As in the case of social isolation, the inconsistent results may be due to different assumptions regarding the latency period of the loneliness effect. The two studies that assumed a latency period of several weeks also found that loneliness affected several mental health outcomes, including depression, (social) anxiety, and paranoia. However, these studies have been limited by the fact that they analysed non-probability samples from the USA (Lim et al., 2016; McDowell et al., 2021). However, the results of these studies were confirmed by **Studies 2 to 4**, all of which supported the causation hypothesis by analysing two high-quality datasets from the UK and Germany. Rather than allowing the effect latency to be dictated by the data without a theoretical basis, these analyses assumed that loneliness had a contemporaneous effect on mental health outcomes to avoid biases due to the misspecification of the time interval between exposure and outcome (Leszczensky and Wolbring, 2022; Vaisey and Miles, 2017). This approach seemed to be appropriate, as studies that have failed to support the causation hypothesis have assumed that loneliness affects mental health only years later (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). While specifying a contemporaneous effect of loneliness opens up the possibility of reverse causality, it is important to note that previous studies have found that mental health did not affect loneliness in adults or that it did so only weakly, regardless of the assumed latency of the effect (Griffin et al., 2022; Joshanloo, 2022; Lim et al., 2016; Luo, 2022; Mayerl et al., 2022; McDowell et al., 2021). Thus, it is unlikely that any bias, to the extent that it exists, could affect the main conclusions.

6.2.2 Robustness across sociodemographic groups

The studies further revealed that evidence for the causation hypothesis can be found among all sociodemographic groups analysed. **Studies 2 and 4** included statistical analyses that were stratified by age group to address potential differences between younger (< 50 years of age) and older people (50 years or older). Previous studies have supported the causation hypothesis in non-probability samples of adults (Lim et al., 2016; McDowell et al., 2021) but have found

little evidence when analysing samples of adolescents from selected Norwegian schools (Kristensen et al., 2022) or nationally representative samples of older adults (Griffin et al., 2022; Joshanloo, 2022; Luo, 2022; Mayerl et al., 2022). However, these studies differed not only in terms of the sampling approaches they used but also in the assumed latency of the effect, with the two studies that found support for causation assuming a short latency of weeks rather than years. In addition, research with a focus on testing the causation hypothesis in younger people remained lacking. Consequently, it remained unclear whether these inconsistent results were due to methodological factors (e.g., differences in the latency of the effect or sampling approaches) or age-related differences in people's vulnerability to the negative effects of loneliness (e.g., older people may be less vulnerable to the negative effects of loneliness). The results of **Studies 2 and 4** showed that the effects of loneliness on all outcomes—psychological distress, general mental health, and life satisfaction—differed only slightly between younger and older people. Therefore, these studies are the first to support the causation hypothesis with regard to these two age groups. As these studies were based on nationally representative samples, this finding suggests that the incorrect specification of the effect's latency is the most likely reason why previous studies on older people have failed to support the causation hypothesis convincingly.

All four studies investigated whether evidence for the causation hypothesis could be found in both men and women. Gender differences could result from the higher relevance of both causation and selection among women. On the one hand, women may be more strongly affected by social disconnection because they are at greater risk of mental illnesses such as anxiety and depression (Steel et al., 2014), may construe their self as more interdependent in Western societies (Cross and Madson, 1997), and may be more likely to care excessively about cultivating positive social connections (Yang and Girgus, 2019). On the other hand, depression and related vulnerabilities may contribute more strongly to the occurrence of interpersonal problems and negative life events in women than in men (Liu and Alloy, 2010). In line with these theoretical arguments, a study of adolescents showed that loneliness influenced symptoms of anxiety and depression more strongly in girls than boys, although this effect was not statistically significant in either gender due to the small sample size. Furthermore, symptoms of anxiety and depression affected loneliness only in girls (Kristensen et al., 2022). Two other studies found no evidence for such differences in older people (Joshanloo, 2022; Mayerl et al., 2022). Because few studies conducted using within estimators have explored possible gender differences, it was necessary to use gender-stratified models to examine whether the causation hypothesis is supported in both men and women. In general, the results

of all four studies indicated only small gender differences. **Studies 2 and 4** revealed that feeling 'often lonely' had a slightly stronger effect on the relevant outcomes—psychological distress, general mental health, and life satisfaction—in women than in men, but substantial effects were observed in both genders. Similarly, **Study 3** found that loneliness influenced the severity of depressive symptoms in both young women and young men. However, this depressive effect was stronger in young women. Interestingly, **Study 1** found the opposite pattern, such that social isolation affected men's mental health slightly more than that of women. However, the causation hypothesis was confirmed for both genders.

6.2.3 Robustness across measurement approaches

The four empirical studies were the first to test the causation hypothesis by using multiple measures of social isolation and loneliness. It was important to show that the measurement of these two concepts does not affect the conclusions drawn regarding causation because these concepts have previously been measured in different ways (e.g., Eckhard, 2018b; Mund et al., 2022; Zavaleta et al., 2017).

Both direct and indirect approaches are commonly used to measure loneliness, and each approach has different strengths and weaknesses (Mund et al., 2022; Office for National Statistics, 2018). Direct measures, which usually take the form of a single item, ask respondents directly how strongly or how frequently they feel lonely. This approach can lead to social desirability bias due to the stigma attached to loneliness. As a result, respondents may be reluctant to discuss their experiences of loneliness due to shame or fear of stigma. In contrast, indirect measures avoid using the term 'lonely' altogether and measure loneliness using multiple items that do not necessarily reflect the respondents' experiences of loneliness. Despite these differences, **Studies 2 and 4** showed that both measures of loneliness yielded very similar estimates of the effects of loneliness on general mental health, psychological distress, and life satisfaction. In general, evidence for the causation hypothesis was remarkably robust across both types of measurement. This finding is consistent with the conclusions of a recent study that analysed the psychometric features of different multi-item scales and single-item measures of loneliness (Mund et al., 2022). The results of that study showed that all measures of loneliness, including those that were analysed in this thesis, were highly correlated and similar in terms of their nomological network. **Studies 2 and 4** complemented this study by showing that direct and indirect measures also tend to produce very consistent results when only the within-individual variation is used to examine the effects of loneliness on mental health. Furthermore, no consensus has yet been reached regarding the definition of

social isolation, a research gap which is reflected in the diversity of measurement approaches (Eckhard, 2018b; Zavaleta et al., 2017). On the one hand, these approaches differ in terms of the aspects of social relationships that they stipulate must be lacking for a person to be classified as socially isolated. On the other hand, it is unclear how these aspects should be weighted and aggregated into an overall index of social isolation. Fortunately, in **Study 1**, the conclusions drawn regarding causation were similar for two measures of social isolation. One of the measures focused on close relationships with regular contact, while the other also took into account social and cultural participation.

6.2.4 Practical implications

Overall, these four empirical studies provide further evidence indicating that social isolation and loneliness entail significant risks to mental health. Importantly, the evidence found for the causation hypothesis was robust across population groups, measurement approaches, and model specifications. This finding has several practical implications. First, it indicates that concerns regarding the possibility that the COVID-19 pandemic could trigger a mental health crisis by increasing the prevalence of social isolation and loneliness in the general population were well founded. Fortunately, today, we know that most people adapted quickly to the new circumstances. For example, a meta-analysis of longitudinal studies of the development of mental health problems during the COVID-19 pandemic showed that levels of loneliness, anxiety, and depression increased briefly in May 2020 but approached pre-pandemic levels by June 2020 (Cénat et al., 2022). However, social isolation and loneliness are essential aspects of human existence (Cacioppo and Cacioppo, 2018a; Qualter et al., 2015). Therefore, they represented major challenges for society before the pandemic and will continue to do so in the future (Cacioppo and Cacioppo, 2018b). Second, the strong support for the causation hypothesis also highlights the critical importance of addressing social isolation and loneliness. Because of their high prevalence worldwide and their severe impacts on mental health, these conditions not only cause great human suffering but might also entail significant costs for health care systems (Meisters et al., 2021; Mihalopoulos et al., 2020). Fortunately, social isolation and loneliness can be targeted by effective interventions (Beckers et al., 2022; Zagic et al., 2022). These interventions target different mechanisms, such as improving social skills, increasing social support, providing opportunities for social contact, and addressing dysfunctional social cognition (Masi et al., 2011). In general, certain interventions seem to be effective with regard to improving social connections and reducing feelings of loneliness (Masi et al., 2011; Zagic et al., 2022). However, most of the evidence available on loneliness

interventions is from the USA, and less is known regarding the long-term effectiveness of such interventions (Beckers et al., 2022). In addition, most research has focused on interventions that target older people (Beckers et al., 2022), which is problematic because the findings of this thesis indicate that loneliness affects the mental health of both young people and older people. However, although the four empirical studies contained in this thesis found only small differences in the impacts of social isolation and loneliness on health across population groups, it is important to tailor interventions to specific target populations, as some interventions may be effective for one group but not for another.

6.3 Limitations and directions for further research

As is the case for all empirical research, the four studies contained in this thesis have some general limitations that must be addressed in future research. A first limitation pertains to the measurement of mental health. The studies used established and validated scales to measure mental health, such as the 12-item General Health Questionnaire (GHQ-12), the Short-Form Health Survey (SF-12), or the State-Trait Depression Scales (STDS). However, these measures are based on self-reports and tell us little about clinical diagnoses of specific mental disorders. For example, it is unclear whether people who received high scores on the STDS would meet the diagnostic criteria for major depression. It is therefore important for future research to include diagnostic interviews for specific disorders in the analysis of the negative impacts of social isolation and loneliness on mental health. In contrast, self-reports may be less problematic with regard to subjective well-being, which is by definition subjective and thus requires a subjective evaluation of one's own life. However, only the cognitive dimension of well-being (i.e., life satisfaction) could be analysed in **Study 4** because affective reactions to one's life (negative and positive affect) were not measured in the data. Therefore, future studies must examine the effects of loneliness on affective outcomes.

Second, the studies did not test the precise mechanisms underlying causation and the two types of selection. Instead, they used advanced methods of panel data analysis to investigate whether social isolation and loneliness were still associated with different mental health outcomes when selection was taken into account. As discussed, such associations were found consistently across studies, thus providing strong evidence for the causation hypothesis. However, an exploration of the relative importance of the psychosocial, behavioural, and biological factors described in Chapter 1.3 that might underlie the effects of social isolation and loneliness on mental health was beyond the scope of this thesis. Certainly, a systematic

investigation of these pathways would greatly advance the literature. In particular, identifying the precise mechanisms is not only essential to the task of advancing our theoretical understanding of the causal links between social isolation, loneliness, and mental health. Targeting these mechanisms may also increase the effectiveness of interventions aimed at preventing mental health problems in people who lack social connections. Furthermore, the four studies did not test the direct and indirect selection hypotheses directly. Selection processes were treated not as a phenomenon to be elucidated but rather as a statistical problem (i.e., a source of bias) to be addressed by statistical modelling. Nevertheless, a key contribution of this thesis was to theoretically identify the possible mechanisms underlying the potential tendency of people with mental health problems to be at higher risk of social isolation and loneliness. Future research should also test these mechanisms empirically. Understanding the precise pathways underlying selection is crucial for designing strategies to prevent social isolation and loneliness in people with mental illness.

