# Social network characteristics and loneliness in older adults

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# Abstract

**Background:** Loneliness is a prevalent experience associated with many negative physical and mental health outcomes. Due to the ageing population worldwide, and the greater vulnerability of older adults to these outcomes, it is important that loneliness is understood in this age group to inform effective interventions. To date, research has not examined how commonly employed scales capture loneliness in older adults or how close friendships and other social network aspects relate to loneliness in depth.

**Methods:** Cross-sectional quantitative survey methods were employed throughout this thesis. The first two studies were conducted online to assess the measurement properties and overlap of commonly employed loneliness scales and, the relationship between close friendships and loneliness and psychological well-being in older adults. Postal surveys were utilised to examine egocentric social network characteristics in relation to loneliness and psychological well-being. Various network analytic techniques as well as polynomial and segmented regression methods were applied.

**Findings:** It was highlighted that the SELSA-S appeared to have the ability to tap into more diverse loneliness dimensions whereas others measured fewer dimensions. One specific item from all loneliness scales examined seemed to tap in the most domains of loneliness. An inverse curvilinear relationship was demonstrated between the number of close friendships and loneliness and psychological well-being. Emotional closeness to friends as well as network size and an increased number of friends were also indicated as important network characteristics in relation to improved levels of loneliness.

**Conclusions:** The SELSA-S may be the most appropriate tool to assess loneliness in older adults when wishing to measure loneliness resulting from deficits in specific social connections. Increasing focus on building and deepening emotionally close friendships as well as network size are social network characteristics which could improve the effectiveness of loneliness interventions in this age group.

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# Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Postgraduate Ethics Committee on 28/05/2019.

**I declare that the Word Count of this Thesis is 39,180 words**

Name: Alexandra Thompson

Signature:

Date: 10/02/2023

# Chapter 1. Background

## 1.1.The Importance of Loneliness

The first formal reference to loneliness emerged during the 17th century in John Milton's epic poem, 'Paradise Lost', in describing Satan's journey out of hell. Here not illustrating emotions but in portrayal of a vulnerability of moving from the relative safety of one's home (Milton, 1667). Similarly, in 1674, the term 'lonely' was included in a list of infrequently used terms as a way to describe being far from neighbours (John, 1691). At this point in history, loneliness was conceptualised as being far from others. More recently, modern understandings of loneliness recognise that this distance can be emotional and internal rather than explicit and external with loneliness being experienced by those residing in large cities as well as in isolated villages and with some enjoying aloneness regardless of any geographical interpersonal space from others.

The existentialist philosopher and teacher, Paul Tillich, famously wrote that, *"Language has created the word "loneliness" to express the pain of being alone, and it has created the word "solitude" to express the glory of being alone"*, (Tillich, 1963, p.2). Indeed, the experience of loneliness has been described as being agonising with individuals depicting the state as one of darkness, despondency and discomfort (Hauge & Kirkevold, 2012). Individuals who experience the pain that accompanies feeling chronically lonely often suffer with physical and/or psychological morbidities experienced on an individual level (e.g., Ong et al., 2016) which in turn have impacts on society as a whole at a wider level (Jeffrey et al., 2017). The nature of loneliness, along with its precipitants and prevalence are discussed along with these impacts below.

## 1.2.Societal Impacts of Loneliness

### *1.2.1. Economic and Social Impacts*

The experience of loneliness has an impact on society as a whole and is associated with economic costs. The cost of loneliness to UK employers has been estimated as being approximately £2.2 - £3.7 billion per year due to increased staff turnover, reduced productivity, the impact of caring responsibilities as well absences (Jeffrey et al., 2017). The monetised impact of loneliness in the UK has been estimated as £9,900 per person due to this impact on well-being, health and productivity (Simetrica, 2020). However, it has been argued that these estimates are likely to be conservative due to lack of evidence around the impact of loneliness on productivity (Mihalopoulos et al., 2020). With the increasing age of retirement and the ageing population, these detrimental economic impacts are likely to increase in the near future.

Loneliness is also associated with an increased burden on health and social care. Research from the Health and Retirement Study in the United States has suggested that chronic loneliness promotes a cycle of illness and health care utilisation (Gerst-Emerson & Jayawardhana, 2015). In this study, loneliness was associated with an increased number of doctor visits. This is a finding that has been replicated in a UK based study in which loneliness in older adults was consistently and positively associated with the number of General Practitioner (GP) visits in both cross-sectional and longitudinal analyses. In this study, loneliness was also associated with an increased number of Emergency Department visits for women (Burns et al., 2020). This was suggested to be explained due to increased symptom reporting and symptom intensity reported by women in previous research (Barsky et al., 2001).

Additionally, older patients living alone have been shown to be 50% more likely to have an emergency department attendance and 40% more likely to have over 12 GP visits in a year (Dreyer et al., 2018). The increased morbidity associated with loneliness could logically account for the increased usage of GP services, however, as the effect of loneliness on GP visits still stands after illness and subjective

health have been controlled for, it has been suggested that the doctor-patient relationship provides social support as well as medical care. This has been supported by models showing increases in GP visits but not hospitalisation with increasing loneliness (Gerst-Emerson & Jayawardhana, 2015).

Loneliness also has an impact on the social care sector. Analysis of data from the English Longitudinal Study of Ageing suggested that loneliness is independently associated with an increased risk of moving into a care home; even after controlling for well known risk factors such as age, poor health and depression (Hanratty et al., 2018). This effect of loneliness was also found independently of the effect of social isolation on care home admission. This is an important finding as unlike many other variables (e.g., age) that are linked to care home admission, loneliness has the potential to be alleviated via intervention. The authors suggested that addressing loneliness may be a way of allowing older adults to remain in their own homes for as long as possible and may reduce the demand for residential care (Hanratty et al., 2018).

In terms of monetised impact on the health and social care sector, a report from the London School of Economics have suggested that £1,700 could be saved per person over 10 years if action was taken to reduce loneliness with the majority being achieved due to the avoidance of unplanned hospital admissions (McDaid et al., 2016). Similarly, it has been estimated that an individual may cost this sector around £12,000 over 15 years with much of the cost relating to GP visits, accident and emergency department visits, hospital admission, residential care and costs associated conditions such as diabetes and depression (Social Finance, 2015).

#### *1.2.2. Loneliness as a Public Health Issue*

Due to these economic and social impacts as well as individual level health and well-being consequences, loneliness has been implicated as a public health concern by both researchers (Holt-Lunstad et al., 2017; Leigh-Hunt et al., 2017; O'Sullivan et al., 2022) and loneliness-focused organisations (Campaign to End Loneliness, 2022). Given the vast array of psychological and physical health outcomes

associated with loneliness (For a review see Courtin & Knapp, 2017), it is not surprising that loneliness has received increasing interest from the UK Government and other bodies.

### *1.2.1. Loneliness Campaigns*

A variety of charitable organisations have taken an interest in focusing efforts on reducing loneliness in the UK. The largest of such campaigns is the Campaign to End Loneliness hosted by the What Works Centre for Wellbeing and supported by National Lottery funding. Having recognised the wide ranging issues that loneliness poses, the campaign aims to ensure that those at risk of loneliness are accessed and supported, that services and activities are made more effective, and that a wider range of services are developed (Campaign to End Loneliness, 2022).

In 2017, the campaign began to engage businesses and the public to highlight the issues relating to loneliness. With help from the National Lottery Community Fund, the Campaign was able to create 'The Loneliness Project', a film which has been watched by more than 85 million times. Research, local and national campaigning and initiatives have been continued by the organisation. The latest of these has included a collaboration with rail company Transpennine Express, which aims to encourage individuals to strengthen their social connections following the COVID-19 pandemic (Campaign to End Loneliness, 2021).