Third, differential vulnerability to the adverse effects of social isolation and loneliness was examined only with respect to broader sociodemographic groups (i.e., men and women, younger and older people). Subgroup analyses were performed primarily to ensure the robustness of the evidence for the causation hypothesis. In particular, the fact that evidence for causation was found among both younger and older people was important because previous studies have been unable to confirm this hypothesis in older people. In contrast, the empirical studies contained in this thesis found only small differences between the population groups under study. In terms of differential vulnerability, future research should focus on exploring diathesis-stress models of mental illness. The theoretical idea underlying these models is that a stressor contributes to mental illness only in people with a high degree of vulnerability to developing such mental illness. This vulnerability may result from genetic, psychological, or behavioural factors. For example, in a study of adolescents, Vanhalst et al. (2012) showed that loneliness and depressive symptoms predicted each other, but only in adolescents with high scores on the personality trait of neuroticism. More research is needed to investigate diathesis-stress models using better-suited methods of panel data analysis. In addition, some research has hinted at a status-specific vulnerability that entails that social disconnection is more detrimental to mental health among socially disadvantaged people (Vonneilich, 2022). Therefore, if social isolation and loneliness are more common among socially disadvantaged people (Eckhard, 2018a; Pinquart and Sorensen, 2001) but also more damaging to mental health among these people, both conditions would qualify as powerful mechanisms underlying the emergence of social inequalities in mental health. In general, exploring differential

vulnerability to the adverse effects of social isolation and loneliness is crucial to the task of identifying vulnerable groups for whom interventions aimed at preventing social isolation and loneliness can be particularly effective and cost-effective.

Overall, this thesis further supports the claim that social isolation and loneliness entail substantial risks for mental health. Future research should seek to test the proposed mechanisms underlying causation and selection, to replicate the results of the empirical studies contained in this thesis by using other samples and methodological approaches, and to identify groups of people who are particularly vulnerable to the health risks associated with social disconnection. Until such research is conducted, social isolation and loneliness remain major challenges for contemporary societies, not only as unpleasant experiences that affect the lives of hundreds of millions of people but also as major topics of scientific inquiry.

References

Abdellaoui, A., Sanchez-Roige, S., Sealock, J., Treur, J.L., Dennis, J., Fontanillas, P., Elson, S., Nivard, M.G., Ip, H.F., van der Zee, M., Baselmans, B.M.L., Hottenga, J.J., Willemsen, G., Mosing, M., Lu, Y., Pedersen, N.L., Denys, D., Amin, N., van M Duijn, C., Szilagyi, I., Tiemeier, H., Neumann, A., Verweij, K.J.H., Cacioppo, S., Cacioppo, J.T., Davis, L.K., Palmer, A.A., Boomsma, D.I., 2019. Phenome-wide investigation of health outcomes associated with genetic predisposition to loneliness. Human Molecular Genetics 28, 3853–3865. https://doi.org/10.1093/hmg/ddz219.

Achat, H., Kawachi, I., Levine, S., Berkey, C., Coakley, E., Colditz, G., 1998. Social networks, stress and health-related quality of life. Quality of Life Research 7, 735–750. https://doi.org/10.1023/a:1008837002431.

Age UK, 2020. Measuring the prevalence of loneliness in England: Combining responses from a single-item direct loneliness question and the UCLA 3-item loneliness scale. https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/reports-and-briefings/loneliness/loneliness-measure-for-england.pdf (accessed 21 October 2023).

Allison, P.D., Williams, R., Moral-Benito, E., 2017. Maximum likelihood for cross-lagged panel models with fixed effects. Socius 3, 1–17. https://doi.org/10.1177/2378023117710578.

American Psychiatric Association, 2022. Diagnostic and statistical manual of mental disorders: DSM-5-TR. American Psychiatric Association Publishing, Washington DC.

Andersen, H.H., Mühlbacher, A., Nübling, M., Schupp, J., Wagner, G.G., 2007. Computation of standard values for physical and mental health scale scores using the SOEP version of SF-12v2. Schmollers Jahrbuch - Journal of Contextual Economics 127, 171–182.

Andersen, L.M.B., Rasmussen, A.N., Reavley, N.J., Bøggild, H., Overgaard, C., 2021. The social route to mental health: A systematic review and synthesis of theories linking social relationships to mental health to inform interventions. SSM - Mental Health 1, 100042. https://doi.org/10.1016/j.ssmmh.2021.100042.

Angermeyer, M.C., Matschinger, H., Schomerus, G., 2013. Attitudes towards psychiatric treatment and people with mental illness: Changes over two decades. The British Journal of Psychiatry 203, 146–151. https://doi.org/10.1192/bjp.bp.112.122978.

Badcock, J.C., Barkus, E., Cohen, A.S., Bucks, R., Badcock, D.R., 2016. Loneliness and schizotypy are distinct constructs, separate from general psychopathology. Frontiers in Psychology 7, 1018. https://doi.org/10.3389/fpsyg.2016.01018.

Barkus, E., 2021. The effects of anhedonia in social context. Current Behavioral Neuroscience Reports 8, 77–89. https://doi.org/10.1007/s40473-021-00232-x.

Barkus, E., Badcock, J.C., 2019. A transdiagnostic perspective on social anhedonia. Frontiers in Psychiatry 10, 216. https://doi.org/10.3389/fpsyt.2019.00216.

Bartels, M., 2015. Genetics of wellbeing and its components satisfaction with life, happiness, and quality of life: A review and meta-analysis of heritability studies. Behavior Genetics 45, 137–156. https://doi.org/10.1007/s10519-015-9713-y#Sec9.

Baselmans, B.M.L., van de Weijer, M.P., Abdellaoui, A., Vink, J.M., Hottenga, J.J., Willemsen, G., Nivard, M.G., Geus, E.J.C. de, Boomsma, D.I., Bartels, M., 2019. A genetic investigation of the well-being spectrum. Behavior Genetics 49, 286–297. https://doi.org/10.1007/s10519-019-09951-0.

Baumeister, R.F., Leary, M.R., 1995. The need to belong: Desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin 117, 497–529. https://doi.org/10.1037/0033-2909.117.3.497.

Baune, B.T., 2021. Cognitive dimensions of major depressive disorder: Clinical implications, assessment, and treatment. Oxford University Press, Oxford.

Beck, A.T., Rush, J.A., Shaw, B.F., Emery, G., 1979. Cognitive therapy of depression. The Guilford Press, New York.

Beckers, A., Buecker, S., Casabianca, E.J., Nurminen, M., 2022. Effectiveness of interventions tackling loneliness: A literature review. Publications Office of the European Union, Luxembourg (accessed 20 September 2023).

Berkman, L.F., Syme, S.L., 1979. Social networks, host resistance, and mortality: A nine-year follow-up study of Alameda County residents. American Journal of Epidemiology 109, 186–204. https://doi.org/10.1093/oxfordjournals.aje.a112674.

Beutel, M.E., Brähler, E., Wiltink, J., Kerahrodi, J.G., Burghardt, J., Michal, M., Schulz, A., Wild, P.S., Münzel, T., Schmidtmann, I., Lackner, K.J., Pfeiffer, N., Borta, A., Tibubos, A.N., 2019. New onset of depression in aging women and men: contributions of social, psychological, behavioral, and somatic predictors in the community. Psychological Medicine 49, 1148–1155. https://doi.org/10.1017/S0033291718001848.

Blane, D., Smith, G.D., Bartley, M., 1993. Social selection: What does it contribute to social class differences in health? Sociology of Health & Illness 15, 1–15. https://doi.org/10.1111/j.1467-9566.1993.tb00328.x.

Bollen, K.A., Brand, J.E., 2010. A general panel model with random and fixed effects: A structural equations approach. Social Forces 89, 1–34. https://doi.org/10.1353/sof.2010.0072.

Boyd, J.E., Muñoz López, M., González-Sanguino, C., Harris, J.I., Sampson, I.T., 2022. Consequences of the self-stigma of mental illness, in: Vogel, D.L., Wade, N.G. (Eds.), The Cambridge Handbook of Stigma and Mental Health. Cambridge University Press, pp. 88–110.

Braga, T., Cunha, O., Maia, Â., 2018. The enduring effect of maltreatment on antisocial behavior: A meta-analysis of longitudinal studies. Aggression and Violent Behavior 40, 91–100. https://doi.org/10.1016/j.avb.2018.04.003.

Bralten, J., Mota, N.R., Klemann, C.J.H.M., De Witte, W., Laing, E., Collier, D.A., de Kluiver, H., Bauduin, S.E.E.C., Arango, C., Ayuso-Mateos, J.L., Fabbri, C., Kas, M.J., van der Wee, N., Penninx, B.W.J.H., Serretti, A., Franke, B., Poelmans, G., 2021. Genetic underpinnings of sociability in the general population. Neuropsychopharmacology 46, 1627–1634. https://doi.org/10.1038/s41386-021-01044-z.

Brodeur, A., Clark, A.E., Fleche, S., Powdthavee, N., 2021. COVID-19, lockdowns and well-being: evidence from Google trends. Journal of Public Economics 193, 104346. https://doi.org/10.1016/j.jpubeco.2020.104346.

Brown, L.H., Silvia, P.J., Myin-Germeys, I., Kwapil, T.R., 2007. When the need to belong goes wrong: The expression of social anhedonia and social anxiety in daily life. Psychological Science 18, 778–782. https://doi.org/10.1111/j.1467-9280.2007.01978.x.

Brüderl, J., Drobnič, S., Hank, K., Neyer, F.J., Walper, S., Alt, P., Borschel, E., Bozoyan, C., Garrett, M., Geissler, S., Gonzalez Avilés, T., Gröpler, N., Hajek, K., Herzig, M., Lenke, R., Lorenz, R., Lutz, K., Peter, T., Preetz, R., Reim, J., Sawatzki, B., Schmiedeberg, C., Schütze, P., Schumann, N., Thönnissen, C., Timmermann, K., Wetzel, M., 2022. The German Family Panel (pairfam): GESIS Data Archive, Cologne. ZA5678 Data file Version 13.0.0. https://doi.org/10.4232/pairfam.5678.13.0.0.

Brüderl, J., Ludwig, V., 2015. Fixed-effects panel regression, in: Best, H., Wolf, C. (Eds.), The SAGE Handbook of Regression Analysis and Causal Inference. SAGE Publications Ltd, Los Angeles, pp. 327–357.

Buecker, S., Maes, M., Denissen, J.J.A., Luhmann, M., 2020. Loneliness and the Big Five personality traits: A meta–analysis. European Journal of Personality 34, 8–28. https://doi.org/10.1002/per.2229.

Cacioppo, J.T., Cacioppo, S., 2018a. Loneliness in the modern age: An evolutionary theory of loneliness (ETL). Advances in Experimental Social Psychology 58, 127–197. https://doi.org/10.1016/bs.aesp.2018.03.003.

Cacioppo, J.T., Cacioppo, S., 2018b. The growing problem of loneliness. The Lancet 391, 426. https://doi.org/10.1016/S0140-6736(18)30142-9.

Cacioppo, J.T., Cacioppo, S., Boomsma, D.I., 2014. Evolutionary mechanisms for loneliness. Cognition & Emotion 28, 3–21. https://doi.org/10.1080/02699931.2013.837379.

Cacioppo, J.T., Cacioppo, S., Capitanio, J.P., Cole, S.W., 2015. The neuroendocrinology of social isolation. Annual Review of Psychology 66, 733–767. https://doi.org/10.1146/annurev-psych-010814-015240.

Cacioppo, J.T., Hawkley, L.C., 2009. Perceived social isolation and cognition. Trends in cognitive sciences 13, 447–454. https://doi.org/10.1016/j.tics.2009.06.005.

Cacioppo, J.T., Hawkley, L.C., Ernst, J.M., Burleson, M.H., Berntson, G.G., Nouriani, B., Spiegel, D., 2006. Loneliness within a nomological net: An evolutionary perspective. Journal of Research in Personality 40, 1054–1085. https://doi.org/10.1016/j.jrp.2005.11.007.

Cacioppo, J.T., Hawkley, L.C., Kalil, A., Hughes, M.E., Waite, L.J., Thisted, R.A., 2008. Happiness and the invisible threads of social connection: The Chicago Health, Aging, and Social Relations Study, in: Eid, M., Larsen, R.J. (Eds.), The Science of Subjective Well-Being. The Guilford Press, New York, London, pp. 195–219.