Additional loneliness initiatives have been established by various other bodies. The Marmalade Trust launched Loneliness Awareness Week in 2017. This is the organisation's annual campaign with the aim of raising awareness and starting a conversation around loneliness (Marmalade Trust, 2022). The British Red Cross offer services such as their support phone line, while in Scotland the organisation offers the 'Connecting with You' service to assist individuals in connecting with their local community (British Red Cross, n.d.). Age UK have a focus on reducing loneliness in older adults and offer provisions such as

befriending services, social activities and IT training to assist in building social connections (Age UK, 2022).

### *1.2.2. Loneliness as a policy issue*

This interest in loneliness from researchers and charitable organisations has translated into Governmental policy. In 2017, the cross-party Jo Cox Commission on Loneliness published a report titled 'Combating loneliness one conversation at a time' (Jo Cox Loneliness Commission, 2017). Most of the recommendations of the report were adopted by the UK Government. Crucially, loneliness was added to the remit of the role now known as the Minister for Civil Society and Department for Culture Media and Sport; often dubbed the 'Minister for Loneliness'. This meant that targeted policies around loneliness could be more readily developed. Additionally, the Government announced two funds to assist with combatting loneliness. The first was £98 million for the Healthy Ageing Programme which intended to create products and services to allow individuals to remain in their own homes for longer, tackle loneliness, and increase independence and wellbeing. The second was £11 million for the Building Connections Fund to support organisations in bringing communities together (UK Parliament, 2021) which was also funded by the Coop Foundation and the National Lottery Community Fund. Grants from the Building Connections fund were awarded to 126 organisations working with individuals of different ages and from a diverse range of backgrounds and undertaking a variety of activities. Evaluations of these activities demonstrated improvements in loneliness, resilience, wellbeing and confidence before the COVID-19 pandemic struck (Rose et al., 2021) and that many grant holders were able to adapt to the conditions imposed by the pandemic to continue their work (Todres et al., 2021).

A loneliness strategy called 'A connected society: A strategy for tackling loneliness – laying the foundations for change' was then published by the UK government in collaboration with the Loneliness Action Group in 2018. The strategy set out plans for the government to provide 'national leadership' to tackle loneliness in the UK. This included measures such as enabling 'social prescribing' to connect

services with individuals at risk of loneliness, to strengthen transport infrastructure, develop housing and community spaces, to improve digital inclusion as well as to reduce the stigma around discussing loneliness (Department for Digital Culture, Media and Sport, 2018). Two progress reports on this strategy have since been published suggesting that many of the initiatives set out in the strategy are being met (Department for Digital Culture Media & Sport, 2021a).

In 2021 the Department for Culture, Media and Sport established the Tackling Loneliness evidence group with the aim of coordinating UK based loneliness research to avoid duplication and ensure focus on evidence gaps. The group published an independent report to provide policymakers and researchers with the evidence gaps around loneliness and to suggest priorities for future research (Department for Digital Culture Media & Sport, 2022).

The COVID-19 pandemic impacted individuals and communities in a profound way. Social distancing measures and repeated lockdowns raised concerns around increasing levels of social isolation and loneliness. Research suggested that those who reported always or often feeling lonely were three times more likely to feel that they could not cope with the pandemic (British Red Cross, 2020). This was a particular concern for the most vulnerable in society, those who were shielding, those who were residing in a care home, living alone or who had lost loved ones. With further research suggesting that individuals already at risk of experiencing loneliness were at an increased risk during the pandemic. This included young adults, those with a low household income and adults living alone (UK Parliament, 2021).

Due to this potential additional impact of the COVID-19 pandemic on loneliness in the UK, in 2020 the Government announced a plan to address this. The aim of the plan was to ensure that for people of all ages and backgrounds, staying home did not need to lead to loneliness. The initiatives included a new #Let'sTalkLoneliness public social media campaign launched by the culture secretary to get people to talk openly about loneliness. Loneliness was announced as a priority category for a £750 million charity funding package. £5 million worth of additional funds were allocated as a boost for national loneliness organisations at the forefront of the fight against loneliness during the pandemic. This further included the

creation of a Tackling Loneliness Network which brought together over 70 cross-sector organisations from to collaborate on four key areas: Tackling loneliness in young people, tackling loneliness in older adults, local and place-based approaches to tackling loneliness and digital inclusion. In 2021 the evidence group published a report outlining commitments around two themes that the Government would focus on over the next year. These were: Supporting organisations to tackle loneliness and Supporting individuals to tackle loneliness (Department for Digital Culture, Media & Sport, 2021).