Cacioppo, J.T., Hawkley, L.C., Thisted, R.A., 2010. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. Psychology and Aging 25, 453–463. https://doi.org/10.1037/a0017216.

Calati, R., Ferrari, C., Brittner, M., Oasi, O., Olié, E., Carvalho, A.F., Courtet, P., 2019. Suicidal thoughts and behaviors and social isolation: A narrative review of the literature. Journal of Affective Disorders 245, 653–667. https://doi.org/10.1016/j.jad.2018.11.022.

Cambridge, O.R., Knight, M.J., Mills, N., Baune, B.T., 2018. The clinical relationship between cognitive impairment and psychosocial functioning in major depressive disorder: A systematic review. Psychiatry Research 269, 157–171. https://doi.org/10.1016/j.psychres.2018.08.033.

Cao, H., Ma, R., Li, X., Liang, Y., Wu, Q., Chi, P., Li, J.-B., Zhou, N., 2022. Childhood emotional maltreatment and adulthood romantic relationship well-being: A multilevel, meta-analytic review. Trauma, Violence & Abuse 23, 778–794. https://doi.org/10.1177/1524838020975895.

Carr, A., Duff, H., Craddock, F., 2020. A systematic review of reviews of the outcome of noninstitutional child maltreatment. Trauma, Violence & Abuse 21, 828–843. https://doi.org/10.1177/1524838018801334.

Caunt, B.S., Franklin, J., Brodaty, N.E., Brodaty, H., 2013. Exploring the causes of subjective well-being: A content analysis of peoples' recipes for long-term happiness. Journal of Happiness Studies 14, 475–499. https://doi.org/10.1007/s10902-012-9339-1.

Cénat, J.M., Farahi, S.M.M.M., Dalexis, R.D., Darius, W.P., Bekarkhanechi, F.M., Poisson, H., Broussard, C., Ukwu, G., Auguste, E., Nguyen, D.D., Sehabi, G., Furyk, S.E., Gedeon, A.P., Onesi, O., El Aouame, A.M., Khodabocus, S.N., Shah, M.S., Labelle, P.R., 2022. The global evolution of mental health problems during the COVID-19 pandemic: A systematic review and meta-analysis of longitudinal studies. Journal of Affective Disorders 315, 70–95. https://doi.org/10.1016/j.jad.2022.07.011.

Cheung, F., Lucas, R.E., 2014. Assessing the validity of single-item life satisfaction measures: results from three large samples. Quality of Life Research 23, 2809–2818. https://doi.org/10.1007/s11136-014-0726-4.

Chrostek, A., Grygiel, P., Anczewska, M., Wciórka, J., Świtaj, P., 2016. The intensity and correlates of the feelings of loneliness in people with psychosis. Comprehensive Psychiatry 70, 190–199. https://doi.org/10.1016/j.comppsych.2016.07.015.

Cohen, S., Wills, T.A., 1985. Stress, social support, and the buffering hypothesis. Psychological Bulletin 98, 310–357. https://doi.org/10.1037/0033-2909.98.2.310.

Cornwell, E.Y., Waite, L.J., 2009. Social disconnectedness, perceived isolation, and health among older adults. Journal of Health and Social Behavior 50, 31–48. https://doi.org/10.1177/002214650905000103.

Corrigan, P.W., Bink, A.B., Schmidt, A., Jones, N., Rüsch, N., 2016. What is the impact of self-stigma? Loss of self-respect and the "why try" effect. Journal of Mental Health 25, 10–15. https://doi.org/10.3109/09638237.2015.1021902.

Corrigan, P.W., Larson, J.E., Rüsch, N., 2009. Self-stigma and the "why try" effect: Impact on life goals and evidence-based practices. World Psychiatry 8, 75–81. https://doi.org/10.1002/j.2051-5545.2009.tb00218.x.

Cotter, J., Granger, K., Backx, R., Hobbs, M., Looi, C.Y., Barnett, J.H., 2018. Social cognitive dysfunction as a clinical marker: A systematic review of meta-analyses across 30 clinical conditions. Neuroscience and Biobehavioral Reviews 84, 92–99. https://doi.org/10.1016/j.neubiorev.2017.11.014.

Cougle, J.R., Fitch, K.E., Fincham, F.D., Riccardi, C.J., Keough, M.E., Timpano, K.R., 2012. Excessive reassurance seeking and anxiety pathology: Tests of incremental associations and directionality. Journal of Anxiety Disorders 26, 117–125. https://doi.org/10.1016/j.janxdis.2011.10.001.

Coyle, C.E., Dugan, E., 2012. Social isolation, loneliness and health among older adults. Journal of Aging and Health 24, 1346–1363. https://doi.org/10.1177/0898264312460275.

Coyne, J.C., 1976. Toward an interactional description of depression. Psychiatry 39, 28–40. https://doi.org/10.1080/00332747.1976.11023874.

Cross, S.E., Madson, L., 1997. Models of the self: Self-construals and gender. Psychological Bulletin 122, 5–37. https://doi.org/10.1037/0033-2909.122.1.5.

Curran, P.J., Howard, A.L., Bainter, S.A., Lane, S.T., McGinley, J.S., 2014. The separation of between-person and within-person components of individual change over time: A latent curve model with structured residuals. Journal of Consulting and Clinical Psychology 82, 879–894. https://doi.org/10.1037/a0035297.

Danneel, S., Nelemans, S.A., Spithoven, A.W.M., Bastin, M., Bijttebier, P., Colpin, H., van den Noortgate, W., van Leeuwen, K., Verschueren, K., Goossens, L., 2019. Internalizing problems in adolescence: Linking loneliness, social anxiety symptoms, and depressive symptoms over time. Journal of Abnormal Child Psychology 47, 1691–1705. https://doi.org/10.1007/s10802-019-00539-0.

Day, F.R., Ong, K.K., Perry, J.R.B., 2018. Elucidating the genetic basis of social interaction and isolation. Nature Communications 9, 2457. https://doi.org/10.1038/s41467-018-04930-1.

de Heer, C., Bi, S., Finkenauer, C., Alink, L.R.A., Maes, M., 2022. The association between child maltreatment and loneliness across the lifespan: A systematic review and multilevel meta-analysis. Child Maltreatment, OnlineFirst. https://doi.org/10.1177/10775595221103420.

De Jong Gierveld, J., van Tilburg, T., Dykstra, P.A., 2012. Loneliness and social isolation, in: Vangelisti, A.L., Perlman, D. (Eds.), The Cambridge Handbook of Personal Relationships. Cambridge University Press, pp. 485–500.

Del Rosal, E., González-Sanguino, C., Bestea, S., Boyd, J.E., Muñoz, M., 2021. Correlates and consequences of internalized stigma assessed through the Internalized Stigma of Mental Illness Scale for people living with mental illness: A scoping review and meta-analysis from 2010. Stigma and Health 6, 324–334. https://doi.org/10.1037/sah0000267.

Delerue Matos, A., Barbosa, F., Cunha, C., Voss, G., Correia, F., 2021. Social isolation, physical inactivity and inadequate diet among European middle-aged and older adults. BMC Public Health 21, 924. https://doi.org/10.1186/s12889-021-10956-w.

DeNeve, K.M., Cooper, H., 1998. The happy personality: A meta-analysis of 137 personality traits and subjective well-being. Psychological Bulletin 124, 197–229. https://doi.org/10.1037/0033-2909.124.2.197.

Dieckhoff, M., Gash, V., 2015. Unemployed and alone? Unemployment and social participation in Europe. International Journal of Sociology and Social Policy 35, 67–90. https://doi.org/10.1108/IJSSP-01-2014-0002.

Diener, E., 1984. Subjective well-being. Psychological Bulletin 95, 542–575. https://doi.org/10.1037/0033-2909.95.3.542.

Diener, E., Lucas, R.E., Oishi, S., 2018. Advances and open questions in the science of subjective well-being. Collabra: Psychology 4. https://doi.org/10.1525/collabra.115.

Diener, E., Napa-Scollon, C.K., Oishi, S., Dzokoto, V., Suh, E.M., 2000. Positivity and the construction of life satisfaction judgments: Global happiness is not the sum of its parts. Journal of Happiness Studies 1, 159–176. https://doi.org/10.1023/A:1010031813405.

Diener, E., Seligman, M.E.P., 2002. Very happy people. Psychological Science 13, 81–84. https://doi.org/10.1111/1467-9280.00415.

Domènech-Abella, J., Mundó, J., Switsers, L., van Tilburg, T., Fernández, D., Aznar-Lou, I., 2021. Social network size, loneliness, physical functioning and depressive symptoms among older adults: Examining reciprocal associations in four waves of the Longitudinal Aging Study Amsterdam (LASA). International Journal of Geriatric Psychiatry 36, 1541–1549. https://doi.org/10.1002/gps.5560.

Dunn, C., Sicouri, G., 2022. The relationship between loneliness and depressive symptoms in children and adolescents: A meta-analysis. Behaviour Change 39, 134–145. https://doi.org/10.1017/bec.2022.13.

East-Richard, C., R.-Mercier, A., Nadeau, D., Cellard, C., 2020. Transdiagnostic neurocognitive deficits in psychiatry: A review of meta-analyses. Canadian Psychology / Psychologie canadienne 61, 190–214. https://doi.org/10.1037/cap0000196.

Eckhard, J., 2018a. Does poverty increase the risk of social isolation? Insights based on panel data from Germany. The Sociological Quarterly 59, 338–359. https://doi.org/10.1080/00380253.2018.1436943.

Eckhard, J., 2018b. Indicators of social isolation: A comparison based on survey data from Germany. Social Indicators Research 139, 963–988. https://doi.org/10.1007/s11205-017-1741-y.

Eckhard, J., 2021. Social isolation as a consequence of poverty – An international comparison. Unpublished manuscript. Heidelberg University.

Eckhard, J., 2022. Gender differences in the social consequences of unemployment: How job loss affects the risk of becoming socially isolated. Work, Employment and Society 36, 3–20. https://doi.org/10.1177/0950017020967903.

Enders, C., Bandalos, D., 2001. The relative performance of full information maximum likelihood estimation for missing data in structural equation models. Structural Equation Modeling: A Multidisciplinary Journal 8, 430–457. https://doi.org/10.1207/S15328007SEM0803_5.

Erzen, E., Çikrikci, Ö., 2018. The effect of loneliness on depression: A meta-analysis. The International Journal of Social Psychiatry 64, 427–435. https://doi.org/10.1177/0020764018776349.

Eurostat, 2018. Living conditions in Europe - 2018 edition. Publications Office of the European Union, Luxembourg.

Everaert, J., Podina, I.R., Koster, E.H.W., 2017. A comprehensive meta-analysis of interpretation biases in depression. Clinical Psychology Review 58, 33–48. https://doi.org/10.1016/j.cpr.2017.09.005.

Everaert, J., Vrijsen, J.N., Martin-Willett, R., van de Kraats, L., Joormann, J., 2022. A meta-analytic review of the relationship between explicit memory bias and depression: Depression features an explicit memory bias that persists beyond a depressive episode. Psychological Bulletin 148, 435–463. https://doi.org/10.1037/bul0000367.

Evraire, L.E., Dozois, D.J.A., 2011. An integrative model of excessive reassurance seeking and negative feedback seeking in the development and maintenance of depression. Clinical Psychology Review 31, 1291–1303. https://doi.org/10.1016/j.cpr.2011.07.014.

Fakoya, O.A., McCorry, N.K., Donnelly, M., 2020. Loneliness and social isolation interventions for older adults: A scoping review of reviews. BMC Public Health 20, 129. https://doi.org/10.1186/s12889-020-8251-6.

Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, 2023. Diskussionspapier "Auf dem Weg zu einer Strategie der Bundesregierung gegen Einsamkeit" - Entwurf. [Discussion Paper "Towards a federal government strategy against loneliness" - Draft]. https://kompetenznetz-einsamkeit.de/ankuendigung-veroeffentlichung-des-diskussionspapiers (accessed 21 October 2023).

Firth, J., Solmi, M., Wootton, R.E., Vancampfort, D., Schuch, F.B., Hoare, E., Gilbody, S., Torous, J., Teasdale, S.B., Jackson, S.E., Smith, L., Eaton, M., Jacka, F.N., Veronese, N., Marx, W., Ashdown-Franks, G., Siskind, D., Sarris, J., Rosenbaum, S., Carvalho, A.F., Stubbs, B., 2020. A meta-review of "lifestyle psychiatry": The role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. World Psychiatry 19, 360–380. https://doi.org/10.1002/wps.20773.

Fitton, L., Yu, R., Fazel, S., 2020. Childhood maltreatment and violent outcomes: A systematic review and meta-analysis of prospective studies. Trauma, Violence & Abuse 21, 754–768. https://doi.org/10.1177/1524838018795269.

Flensborg-Madsen, T., Tolstrup, J., Sørensen, H.J., Mortensen, E.L., 2012. Social and psychological predictors of onset of anxiety disorders: Results from a large prospective cohort study. Social Psychiatry and Psychiatric Epidemiology 47, 711–721. https://doi.org/10.1007/s00127-011-0373-9.

Foverskov, E., Holm, A., 2016. Socioeconomic inequality in health in the British household panel: Tests of the social causation, health selection and the indirect selection hypothesis using dynamic fixed effects panel models. Social Science & Medicine 150, 172–183. https://doi.org/10.1016/j.socscimed.2015.12.021.

Frayling, T.M., 2014. Genome-wide association studies: The good, the bad and the ugly. Clinical Medicine 14, 428–431. https://doi.org/10.7861/clinmedicine.14-4-428.

Gadassi, R., Rafaeli, E., 2015. Interpersonal perception as a mediator of the depression–interpersonal difficulties link: A review. Personality and Individual Differences 87, 1–7. https://doi.org/10.1016/j.paid.2015.07.023.

Gandhi, A., Mote, J., Fulford, D., 2022. A transdiagnostic meta-analysis of physical and social anhedonia in major depressive disorder and schizophrenia spectrum disorders. Psychiatry Research 309, 114379. https://doi.org/10.1016/j.psychres.2021.114379.

Gao, J., Davis, L.K., Hart, A.B., Sanchez-Roige, S., Han, L., Cacioppo, J.T., Palmer, A.A., 2017a. Genome-wide association study of loneliness demonstrates a role for common variation. Neuropsychopharmacology 42, 811–821. https://doi.org/10.1038/npp.2016.197.

Gao, S., Assink, M., Cipriani, A., Lin, K., 2017b. Associations between rejection sensitivity and mental health outcomes: A meta-analytic review. Clinical Psychology Review 57, 59–74. https://doi.org/10.1016/j.cpr.2017.08.007.

Gardner, M.J., Thomas, H.J., Erskine, H.E., 2019. The association between five forms of child maltreatment and depressive and anxiety disorders: A systematic review and meta-analysis. Child Abuse & Neglect 96, 104082. https://doi.org/10.1016/j.chiabu.2019.104082.

GBD 2019 Mental Disorders Collaborators, 2022. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: A systematic analysis for the Global Burden of Disease Study 2019. The Lancet Psychiatry 9, 137–150. https://doi.org/10.1016/S2215-0366(21)00395-3.

Gill, S.C., Butterworth, P., Rodgers, B., Mackinnon, A., 2007. Validity of the mental health component scale of the 12-item Short-Form Health Survey (MCS-12) as measure of common mental disorders in the general population. Psychiatry Research 152, 63–71. https://doi.org/10.1016/j.psychres.2006.11.005.

Goldberg, D.P., 1972. The detection of psychiatric illness by questionnaire. Oxford University Press, London.

Gordon, A.M., Carrillo, B., Barnes, C.M., 2021. Sleep and social relationships in healthy populations: A systematic review. Sleep Medicine Reviews 57, 101428. https://doi.org/10.1016/j.smrv.2021.101428.

Gotlib, I.H., Joormann, J., 2010. Cognition and depression: Current status and future directions. Annual Review of Clinical Psychology 6, 285–312. https://doi.org/10.1146/annurev.clinpsy.121208.131305.

Graham, J.W., 2003. Adding missing-data-relevant variables to FIML-based structural equation models. Structural Equation Modeling: A Multidisciplinary Journal 10, 80–100. https://doi.org/10.1207/S15328007SEM1001_4.

Griffin, S.C., Blakey, S.M., Brant, T.R., Eshera, Y.M., Calhoun, P.S., 2022. Disentangling the longitudinal relationship between loneliness and depressive symptoms in U.S. adults over 50. Clinical Gerontologist, 1–13. https://doi.org/10.1080/07317115.2022.2147115.

Groarke, J.M., McGlinchey, E., McKenna-Plumley, P.E., Berry, E., Graham-Wisener, L., Armour, C., 2021. Examining temporal interactions between loneliness and depressive symptoms and the mediating role of emotion regulation difficulties among UK residents during the COVID-19 lockdown: Longitudinal results from the COVID-19 psychological

wellbeing study. Journal of Affective Disorders 285, 1–9. https://doi.org/10.1016/j.jad.2021.02.033.

Hagenaars, A.J., Vos, K. de, Zaidi, M.A., 1994. Poverty statistics in the late 1980s: Research based on micro-data. Office for Official Publications of the European Communities, Luxembourg.

Hakulinen, C., Elovainio, M., Arffman, M., Lumme, S., Pirkola, S., Keskimäki, I., Manderbacka, K., Böckerman, P., 2019a. Mental disorders and long-term labour market outcomes: Nationwide cohort study of 2,055,720 individuals. Acta Psychiatrica Scandinavica 140, 371–381. https://doi.org/10.1111/acps.13067.

Hakulinen, C., Musliner, K.L., Agerbo, E., 2019b. Bipolar disorder and depression in early adulthood and long-term employment, income, and educational attainment: A nationwide cohort study of 2,390,127 individuals. Depression and Anxiety 36, 1080–1088. https://doi.org/10.1002/da.22956.

Hamaker, E.L., Kuiper, R.M., Grasman, R.P.P.P., 2015. A critique of the cross-lagged panel model. Psychological Methods 20, 102–116. https://doi.org/10.1037/a0038889.

Hames, J.L., Hagan, C.R., Joiner, T.E., 2013. Interpersonal processes in depression. Annual Review of Clinical Psychology 9, 355–377. https://doi.org/10.1146/annurev-clinpsy-050212-185553.

Hammen, C.L., 2006. Stress generation in depression: Reflections on origins, research, and future directions. Journal of Clinical Psychology 62, 1065–1082. https://doi.org/10.1002/jclp.20293.

Harris, K., Vazire, S., 2016. On friendship development and the Big Five personality traits. Social and Personality Psychology Compass 10, 647–667. https://doi.org/10.1111/spc3.12287.

Hawkley, L.C., Buecker, S., Kaiser, T., Luhmann, M., 2022. Loneliness from young adulthood to old age: Explaining age differences in loneliness. International Journal of Behavioral Development 46, 39–49. https://doi.org/10.1177/0165025420971048.

Hawkley, L.C., Cacioppo, J.T., 2010. Loneliness matters: A theoretical and empirical review of consequences and mechanisms. Annals of Behavioral Medicine 40, 218–227. https://doi.org/10.1007/s12160-010-9210-8.

Hawkley, L.C., Preacher, K.J., Cacioppo, J.T., 2010. Loneliness impairs daytime functioning but not sleep duration. Health Psychology 29, 124–129. https://doi.org/10.1037/a0018646.

Hawkley, L.C., Thisted, R.A., Cacioppo, J.T., 2009. Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. Health Psychology 28, 354–363. https://doi.org/10.1037/a0014400.

Hawton, A., Green, C., Dickens, A.P., Richards, S.H., Taylor, R.S., Edwards, R., Greaves, C.J., Campbell, J.L., 2011. The impact of social isolation on the health status and health-related quality of life of older people. Quality of Life Research 20, 57–67. https://doi.org/10.1007/s11136-010-9717-2.

Headey, B., 2014. Bottom-up versus top-down theories of life satisfaction, in: Michalos, A.C. (Ed.), Encyclopedia of quality of life and well-being research. Springer, Dordrecht, pp. 423–426.

Heinrich, L.M., Gullone, E., 2006. The clinical significance of loneliness: A literature review. Clinical Psychology Review 26, 695–718. https://doi.org/10.1016/j.cpr.2006.04.002.

Heintzelman, S.J., Diener, E., 2019. Subjective well-being, social interpretation, and relationship thriving. Journal of Research in Personality 78, 93–105. https://doi.org/10.1016/j.jrp.2018.11.007.

Herbolsheimer, F., Ungar, N., Peter, R., 2018. Why is social isolation among older adults associated with depressive symptoms? The mediating role of out-of-home physical activity. International Journal of Behavioral Medicine 25, 649–657. https://doi.org/10.1007/s12529-018-9752-x.

Heritage, Z., Wilkinson, R.G., Grimaud, O., Pickett, K.E., 2008. Impact of social ties on self reported health in France: Is everyone affected equally? BMC Public Health 8, 243. https://doi.org/10.1186/1471-2458-8-243.

Heyns, C., Jewkes, R., Liebenberg, S., Mbazira, C., 2021. The hidden crisis: Mental health on times of COVID-19: Proceedings report. https://www.leopoldina.org/en/publications/detailview/publication/the-hidden-crisis-mental-health-in-times-of-covid-19-2021/ (accessed 21 October 2023).

Holt-Lunstad, J., 2017. The potential public health relevance of social isolation and loneliness: Prevalence, epidemiology, and risk factors. Public Policy & Aging Report 27, 127–130. https://doi.org/10.1093/ppar/prx030.

Holt-Lunstad, J., 2021. A pandemic of social isolation? World Psychiatry 20, 55–56. https://doi.org/10.1002/wps.20839.

Holt-Lunstad, J., Robles, T.F., Sbarra, D.A., 2017. Advancing social connection as a public health priority in the United States. The American Psychologist 72, 517–530. https://doi.org/10.1037/amp0000103.

Holt-Lunstad, J., Smith, T.B., Baker, M., Harris, T., Stephenson, D., 2015. Loneliness and social isolation as risk factors for mortality: A meta-analytic review. Perspectives on Psychological Science 10, 227–237. https://doi.org/10.1177/1745691614568352.

Holt-Lunstad, J., Smith, T.B., Layton, J.B., 2010. Social relationships and mortality risk: A meta-analytic review. PLOS Medicine 7, e1000316. https://doi.org/10.1371/journal.pmed.1000316.

Hölzel, L., Härter, M., Reese, C., Kriston, L., 2011. Risk factors for chronic depression — A systematic review. Journal of Affective Disorders 129, 1–13. https://doi.org/10.1016/j.jad.2010.03.025.

Hom, M.A., Chu, C., Rogers, M.L., Joiner, T.E., 2020. A meta-analysis of the relationship between sleep problems and loneliness. Clinical Psychological Science 8, 799–824. https://doi.org/10.1177/2167702620922969.

Houtjes, W., Deeg, D., van de Ven, P.M., van Meijel, B., van Tilburg, T., Beekman, A.T.F., 2017. Is the naturalistic course of depression in older people related to received support over time? Results from a longitudinal population-based study. International Journal of Geriatric Psychiatry 32, 657–663. https://doi.org/10.1002/gps.4508.