Many of the initiatives and interventions mentioned above that have been implemented via policy or through third sector organisations have tended to focus on objective social isolation rather than attending to the psychological aspects of loneliness. For example, creating opportunities for social connection through the provision of befriending services and the reduction of barriers to social engagement. These types of interventions have shown some success in reducing loneliness (Lester et al., 2012); however, evidence suggests that tackling loneliness requires more complex interventions.

A recent review of loneliness interventions for older adults highlighted the importance of including multiple approaches for increased effectiveness (Poscia et al., 2018). Programmes which included educational, cognitive and social support aspects appeared to have the most benefit (Saito et al., 2012), with psychological aspects involving altering cognitions also being noted in a review of loneliness interventions for those experiencing mental health issues (Mann et al., 2017). Therefore, these more complex interventions including psychological approaches may have more utility in improving loneliness that the sometimes more generic initiatives supported by governmental and charitable bodies.

### 1.3.Loneliness Definitions and Typologies

Due to the multitude of negative impacts associated with loneliness, researchers have sought to define and understand the nature of this experience in order develop effective interventions to combat this experience.

### *1.3.3. Definitions and Models*

Loneliness has been defined in a variety of ways. However, to date there is no single accepted consensus. The majority of definitions note that loneliness is a subjective negative experience that results from a perceived lack of, or inadequate social relationships (e.g. Fried et al., 2020; Prohaska et al., 2020). Definitions typically refer to perceived social isolation or to the subjective feeling of being lonely rather than objective assessments and as such loneliness is suggested to be a functional aspect of social connection (Holt-Lunstad, 2018). Loneliness is described as an involuntary state and is thought to be alleviated only via the formation of intimate social bonds (Dickens et al., 2011). This is because the quality of social connections has been shown to be important in predicting loneliness (Grenade & Boldy, 2008; Pettigrew & Roberts, 2008; Martin Pinquart & Sörensen, 2001a; Segrin & Passalacqua, 2010).

One early and widely accepted definition describes loneliness as: *"the unpleasant experience that occurs when a person's network of social relationships is deficient in some important way, either quantitatively or qualitatively"* (Perlman & Peplau, 1981, p. 31). The authors highlighted three key components to their conceptualisation of loneliness. First, they suggest that loneliness results from deficiencies in a person's social relationships; second, they note that loneliness is a subjective experience which is not always synonymous with social isolation; third, they emphasise that loneliness is a negative and distressing phenomenon.

Perlman and Peplau (1981) developed the cognitive discrepancy model of loneliness which posits that loneliness results from a perceived discrepancy between a person's desired and achieved levels of personal relationships. Framing loneliness in this way further underscores its subjective nature. The model suggests that a person's number of social connections is not the sole prerequisite for loneliness to occur. Rather, everyone has their own required levels of social connection and if those levels are not met, then loneliness may be experienced. In sum, this view takes into account any individual differences in terms of cognitive factors which may mediate this perceived deficiency and negative emotional responses to this (Perlman & Peplau, 1981).

### *1.3.4. Loneliness Typologies*

Two main typologies of loneliness have been proposed which can be classified as either unidimensional or multidimensional. The unidimensional approach tends to view loneliness as a singular experience that can be reached through deficits in a variety of relationships and that varies in the intensity of its experience. It also assumes that there are common themes in the experience of loneliness (Russell, 1982). Many measures of loneliness were developed in a way that aims to capture the unidimensional structure. The earliest of which was by Eddy in 1961 (Russell, 1982). However, the most recognised measure which operationalises loneliness in this way is the University of California Loneliness Scale (Russell, Peplau, & Ferguson, 1978).