Houtjes, W., van Meijel, B., van de Ven, P.M., Deeg, D., van Tilburg, T., Beekman, A.T.F., 2014. The impact of an unfavorable depression course on network size and loneliness in older people: A longitudinal study in the community. International Journal of Geriatric Psychiatry 29, 1010–1017. https://doi.org/10.1002/gps.4091.

Hughes, M.E., Waite, L.J., Hawkley, L.C., Cacioppo, J.T., 2004. A short scale for measuring loneliness in large surveys: Results from two population-based studies. Research on Aging 26, 655–672. https://doi.org/10.1177/0164027504268574.

Huinink, J., Brüderl, J., Nauck, B., Walper, S., Castiglioni, L., Feldhaus, M., 2011. Panel Analysis of Intimate Relationships and Family Dynamics (pairfam): Conceptual framework and design. Journal of Family Research 23, 77–101. https://doi.org/10.20377/jfr-235.

Hyde, J.S., Mezulis, A.H., 2020. Gender differences in depression: Biological, affective, cognitive, and sociocultural factors. Harvard Review of Psychiatry 28, 4–13. https://doi.org/10.1097/HRP.0000000000000230.

Institute for Social and Economic Research, 2022a. Understanding Society Main Study changes due to the COVID-19 pandemic (Wave 12 release). University of Essex, Colchester.

Institute for Social and Economic Research, 2022b. Understanding Society: Waves 1-12, 2009-2021 and Harmonised BHPS: Waves 1-18, 1991-2009. 7th Edition. UK Data Service. SN: 6614. https://doi.org/10.5255/UKDA-SN-6614-18.

Institute for Social and Economic Research, 2022c. Understanding Society: Waves 1-12, 2009-2021 and Harmonised BHPS: Waves 1-18, 1991-2009, User Guide, 14 November 2022. University of Essex, Colchester.

Jeronimus, B.F., Kotov, R., Riese, H., Ormel, J., 2016. Neuroticism's prospective association with mental disorders halves after adjustment for baseline symptoms and psychiatric history, but the adjusted association hardly decays with time: A meta-analysis on 59 longitudinal/prospective studies with 443 313 participants. Psychological Medicine 46, 2883–2906. https://doi.org/10.1017/S0033291716001653.

Joiner, T.E., Metalsky, G.I., Katz, J., Beach, S.R.H., 1999. Depression and excessive reassurance-seeking. Psychological Inquiry 10, 269–278. https://doi.org/10.1207/S15327965PLI1004_1.

Joshanloo, M., 2022. The longitudinal interplay of depressive symptoms and loneliness: Causal effects work in both directions and decay to zero before six years. Aging & Mental Health 26, 1106–1111. https://doi.org/10.1080/13607863.2021.1897521.

Kansky, J., Diener, E., 2017. Benefits of well-being: health, social relationships, work, and resilience. Journal of Positive Psychology and Wellbeing 1, 129–169.

Karraker, A., Latham, K., 2015. In sickness and in health? Physical illness as a risk factor for marital dissolution in later life. Journal of Health and Social Behavior 56, 420–435. https://doi.org/10.1177/0022146515596354.

Khazanov, G.K., Ruscio, A.M., 2016. Is low positive emotionality a specific risk factor for depression? A meta-analysis of longitudinal studies. Psychological Bulletin 142, 991–1015. https://doi.org/10.1037/bul0000059.

Kiely, K.M., Sutherland, G., Butterworth, P., Reavley, N.J., 2021. Age and gender differences in the reciprocal relationship between social connectedness and mental health. Social Psychiatry and Psychiatric Epidemiology 56, 1069–1081. https://doi.org/10.1007/s00127-020-01960-3.

Kim, S., Thibodeau, R., Jorgensen, R.S., 2011. Shame, guilt, and depressive symptoms: A meta-analytic review. Psychological Bulletin 137, 68–96. https://doi.org/10.1037/a0021466.

Koh, J.X., Liew, T.M., 2022. How loneliness is talked about in social media during COVID-19 pandemic: Text mining of 4,492 Twitter feeds. Journal of Psychiatric Research 145, 317–324. https://doi.org/10.1016/j.jpsychires.2020.11.015.

Kotov, R., Gamez, W., Schmidt, F., Watson, D., 2010. Linking "big" personality traits to anxiety, depressive, and substance use disorders: A meta-analysis. Psychological Bulletin 136, 768–821. https://doi.org/10.1037/a0020327.

Kreyenfeld, M., Huinink, J., Trappe, H., Walke, R., 2012. DemoDiff: A dataset for the study of family change in Eastern (and Western) Germany. Schmollers Jahrbuch 132, 653–660. https://doi.org/10.3790/schm.132.4.653.

Kristensen, S.M., Urke, H.B., Larsen, T.B., Danielsen, A.G., 2022. Hello darkness, my old friend: Moderating a random intercept cross-lagged panel model of loneliness and symptoms of anxiety and depression. Research on Child and Adolescent Psychopathology. https://doi.org/10.1007/s10802-022-00995-1.

Kröger, H., Pakpahan, E., Hoffmann, R., 2015. What causes health inequality? A systematic review on the relative importance of social causation and health selection. European Journal of Public Health 25, 951–960. https://doi.org/10.1093/eurpub/ckv111.

Krohne, H.W., Schmukle, S.C., Spaderna, H., Spielberger, C.D., 2002. The State-Trait Depression Scales: An international comparison. Anxiety, Stress & Coping 15, 105–122. https://doi.org/10.1080/10615800290028422.

Kuiper, J.S., Zuidersma, M., Oude Voshaar, R.C., Zuidema, S.U., van den Heuvel, E.R., Stolk, R.P., Smidt, N., 2015. Social relationships and risk of dementia: A systematic review and meta-analysis of longitudinal cohort studies. Ageing Research Reviews 22, 39–57. https://doi.org/10.1016/j.arr.2015.04.006.

Kuiper, J.S., Zuidersma, M., Zuidema, S.U., Burgerhof, J.G., Stolk, R.P., Oude Voshaar, R.C., Smidt, N., 2016. Social relationships and cognitive decline: A systematic review and meta-analysis of longitudinal cohort studies. International Journal of Epidemiology 45, 1169–1206. https://doi.org/10.1093/ije/dyw089.

Kuiper, R.M., Ryan, O., 2018. Drawing conclusions from cross-lagged relationships: Re-considering the role of the time-interval. Structural Equation Modeling: A Multidisciplinary Journal 25, 809–823. https://doi.org/10.1080/10705511.2018.1431046.

Kupferberg, A., Bicks, L., Hasler, G., 2016. Social functioning in major depressive disorder. Neuroscience and Biobehavioral Reviews 69, 313–332. https://doi.org/10.1016/j.neubiorev.2016.07.002.

Kwapil, T.R., Silvia, P.J., Myin-Germeys, I., Anderson, A.J., Coates, S.A., Brown, L.H., 2009. The social world of the socially anhedonic: Exploring the daily ecology of asociality. Journal of Research in Personality 43, 103–106. https://doi.org/10.1016/j.jrp.2008.10.008.

Kwong, A.S.F., Morris, T.T., Pearson, R.M., Timpson, N.J., Rice, F., Stergiakouli, E., Tilling, K., 2021. Polygenic risk for depression, anxiety and neuroticism are associated with the severity and rate of change in depressive symptoms across adolescence. Journal of Child Psychology and Psychiatry, and Allied Disciplines 62, 1462–1474. https://doi.org/10.1111/jcpp.13422.

Lambert, N.M., Stillman, T.F., Hicks, J.A., Kamble, S., Baumeister, R.F., Fincham, F.D., 2013. To belong is to matter: Sense of belonging enhances meaning in life. Personality & Social Psychology Bulletin 39, 1418–1427. https://doi.org/10.1177/0146167213499186.

Langenkamp, A., 2023. The influence of loneliness on perceived connectedness and trust beliefs – Longitudinal evidence from the Netherlands. Journal of Social and Personal Relationships 40, 2298–2322. https://doi.org/10.1177/02654075221144716.

Lasalvia, A., Bonetto, C., Miglietta, E., Giacco, D., Nicaise, P., Lorant, V., Moskalewicz, J., Welbel, M., Bauer, M., Pfennig, A., Ruggeri, M., Priebe, S., 2021. Comparing discrimination among people with schizophrenia, affective and anxiety disorders. A multilevel study in five European countries. Journal of Affective Disorders 279, 191–202. https://doi.org/10.1016/j.jad.2020.10.002.

Lasalvia, A., Zoppei, S., van Bortel, T., Bonetto, C., Cristofalo, D., Wahlbeck, K., Bacle, S.V., van Audenhove, C., van Weeghel, J., Reneses, B., Germanavicius, A., Economou, M., Lanfredi, M., Ando, S., Sartorius, N., Lopez-Ibor, J.J., Thornicroft, G., 2013. Global pattern of experienced and anticipated discrimination reported by people with major depressive disorder: A cross-sectional survey. The Lancet 381, 55–62. https://doi.org/10.1016/S0140-6736(12)61379-8.

Lasgaard, M., Goossens, L., Elklit, A., 2011. Loneliness, depressive symptomatology, and suicide ideation in adolescence: Cross-sectional and longitudinal analyses. Journal of Abnormal Child Psychology 39, 137–150. https://doi.org/10.1007/s10802-010-9442-x.

Lauriola, M., Iani, L., 2015. Does positivity mediate the relation of extraversion and neuroticism with subjective happiness? PLOS One 10, e0121991. https://doi.org/10.1371/journal.pone.0121991.

Leach, L.S., Butterworth, P., 2020. Depression and anxiety in early adulthood: Consequences for finding a partner, and relationship support and conflict. Epidemiology and Psychiatric Sciences 29, e141. https://doi.org/10.1017/S2045796020000530.

Lee, S.L., Pearce, E., Ajnakina, O., Johnson, S., Lewis, G., Mann, F., Pitman, A., Solmi, F., Sommerlad, A., Steptoe, A., Tymoszuk, U., Lewis, G., 2021. The association between loneliness and depressive symptoms among adults aged 50 years and older: A 12-year population-based cohort study. The Lancet Psychiatry 8, 48–57. https://doi.org/10.1016/S2215-0366(20)30383-7.

Leigh-Hunt, N., Bagguley, D., Bash, K., Turner, V., Turnbull, S., Valtorta, N.K., Caan, W., 2017. An overview of systematic reviews on the public health consequences of social isolation and loneliness. Public Health 152, 157–171. https://doi.org/10.1016/j.puhe.2017.07.035.

LeMoult, J., 2020. From stress to depression: Bringing together cognitive and biological science. Current Directions in Psychological Science 29, 592–598. https://doi.org/10.1177/0963721420964039.

LeMoult, J., Gotlib, I.H., 2019. Depression: A cognitive perspective. Clinical Psychology Review 69, 51–66. https://doi.org/10.1016/j.cpr.2018.06.008.

Leszczensky, L., Wolbring, T., 2022. How to deal with reverse causality using panel data? Recommendations for researchers based on a simulation study. Sociological Methods & Research 51, 837–865. https://doi.org/10.1177/0049124119882473.

Levy, S.R., Ayduk, O., Downey, G., 2006. The role of rejection sensitivity in people's relationships with significant others and valued social groups, in: Leary, M.R. (Ed.), Interpersonal rejection. Oxford University Press, New York, pp. 250–289.

Li, M., D'Arcy, C., Meng, X., 2016. Maltreatment in childhood substantially increases the risk of adult depression and anxiety in prospective cohort studies: Systematic review, meta-analysis, and proportional attributable fractions. Psychological Medicine 46, 717–730. https://doi.org/10.1017/S0033291715002743.

Lillard, L.A., Panis, C.W.A., 1996. Marital status and mortality: The role of health. Demography 33, 313–327. https://doi.org/10.2307/2061764.

Lim, M.H., Rodebaugh, T.L., Zyphur, M.J., Gleeson, J.F.M., 2016. Loneliness over time: The crucial role of social anxiety. Journal of Abnormal Psychology 125, 620–630. https://doi.org/10.1037/abn0000162.

Lippke, S., Warner, L.M., 2023. Understanding and overcoming challenges in times of personal or global crisis - Editorial on the special issue on loneliness and health. Applied Psychology: Health and Well-Being 15, 3–23. https://doi.org/10.1111/aphw.12420.

Liu, B., Floud, S., 2017. Unravelling the associations between social isolation, loneliness, and mortality. The Lancet Public Health 2, e248-e249. https://doi.org/10.1016/S2468-2667(17)30090-7.

Liu, R.T., 2013. Stress generation: Future directions and clinical implications. Clinical Psychology Review 33, 406–416. https://doi.org/10.1016/j.cpr.2013.01.005.

Liu, R.T., 2019. Childhood maltreatment and impulsivity: A meta-analysis and recommendations for future study. Journal of Abnormal Child Psychology 47, 221–243. https://doi.org/10.1007/s10802-018-0445-3.

Liu, R.T., Alloy, L.B., 2010. Stress generation in depression: A systematic review of the empirical literature and recommendations for future study. Clinical Psychology Review 30, 582–593. https://doi.org/10.1016/j.cpr.2010.04.010.

Livingston, J.D., Boyd, J.E., 2010. Correlates and consequences of internalized stigma for people living with mental illness: A systematic review and meta-analysis. Social Science & Medicine 71, 2150–2161. https://doi.org/10.1016/j.socscimed.2010.09.030.

López García, E., Banegas, J.R., Pérez-Regadera, A.G., Cabrera, R.H., Rodríguez-Artalejo, F., 2005. Social network and health-related quality of life in older adults: A population-based study in Spain. Quality of Life Research 14, 511–520. https://doi.org/10.1007/s11136-004-5329-z.

Lubben, J., 2017. Addressing social isolation as a potent killer! Public Policy & Aging Report 27, 136–138. https://doi.org/10.1093/ppar/prx026.

Lucas, R.E., 2004. Top-down and bottom-up models of life satisfaction judgments: Paper presented at the 6th International German Socio-Economic Panel Study User Conference June 26th, 2004.

Lucas, R.E., 2023. Why the cross-lagged panel model is almost never the right choice. Advances in Methods and Practices in Psychological Science 6, 1–22. https://doi.org/10.1177/25152459231158378.

Ludwig, V., 2019. XTFEIS: Stata module to estimate linear fixed-effects model with individual-specific slopes (FEIS). https://EconPapers.repec.org/RePEc:boc:bocode:s458045.

Luhmann, M., Hawkley, L.C., 2016. Age differences in loneliness from late adolescence to oldest old age. Developmental Psychology 52, 943–959. https://doi.org/10.1037/dev0000117.

Luo, M., 2022. Social isolation, loneliness, and depressive symptoms: A twelve-year population study of temporal dynamics. The Journals of Gerontology. Series B. https://doi.org/10.1093/geronb/gbac174.

Luo, Y., Hawkley, L.C., Waite, L.J., Cacioppo, J.T., 2012. Loneliness, health, and mortality in old age: A national longitudinal study. Social Science & Medicine 74, 907–914. https://doi.org/10.1016/j.socscimed.2011.11.028.

Lyubomirsky, S., King, L., Diener, E., 2005. The benefits of frequent positive affect: Does happiness lead to success? Psychological Bulletin 131, 803–855. https://doi.org/10.1037/0033-2909.131.6.803.

Masi, C.M., Chen, H.-Y., Hawkley, L.C., Cacioppo, J.T., 2011. A meta-analysis of interventions to reduce loneliness. Personality and Social Psychology Review 15, 219–266. https://doi.org/10.1177/1088868310377394.

Mathews, A., MacLeod, C., 2005. Cognitive vulnerability to emotional disorders. Annual Review of Clinical Psychology 1, 167–195. https://doi.org/10.1146/annurev.clinpsy.1.102803.143916.

Matthews, T., Danese, A., Wertz, J., Odgers, C.L., Ambler, A., Moffitt, T.E., Arseneault, L., 2016. Social isolation, loneliness and depression in young adulthood: A behavioural genetic analysis. Social Psychiatry and Psychiatric Epidemiology 51, 339–348. https://doi.org/10.1007/s00127-016-1178-7.

Mayerl, H., Stolz, E., Freidl, W., 2021. Longitudinal effects of COVID-19-related loneliness on symptoms of mental distress among older adults in Austria. Public Health 200, 56–58. https://doi.org/10.1016/j.puhe.2021.09.009.

Mayerl, H., Stolz, E., Freidl, W., 2022. Lonely and depressed in older age: Prospective associations and common vulnerabilities. Aging & Mental Health, 1–6. https://doi.org/10.1080/13607863.2022.2056138.

McClelland, H., Evans, J.J., Nowland, R., Ferguson, E., O'Connor, R.C., 2020. Loneliness as a predictor of suicidal ideation and behaviour: A systematic review and meta-analysis of prospective studies. Journal of Affective Disorders 274, 880–896. https://doi.org/10.1016/j.jad.2020.05.004.

McDowell, C.P., Meyer, J.D., Russell, D.W., Sue Brower, C., Lansing, J., Herring, M.P., 2021. Bidirectional associations between depressive and anxiety symptoms and loneliness during the COVID-19 pandemic: Dynamic panel models with fixed effects. Frontiers in Psychiatry 12, 738892. https://doi.org/10.3389/fpsyt.2021.738892.

McHugh Power, J., Hannigan, C., Hyland, P., Brennan, S., Kee, F., Lawlor, B.A., 2020. Depressive symptoms predict increased social and emotional loneliness in older adults. Aging & Mental Health 24, 110–118. https://doi.org/10.1080/13607863.2018.1517728.

Meisters, R., Westra, D., Putrik, P., Bosma, H., Ruwaard, D., Jansen, M., 2021. Does loneliness have a cost? A population-wide study of the association between loneliness and healthcare expenditure. International Journal of Public Health 66, 581286. https://doi.org/10.3389/ijph.2021.581286.

Meyer, A.E., Curry, J.F., 2017. Pathways from anxiety to stressful events: An expansion of the stress generation hypothesis. Clinical Psychology Review 57, 93–116. https://doi.org/10.1016/j.cpr.2017.08.003.

Mihalopoulos, C., Le, L.K.-D., Chatterton, M.L., Bucholc, J., Holt-Lunstad, J., Lim, M.H., Engel, L., 2020. The economic costs of loneliness: A review of cost-of-illness and economic evaluation studies. Social Psychiatry and Psychiatric Epidemiology 55, 823–836. https://doi.org/10.1007/s00127-019-01733-7.

Mikulincer, M., Shaver, P.R., 2014. An attachment perspective on loneliness, in: Coplan, R.J., Bowker, J.C. (Eds.), The Handbook of Solitude: Psychological Perspectives on Social Isolation, Social Withdrawal, and Being Alone. John Wiley & Sons, Ltd., pp. 34–50.

Mishra, M., Allen, M.S., 2023. Rejection sensitivity and romantic relationships: A systematic review and meta-analysis. Personality and Individual Differences 208, 112186. https://doi.org/10.1016/j.paid.2023.112186.

Mood, C., Jonsson, J.O., 2016. The social consequences of poverty: An empirical test on longitudinal data. Social Indicators Research 127, 633–652. https://doi.org/10.1007/s11205-015-0983-9.

Moore, S.M., Diener, E., Tan, K., 2018. Using multiple methods to more fully understand causal relations: Positive affect enhances social relationships, in: Diener, E., Oishi, S., Tay, L. (Eds.), Handbook of Well-Being. DEF Publishers, Salt Lake City, UT, pp. 631–646.

Moral-Benito, E., Allison, P.D., Williams, R., 2019. Dynamic panel data modeling using maximum likelihood: An alternative to Arellano-Bond. Applied Economics 51, 2221–2232. https://doi.org/10.1080/00036846.2018.1540854.

Mund, M., Maes, M., Drewke, P.M., Gutzeit, A., Jaki, I., Qualter, P., 2022. Would the real loneliness please stand up? The validity of loneliness scores and the reliability of single-item scores. Assessment. https://doi.org/10.1177/10731911221077227.

Musliner, K.L., Munk-Olsen, T., Eaton, W.W., Zandi, P.P., 2016. Heterogeneity in long-term trajectories of depressive symptoms: Patterns, predictors and outcomes. Journal of Affective Disorders 192, 199–211. https://doi.org/10.1016/j.jad.2015.12.030.

Muthén, L.K., Muthén, B.O., 1998–2017. Mplus user's guide. 8th Edition. Muthén & Muthén, Los Angeles, CA.

Nandi, A., Beard, J.R., Galea, S., 2009. Epidemiologic heterogeneity of common mood and anxiety disorders over the lifecourse in the general population: A systematic review. BMC Psychiatry 9, 31. https://doi.org/10.1186/1471-244X-9-31.

Nanni, V., Uher, R., Danese, A., 2012. Childhood maltreatment predicts unfavorable course of illness and treatment outcome in depression: A meta-analysis. The American Journal of Psychiatry 169, 141–151. https://doi.org/10.1176/appi.ajp.2011.11020335.

Nelson, J., Klumparendt, A., Doebler, P., Ehring, T., 2017. Childhood maltreatment and characteristics of adult depression: Meta-analysis. The British Journal of Psychiatry 210, 96–104. https://doi.org/10.1192/bjp.bp.115.180752.

Noguchi, T., Saito, M., Aida, J., Cable, N., Tsuji, T., Koyama, S., Ikeda, T., Osaka, K., Kondo, K., 2021. Association between social isolation and depression onset among older adults: A cross-national longitudinal study in England and Japan. BMJ Open 11, e045834. https://doi.org/10.1136/bmjopen-2020-045834.

Office for National Statistics, 2018. Measuring loneliness: Guidance for use of the national indicators on surveys. https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/methodologies/measuringlonelinessguidanceforuseofthenationalindicatorsonsurveys/pdf (accessed 21 October 2023).

Park, C., Majeed, A., Gill, H., Tamura, J., Ho, R.C., Mansur, R.B., Nasri, F., Lee, Y., Rosenblat, J.D., Wong, E., McIntyre, R.S., 2020. The effect of loneliness on distinct health outcomes: A comprehensive review and meta-analysis. Psychiatry Research 294, 113514. https://doi.org/10.1016/j.psychres.2020.113514.

Parrish, C.L., Radomsky, A.S., 2010. Why do people seek reassurance and check repeatedly? An investigation of factors involved in compulsive behavior in OCD and depression. Journal of Anxiety Disorders 24, 211–222. https://doi.org/10.1016/j.janxdis.2009.10.010.

Peplau, L.A., Perlman, D., 1979. The experience of loneliness, in: Frieze, I.H., Bar-Tal, D., Carroll, J.S. (Eds.), New approaches to social problems: Applications of attribution theory. Jossey-Bass, San Francisco, CA, pp. 53–78.

Percheski, C., Meyer, J.M., 2018. Health and union dissolution among parenting couples: Differences by gender and marital status. Journal of Health and Social Behavior 59, 569–584. https://doi.org/10.1177/0022146518808707.

Perlman, D., Peplau, L.A., 1981. Toward a social psychology of loneliness, in: Duck, S., Gilmour, R. (Eds.), Personal Relationships in Disorder. Academic Press, London, pp. 31–56.

Pinquart, M., Sorensen, S., 2001. Influences on loneliness in older adults: A meta-analysis. Basic and Applied Social Psychology 23, 245–266. https://doi.org/10.1207/S15324834BASP2304_2.