A seminal multidimensional typology of loneliness was outlined by Weiss (1973). Weiss described two distinct types of loneliness: Emotional and Social. In describing this typology, Weiss suggested that different relationships provide differing social provisions that are required by individuals. In this conceptualisation, no singular relationship can meet all needs. Therefore, a variety of relationships are needed. When a specific relationship is no longer present, the type of relational deficit experienced by that individual depends on the social provisions that were fulfilled by that relationship. Weiss outlined six social provisions: (a) attachment, provided by relationships in which the individual obtains a sense of safety and security; (b) social integration, provided by a network of relationships in which the members share interests and concerns; (c) opportunity for nurturance, derived from relationships in which the individual feels responsibility for the well-being of another; (d) reassurance of worth, provided by relationships in which the individual's skills and abilities are acknowledged; (e) reliable alliance, derived from relationships in which the person can count on assistance under any circumstances; and (f) guidance, provided by relationships with trustworthy and authoritative people who can provide advice and support.

Weiss suggested that social and emotional loneliness resulted from deficits in two of these social provisions, these were social integration and attachments respectively. As such, each type of loneliness results from deficits in qualitatively different relationships: affiliations and attachments. Affiliations were

suggested to be relationships such as friendships and workplace relationships and, as mentioned, were linked to the provision of social integration. Deficits in affiliations, such as through starting a new job or moving to a new area, were believed to result in social loneliness. In contrast, attachments were suggested to be close, intimate relationships such as romantic relationships or parent-child bonds. Deficits here, such as via divorce, were thought to result in emotional loneliness (Weiss, 1973).

Distinctions between the two types of loneliness were further made in relation to the different forms of distress that they cause. Weiss (1974) suggested that emotional loneliness led to feelings of isolation and anxiety. Whereas social loneliness leads to boredom, aimlessness, and marginality. Further, each type of loneliness could only be improved in specific ways. Social loneliness was suggested to be remediated via the generation of feelings of attachment provided by the formation of new intimate relationships. Social loneliness was suggested to be improved through increased feelings of social integration induced via belonging to a social network.

Support for Weiss' typology of loneliness has been provided by Russell and colleagues (1984). The authors confirmed that the two types of loneliness, as measured via two descriptive statements, were somewhat distinct with the two demonstrating only a weak positive correlation. Support for the specific social provisions suggested to lead to each type of loneliness was also somewhat provided. In line with Weiss' theory, it was demonstrated that emotional loneliness manifests when attachments are not provided by an individual's social relationships. A lack of a romantic relationship, in terms of quality and quantity, also predicted emotional loneliness. Predictors of social loneliness somewhat deviated from Weiss' hypothesis. The analysis suggested that, although the hypothesised provision of social integration was a significant predictor, the social provision of reassurance of worth exerted the greatest influence in this respect. The authors concluded that, social loneliness results from various relational deficits due to a reduced social network. Further, quantity of, and satisfaction with friendships was concluded to be the key determinant of social loneliness. Thus, supporting the differential typology initially suggested by Weiss (1973).

Later work has mostly supported this conceptualisation of loneliness. Vaux (1988) assessed social and emotional loneliness using two descriptive paragraphs based on Russell and colleagues (1984) descriptions as well as via subscales of the University of California Loneliness Scale using items that those same authors identified as having strong correlations with either social or emotional loneliness. The authors demonstrated that the two types of loneliness were somewhat distinct and that the same social provisions as predicted by Weiss, social integration and attachment, were the most strongly associated with social loneliness and emotional loneliness respectively. Reassurance of worth was highlighted as having a relationship with emotional loneliness which is consistent with Russell and colleagues' findings (Russell, Cutrona, Rose, & Yurko, 1984).