Pinquart, M., Sörensen, S., 2000. Influences of socioeconomic status, social network, and competence on subjective well-being in later life: A meta-analysis. Psychology and Aging 15, 187–224. https://doi.org/10.1037/0882-7974.15.2.187.

Proulx, C.M., Helms, H.M., Buehler, C., 2007. Marital quality and personal well-being: A meta-analysis. Journal of Marriage and Family 69, 576–593. https://doi.org/10.1111/J.1741-3737.2007.00393.X.

Qualter, P., Vanhalst, J., Harris, R.A., van Roekel, E., Lodder, G., Bangee, M., Maes, M., Verhagen, M., 2015. Loneliness across the life span. Perspectives on Psychological Science 10, 250–264. https://doi.org/10.1177/1745691615568999.

Raila, H., Scholl, B.J., Gruber, J., 2015. Seeing the world through rose-colored glasses: People who are happy and satisfied with life preferentially attend to positive stimuli. Emotion 15, 449–462. https://doi.org/10.1037/emo0000049.

Ran, G., Zhang, Q., Zhang, Q., Li, J., Chen, J., 2022. The association between child abuse and aggressive behavior: A three-level meta-analysis. Trauma, Violence & Abuse, 15248380221129596. https://doi.org/10.1177/15248380221129596.

Rapp, I., 2018. Partnership formation in young and older age. Journal of Family Issues 39, 3363–3390. https://doi.org/10.1177/0192513X18783469.

Rapp, I., Gruhler, J., 2018. Der Einfluss der Gesundheit und des Gesundheitsverhaltens auf die Entstehung von Partnerschaften [The impact of health and health behavior on the formation of intimate relationships]. KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie 70, 25–52. https://doi.org/10.1007/s11577-018-0513-2.

Rector, N.A., Kamkar, K., Cassin, S.E., Ayearst, L.E., Laposa, J.M., 2011. Assessing excessive reassurance seeking in the anxiety disorders. Journal of Anxiety Disorders 25, 911–917. https://doi.org/10.1016/j.janxdis.2011.05.003.

Reinhard, M.A., Rek, S.V., Nenov-Matt, T., Barton, B.B., Dewald-Kaufmann, J., Merz, K., Musil, R., Jobst, A., Brakemeier, E.-L., Bertsch, K., Padberg, F., 2022. Association of loneliness and social network size in adulthood with childhood maltreatment: Analyses of a population-based and a clinical sample. European Psychiatry 65, e55. https://doi.org/10.1192/j.eurpsy.2022.2313.

Rhebergen, D., Lamers, F., Spijker, J., Graaf, R. de, Beekman, A.T.F., Penninx, B.W.J.H., 2012. Course trajectories of unipolar depressive disorders identified by latent class growth analysis. Psychological Medicine 42, 1383–1396. https://doi.org/10.1017/S0033291711002509.

Rhee, T.G., Marottoli, R.A., Monin, J.K., 2021. Diversity of social networks versus quality of social support: Which is more protective for health-related quality of life among older adults? Preventive Medicine 145, 106440. https://doi.org/10.1016/j.ypmed.2021.106440.

Richard, A., Rohrmann, S., Vandeleur, C.L., Schmid, M., Barth, J., Eichholzer, M., 2017. Loneliness is adversely associated with physical and mental health and lifestyle factors: Results from a Swiss national survey. PLOS One 12, e0181442. https://doi.org/10.1371/journal.pone.0181442.

Rødevand, L., Bahrami, S., Frei, O., Lin, A., Gani, O., Shadrin, A., Smeland, O.B., Connell, K.S.O., Elvsåshagen, T., Winterton, A., Quintana, D.S., Hindley, G.F.L., Werner, M.C.F., Djurovic, S., Dale, A.M., Lagerberg, T.V., Steen, N.E., Andreassen, O.A., 2021. Polygenic overlap and shared genetic loci between loneliness, severe mental disorders, and cardiovascular disease risk factors suggest shared molecular mechanisms. Translational Psychiatry 11, 3. https://doi.org/10.1038/s41398-020-01142-4.

Romero-Canyas, R., Downey, G., 2014. Rejection sensitivity as a predictor of affective and behavioral responses to interpersonal stress: A defensive motivational system, in: Williams, K.D., Forgas, J.P., Hippel, W. von (Eds.), The Social Outcast: Ostracism, Social Exclusion, Rejection, and Bullying. Psychology Press, New York, pp. 131–154.

Romero-Canyas, R., Downey, G., Berenson, K., Ayduk, O., Kang, N.J., 2010. Rejection sensitivity and the rejection-hostility link in romantic relationships. Journal of Personality 78, 119–148. https://doi.org/10.1111/j.1467-6494.2009.00611.x.

Rözer, J.J., Hofstra, B., Brashears, M.E., Volker, B., 2020. Does unemployment lead to isolation? The consequences of unemployment for social networks. Social Networks 63, 100–111. https://doi.org/10.1016/j.socnet.2020.06.002.

Rüsch, N., Angermeyer, M.C., Corrigan, P.W., 2005. Mental illness stigma: Concepts, consequences, and initiatives to reduce stigma. European Psychiatry 20, 529–539. https://doi.org/10.1016/j.eurpsy.2005.04.004.

Rüttenauer, T., Ludwig, V., 2023. Fixed effects individual slopes: Accounting and testing for heterogeneous effects in panel data or other multilevel models. Sociological Methods & Research 52, 43–84. https://doi.org/10.1177/0049124120926211.

Ryan, R.M., Deci, E.L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. The American Psychologist 55, 68–78. https://doi.org/10.1037/0003-066X.55.1.68.

Samsa, G., Edelman, D., Rothman, M.L., Williams, G.R., Lipscomb, J., Matchar, D., 1999. Determining clinically important differences in health status measures: A general approach with illustration to the Health Utilities Index Mark II. PharmacoEconomics 15, 141–155. https://doi.org/10.2165/00019053-199915020-00003.

Santini, Z.I., Jose, P.E., York Cornwell, E., Koyanagi, A., Nielsen, L., Hinrichsen, C., Meilstrup, C., Madsen, K.R., Koushede, V., 2020. Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): A longitudinal mediation analysis. The Lancet Public Health 5, e62-e70. https://doi.org/10.1016/S2468-2667(19)30230-0.

Santini, Z.I., Koyanagi, A., Tyrovolas, S., Mason, C., Haro, J.M., 2015. The association between social relationships and depression: A systematic review. Journal of Affective Disorders 175, 53–65. https://doi.org/10.1016/j.jad.2014.12.049.

Schomerus, G., Schindler, S., Sander, C., Baumann, E., Angermeyer, M.C., 2022. Changes in mental illness stigma over 30 years - Improvement, persistence, or deterioration? European Psychiatry 65, e78. https://doi.org/10.1192/j.eurpsy.2022.2337.

Schubert, K.O., Clark, S.R., Van, L.K., Collinson, J.L., Baune, B.T., 2017. Depressive symptom trajectories in late adolescence and early adulthood: A systematic review. The Australian and New Zealand Journal of Psychiatry 51, 477–499. https://doi.org/10.1177/0004867417700274.

Schupp, J., Goebel, J., Kroh, M., Schröder, C., Bartels, C., Erhardt, K., Fedorets, A., Franken, A., Giesselmann, M., Grabka, M., Krause, P., Kröger, H., Kuehne, S., Metzing, M., Nebelin, J., Richter, D., Schacht, D., Schmelzer, P., Schmitt, C., Schnitzlein, D., Siegers, R., Wenzig, K., Deutsches Institut Für Wirtschaftsforschung, 2017. Sozio-oekonomisches Panel (SOEP), Daten der Jahre 1984-2016.

Schwarzbach, M., Luppa, M., Forstmeier, S., König, H.-H., Riedel-Heller, S.G., 2014. Social relations and depression in late life. A systematic review. International Journal of Geriatric Psychiatry 29, 1–21. https://doi.org/10.1002/gps.3971.

Scott, A.J., Webb, T.L., Martyn-St James, M., Rowse, G., Weich, S., 2021. Improving sleep quality leads to better mental health: A meta-analysis of randomised controlled trials. Sleep Medicine Reviews 60, 101556. https://doi.org/10.1016/j.smrv.2021.101556.

Seddig, D., 2020. Maximum likelihood and structural equations for dynamic panel models, in: Atkinson, P., Delamont, S., Cernat, A., Sakshaug, J.W., Williams, R.A. (Eds.), SAGE Research Methods Foundations. SAGE Publications Ltd, London.

Segel-Karpas, D., Ayalon, L., 2020. Loneliness and hostility in older adults: A cross-lagged model. Psychology and Aging 35, 169–176. https://doi.org/10.1037/pag0000417.

Seidlitz, L., Diener, E., 1993. Memory for positive versus negative life events: The differences between happy and unhappy persons. Journal of Personality and Social Psychology 64, 654–664. https://doi.org/10.1037/0022-3514.64.4.654.

Seifert, N., Seddig, D., Eckhard, J., 2022. Does social isolation affect physical and mental health? A test of the social causation hypothesis using dynamic panel models with fixed effects. Aging & Mental Health 26, 1353–1367. https://doi.org/10.1080/13607863.2021.1961125.

Shankar, A., McMunn, A., Banks, J., Steptoe, A., 2011. Loneliness, social isolation, and behavioral and biological health indicators in older adults. Health Psychology 30, 377–385. https://doi.org/10.1037/a0022826.

Sheehan, L., Palermo, C.V., Corrigan, P., 2022. Theoretical models to understand stigma of mental illness, in: Vogel, D.L., Wade, N.G. (Eds.), The Cambridge Handbook of Stigma and Mental Health. Cambridge University Press, pp. 11–30.

Sluzki, C.E., 2010. Personal social networks and health: Conceptual and clinical implications of their reciprocal impact. Families, Systems & Health 28, 1–18. https://doi.org/10.1037/a0019061.

Smith, K.J., Gavey, S., Riddell, N.E., Kontari, P., Victor, C., 2020. The association between loneliness, social isolation and inflammation: A systematic review and meta-analysis. Neuroscience and Biobehavioral Reviews 112, 519–541. https://doi.org/10.1016/j.neubiorev.2020.02.002.

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., Il Shin, J., Kirkbride, J.B., Jones, P., Kim, J.H., Kim, J.Y., Carvalho, A.F., Seeman, M.V., Correll, C.U., Fusar-Poli, P., 2022. Age at onset of mental disorders worldwide: Large-scale meta-

analysis of 192 epidemiological studies. Molecular Psychiatry 27, 281–295. https://doi.org/10.1038/s41380-021-01161-7.

Spithoven, A.W.M., Bijttebier, P., Goossens, L., 2017. It is all in their mind: A review on information processing bias in lonely individuals. Clinical Psychology Review 58, 97–114. https://doi.org/10.1016/j.cpr.2017.10.003.

Spithoven, A.W.M., Cacioppo, S., Goossens, L., Cacioppo, J.T., 2019. Genetic contributions to loneliness and their relevance to the evolutionary theory of loneliness. Perspectives on Psychological Science 14, 376–396. https://doi.org/10.1177/1745691618812684.

Starr, L.R., Davila, J., 2008. Excessive reassurance seeking, depression, and interpersonal rejection: A meta-analytic review. Journal of Abnormal Psychology 117, 762–775. https://doi.org/10.1037/a0013866.

Steel, Z., Marnane, C., Iranpour, C., Chey, T., Jackson, J.W., Patel, V., Silove, D., 2014. The global prevalence of common mental disorders: A systematic review and meta-analysis 1980-2013. International Journal of Epidemiology 43, 476–493. https://doi.org/10.1093/ije/dyu038.

Stoltenborgh, M., Bakermans-Kranenburg, M.J., Alink, L.R.A., van IJzendoorn, M.H., 2015. The prevalence of child maltreatment across the globe: Review of a series of meta-analyses. Child Abuse Review 24, 37–50. https://doi.org/10.1002/car.2353.

Surkalim, D.L., Luo, M., Eres, R., Gebel, K., van Buskirk, J., Bauman, A., Ding, D., 2022. The prevalence of loneliness across 113 countries: Systematic review and meta-analysis. BMJ 376, e067068. https://doi.org/10.1136/bmj-2021-067068.

Suslow, T., Hußlack, A., Kersting, A., Bodenschatz, C.M., 2020. Attentional biases to emotional information in clinical depression: A systematic and meta-analytic review of eye tracking findings. Journal of Affective Disorders 274, 632–642. https://doi.org/10.1016/j.jad.2020.05.140.

Tamir, M., Robinson, M.D., 2007. The happy spotlight: Positive mood and selective attention to rewarding information. Personality & Social Psychology Bulletin 33, 1124–1136. https://doi.org/10.1177/0146167207301030.

Tan, M., Barkus, E., Favelle, S., 2021. The cross-lagged relationship between loneliness, social support, and psychotic-like experiences in young adults. Cognitive Neuropsychiatry 26, 379–393. https://doi.org/10.1080/13546805.2021.1960156.

Tan, M., Shallis, A., Barkus, E., 2020. Social anhedonia and social functioning: Loneliness as a mediator. PsyCh Journal 9, 280–289. https://doi.org/10.1002/pchj.344.

Tay, L., Diener, E., 2011. Needs and subjective well-being around the world. Journal of Personality and Social Psychology 101, 354–365. https://doi.org/10.1037/a0023779.

Teo, R.H., Cheng, W.H., Cheng, L.J., Lau, Y., Lau, S.T., 2023. Global prevalence of social isolation among community-dwelling older adults: A systematic review and meta-analysis. Archives of Gerontology and Geriatrics 107, 104904. https://doi.org/10.1016/j.archger.2022.104904.

Thoits, P.A., 2011a. Mechanisms linking social ties and support to physical and mental health. Journal of Health and Social Behavior 52, 145–161. https://doi.org/10.1177/0022146510395592.

Thoits, P.A., 2011b. Perceived social support and the voluntary, mixed, or pressured use of mental health services. Society and Mental Health 1, 4–19. https://doi.org/10.1177/2156869310392793.

Tice, D.M., Bratslavsky, E., 2000. Giving in to feel good: The place of emotion regulation in the context of general self-control. Psychological Inquiry 11, 149–159. https://doi.org/10.1207/S15327965PLI1103_03.

Tice, D.M., Bratslavsky, E., Baumeister, R.F., 2001. Emotional distress regulation takes precedence over impulse control: If you feel bad, do it! Journal of Personality and Social Psychology 80, 53–67. https://doi.org/10.1037/0022-3514.80.1.53.

Torales, J., O'Higgins, M., Castaldelli-Maia, J.M., Ventriglio, A., 2020. The outbreak of COVID-19 coronavirus and its impact on global mental health. The International Journal of Social Psychiatry 66, 317–320. https://doi.org/10.1177/0020764020915212.

Tough, H., Brinkhof, M.W.G., Siegrist, J., Fekete, C., 2018. The impact of loneliness and relationship quality on life satisfaction: A longitudinal dyadic analysis in persons with physical disabilities and their partners. Journal of Psychosomatic Research 110, 61–67. https://doi.org/10.1016/j.jpsychores.2018.04.009.

Trøstheim, M., Eikemo, M., Meir, R., Hansen, I., Paul, E., Kroll, S.L., Garland, E.L., Leknes, S., 2020. Assessment of anhedonia in adults with and without mental illness: A systematic review and meta-analysis. JAMA Network Open 3, e2013233. https://doi.org/10.1001/jamanetworkopen.2020.13233.

Twenge, J.M., Catanese, K.R., Baumeister, R.F., 2003. Social exclusion and the deconstructed state: Time perception, meaninglessness, lethargy, lack of emotion, and self-awareness. Journal of Personality and Social Psychology 85, 409–423. https://doi.org/10.1037/0022-3514.85.3.409.

Uchino, B.N., 2006. Social support and health: A review of physiological processes potentially underlying links to disease outcomes. Journal of Behavioral Medicine 29, 377–387. https://doi.org/10.1007/s10865-006-9056-5.

Uchino, B.N., Trettevik, R., Kent de Grey, R.G., Cronan, S., Hogan, J., Baucom, B.R.W., 2018. Social support, social integration, and inflammatory cytokines: A meta-analysis. Health Psychology 37, 462–471. https://doi.org/10.1037/hea0000594.

Umberson, D., 1992. Gender, marital status and the social control of health behavior. Social Science & Medicine 34, 907–917. https://doi.org/10.1016/0277-9536(92)90259-S.

Umberson, D., Crosnoe, R., Reczek, C., 2010. Social relationships and health behavior across life course. Annual Review of Sociology 36, 139–157. https://doi.org/10.1146/annurev-soc-070308-120011.

Umberson, D., Montez, J.K., 2010. Social relationships and health: A flashpoint for health policy. Journal of Health and Social Behavior 51 Suppl, S54-66. https://doi.org/10.1177/0022146510383501.

Vaisey, S., Miles, A., 2017. What you can—and can't—do with three-wave panel data. Sociological Methods & Research 46, 44–67. https://doi.org/10.1177/0049124114547769.

Valtorta, N.K., Kanaan, M., Gilbody, S., Hanratty, B., 2016a. Loneliness, social isolation and social relationships: What are we measuring? A novel framework for classifying and comparing tools. BMJ Open 6, e010799. https://doi.org/10.1136/bmjopen-2015-010799.

Valtorta, N.K., Kanaan, M., Gilbody, S., Ronzi, S., Hanratty, B., 2016b. Loneliness and social isolation as risk factors for coronary heart disease and stroke: Systematic review and meta-analysis of longitudinal observational studies. Heart (British Cardiac Society) 102, 1009–1016. https://doi.org/10.1136/heartjnl-2015-308790.

van Neerven, T., Bos, D.J., van Haren, N.E., 2021. Deficiencies in Theory of Mind in patients with schizophrenia, bipolar disorder, and major depressive disorder: A systematic review of secondary literature. Neuroscience and Biobehavioral Reviews 120, 249–261. https://doi.org/10.1016/j.neubiorev.2020.11.011.

van Zutphen, E.M., Kok, A.A.L., Rijnhart, J.J.M., Rhebergen, D., Huisman, M., Beekman, A.T.F., 2021. An examination of reciprocal effects between cardiovascular morbidity, depressive symptoms and loneliness over time in a longitudinal cohort of Dutch older adults. Journal of Affective Disorders 288, 122–128. https://doi.org/10.1016/j.jad.2021.03.081.

Vanhalst, J., Klimstra, T.A., Luyckx, K., Scholte, R.H.J., Engels, R.C.M.E., Goossens, L., 2012. The interplay of loneliness and depressive symptoms across adolescence: Exploring

the role of personality traits. Journal of Youth and Adolescence 41, 776–787. https://doi.org/10.1007/s10964-011-9726-7.

Vella-Brodrick, D., Joshanloo, M., Slemp, G.R., 2023. Longitudinal relationships between social connection, agency, and emotional well-being: A 13-year study. The Journal of Positive Psychology 18, 883–893. https://doi.org/10.1080/17439760.2022.2131609.

Vilagut, G., Forero, C.G., Pinto-Meza, A., Haro, J.M., Graaf, R. de, Bruffaerts, R., Kovess, V., Girolamo, G. de, Matschinger, H., Ferrer, M., Alonso, J., 2013. The mental component of the short-form 12 health survey (SF-12) as a measure of depressive disorders in the general population: Results with three alternative scoring methods. Value in Health 16, 564–573. https://doi.org/10.1016/j.jval.2013.01.006.

Vonneilich, N., 2022. Social status, social relations, and health, in: Klärner, A., Gamper, M., Keim-Klärner, S., Moor, I., Lippe, H. von der, Vonneilich, N. (Eds.), Social Networks and Health Inequalities: A New Perspective for Research. Springer International Publishing, Cham, pp. 203–213.

Wagner, G.G., Frick, J.R., Schupp, J., 2007. The German Socio-Economic Panel Study (SOEP): Scope, evolution and enhancements. Schmollers Jahrbuch - Journal of Contextual Economics 127, 139–169.

Wakeling, S., Stukas, A.A., Wright, B.J., Evans, L., 2020. Negative feedback seeking and excessive reassurance seeking behavior and depression: A meta-analytic review. Journal of Social and Clinical Psychology 39, 788–823. https://doi.org/10.1521/jscp.2020.39.9.788.

Ward, M., Briggs, R., McGarrigle, C.A., Looze, C. de, O'Halloran, A.M., Kenny, R.A., 2023. The bi-directional association between loneliness and depression among older adults from before to during the COVID-19 pandemic. International Journal of Geriatric Psychiatry 38, e5856. https://doi.org/10.1002/gps.5856.

Ware, J.E., Kosinski, M., Keller, S.D., 1996. A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. Medical Care 34, 220–233. https://doi.org/10.1097/00005650-199603000-00003.

Ware, J.E., Kosinski, M., Turner-Bowker, D.M., Gandek, B., 2001. How to Score Version 2 of the SF-12 Health Survey (With a Supplement Documenting Version 1). Quality Metric Incorporated, Lincoln, RI.

Weightman, M.J., Knight, M.J., Baune, B.T., 2019. A systematic review of the impact of social cognitive deficits on psychosocial functioning in major depressive disorder and

opportunities for therapeutic intervention. Psychiatry Research 274, 195–212. https://doi.org/10.1016/j.psychres.2019.02.035.

West, S.G., Taylor, A.B., Wu, W., 2012. Model fit and model selection in structural equation modeling, in: Hoyle, R.H. (Ed.), Handbook of Structural Equation Modeling. The Guilford Press, New York, NY, pp. 209–231.

Weziak-Bialowolska, D., Bialowolski, P., Lee, M.T., Chen, Y., VanderWeele, T.J., McNeely, E., 2022. Prospective associations between social connectedness and mental health. Evidence from a longitudinal survey and health insurance claims data. International Journal of Public Health 67, 1604710. https://doi.org/10.3389/ijph.2022.1604710.

Yang, K., Girgus, J.S., 2019. Are women more likely than men are to care excessively about maintaining positive social relationships? A meta-analytic review of the gender difference in sociotropy. Sex Roles 81, 157–172. https://doi.org/10.1007/s11199-018-0980-y.

Yang, Y.C., Boen, C., Mullan Harris, K., 2015. Social relationships and hypertension in late life: Evidence from a nationally representative longitudinal study of older adults. Journal of Aging and Health 27, 403–431. https://doi.org/10.1177/0898264314551172.

Yuan, K.-H., Bentler, P.M., 2000. Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data. Sociological Methodology 30, 165–200. https://doi.org/10.1111/0081-1750.00078.

Zagic, D., Wuthrich, V.M., Rapee, R.M., Wolters, N., 2022. Interventions to improve social connections: A systematic review and meta-analysis. Social Psychiatry and Psychiatric Epidemiology 57, 885–906. https://doi.org/10.1007/s00127-021-02191-w.

Zavaleta, D., Samuel, K., Mills, C.T., 2017. Measures of social isolation. Social Indicators Research 131, 367–391.

Zhang, X., Li, J., Xie, F., Chen, X., Xu, W., Hudson, N.W., 2022. The relationship between adult attachment and mental health: A meta-analysis. Journal of Personality and Social Psychology 123, 1089–1137. https://doi.org/10.1037/pspp0000437.

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