Deviating somewhat from these findings, Kraus and colleagues (1993) found that the social provision of attachment was the strongest predictor of both emotional loneliness and social loneliness with social integration and nurturance exerting the next strongest influence respectively. However, what this early work appears to agree on is that the social provisions afforded by attachments and affiliations are key determinants of loneliness.

This multidimensional typology of loneliness was further expanded to acknowledge a distinction within the concept of emotional loneliness. DiTommaso and Spinner (1993) performed a principal components analysis of statements developed to be indicative of Weiss' typology of loneliness. They found that in addition to a social loneliness element, there was a separation between items that related to deficits in family relationships and romantic attachments. The authors suggested a new multidimensional typology based on these findings in which emotional loneliness is a state that can be reached through deficits in either family relationships, romantic relationships, or both.

A variety of tools have been developed to assess the experience of loneliness based on these typologies (See Chapter 2 for a comprehensive account of the tools). However, there are discrepancies relating to the measurement capacity of these scales (for a review see Cramer & Barry, 1999). Given these discrepancies, the incongruencies between the typologies, and the provisions which result in specific types

of loneliness it is important that these scales are fully understood to ensure the accuracy of measurement in specific age groups for example and to inform scale choice where a specific aspect of loneliness is under investigation.

### *1.3.5. Loneliness and Social Isolation*

In contrast to loneliness, social isolation usually refers to the objective quantitative assessment of a lack of, or limited, social contact with others. It is marked by a person having few social network ties, having infrequent social contact, or, potentially, living alone (Dykstra, 2009; National Academies of Sciences, Engineering and Medicine, 2020; Victor, Scambler, Bond, & Bowling, 2022). Social isolation can either be voluntary or involuntary with the former demonstrating a preference for solitude. As such, social isolation is believed to be one of variety structural aspects of social connection alongside other indicators such as marital status and social integration (Holt-Lunstad, 2018) and is thought to be resolved quickly through the creation of social connections and interactions (Wigfield et al., 2020). Loneliness and social isolation can be experienced by an individual concurrently (Victor et al, 2000) or independently (Davidson & Rossall, 2015). The two are not very highly correlated ($r$ = .201) (Coyle & Dugan, 2012), social isolation can lead to loneliness (Petersen et al., 2016) and in some cases, loneliness can lead social isolation (Wenger & Burholt, 2004; Victor et al, 2000). However, although the terms social isolation and loneliness are often used interchangeably, they are considered to be separate phenomena with some key differences.

## 1.4.Determinants of Loneliness

### *1.4.1. Evolutionary Considerations of Loneliness*

Although it is considered an aversive experience which results from deficits in our social connections, loneliness has been considered from an evolutionary perspective and has been suggested to hold some beneficial, adaptive value in the short term. According to Cacioppo's Evolutionary Theory of Loneliness (Cacioppo & Cacioppo, 2018), the aversiveness of the experience is likened to the experience of physical pain, hunger, and thirst which motivate one to take action to prevent physiological damage. This social pain encourages the individual to repair or replace perceived deficiencies in social relationships to relieve this aversion and this would be evolutionary advantageous, increasing the likelihood of passing on one's own genes (e.g., Cacioppo & Cacioppo, 2018; Hawkley & Cacioppo, 2010). In fact, social relationships have been posited to be so intrinsically important to primates that humans evolved unusually large brains i comparison to their body in order to manage the complexity of these social relationships (Dunbar, 1998). Despite this apparent benefit to loneliness, counterintuitively, the experience can also cause a desire to avoid others in a non-conscious drive for self-preservation. Loneliness can indicate that the possibility of mutual aid and altruism is low and so triggers a variety of responses including, a hypervigilance for social threats (Cacioppo, Balogh, & Cacioppo, 2015), an increase in responses that demonstrate concern for ourselves such as selfishness and in some cases spite, and, a set of behavioural and physiological adjustments to aid short term survival (Cacioppo & Cacioppo, 2018). However, these behavioural and physiological adjustments are believed to be pathways to mortality and morbidity for those who experience chronic loneliness.

### *1.4.2. Biological Pathways to Loneliness*

As mentioned, lonely individuals can experience hypervigilance to social threat. This proposition is supported through fMRI data showing increased activation of the visual cortex and decreased activation within the ventral striatum for lonely individuals compared to non-lonely when presented with unpleasant and pleasant social stimuli respectively (Ong et al., 2016). The reduced activation suggests that lonely individuals are less rewarded by social stimuli It is believed that this hypervigilance can lead to documented disruptions to sleep (e.g., Hom et al., 2017). Chronic loneliness, therefore, may lead to sleep disruptions over an extended period. Such disruptions are associated with physiological effects such as glucose intolerance, elevated cortisol levels and increased sympathetic tonus which mimics the effects of ageing. As such, sleep disruption may be one mechanism by which loneliness leads to premature mortality and morbidity.

Lonely individuals have also demonstrated maladaptive stress responses such as alterations in hypothalamic-pituitary-adrenal axis activation and increases in cortisol awakening responses (Hackett et al., 2012). An increased basal sympathetic tonic preparatory state to vasculature and myeloid cells has also been documented. All of these are suggested to enable individuals to mount a rapid neural, hormonal & immunological response in anticipation of social threat in a hypervigilant state. The latter can result in alterations to gene expression involving the upregulation of proinflammatory genes and downregulation of genes involved in viral immunity (Cole et al., 2015) in a pattern named the Conserved Transcriptional Response to Adversity (CTRA). This pattern is evolutionarily beneficial in terms of loneliness when there may be a shift in focus to hostility of social interaction and the potential for bacterial infection due to hostile human or predator contact. While this may have promoted short term survival across history, in the modern world in which humans live close together, viral infection can be passed more readily and chronic inflammation is associated with various diseases such as diabetes and cancer (Schetter et al., 2009; Tsalamandris et al., 2019).

## 1.5.Consequences of Loneliness

In the short term these biological and behavioural adjustments may prove to be beneficial in terms of self-preservation. However, sustained loneliness leading to extensions of these adjustments are associated with a variety of deleterious effects and an increased risk of mortality comparable to that of obesity and of smoking 15 cigarettes per day (Holt-Lunstad et al., 2010, 2015b).

### *1.5.1. Physical Impacts*

The negative physical health outcomes associated with loneliness are well documented. A meta-analysis of longitudinal data has demonstrated that objective and perceived social isolation (loneliness) increased the risk of cardiovascular disease (CVD) and stroke (Valtorta et al., 2016). The analysis of 23 studies suggested that reporting high compared to low levels of loneliness was linked to a 29% increase in the risk of experiencing coronary heart disease and a 32% increase in the risk of stroke. Subsequent research had found that loneliness, but not social isolation, was found to be associated with increased risk of CVD and stroke (Valtorta et al., 2018). Similarly, research has shown that being lonely is associated with an increased risk of hypertension (Bekhet & Zauszniewski, 2012; Cuffee et al., 2014; Hawkley, Thisted, Masi, & Cacioppo, 2010) and that both isolated and lonely people were more at risk of acute myocardial infarction and stroke (Hakulinen et al., 2018).

Links between loneliness and chronic health conditions are also well established. Cross-sectional data indicated that those that self-identified as being lonely were 41% more likely to be affected by self-reported chronic illnesses, 40% more likely have diabetes, 31% more likely to have high cholesterol and 94% more likely to self-report impaired health (Richard et al., 2017). Similarly, reporting feeling sometimes or often lonely compared to not being lonely has been associated with a 2.5 times increased risk of poor self-rated health, a 91% increased risk of experiencing limited physical abilities and a 77% increased risk of multiple diagnoses (Jessen et al., 2018). Associations have also been found in

longitudinal data between loneliness and functional decline (Perissinotto et al., 2012) and motor function (Buchman et al., 2010).

Additionally, meta-analyses have suggested that loneliness is associated with a 50% increased risk of developing dementia (Kuiper et al., 2015). Longitudinal data has demonstrated that loneliness is linked to decreased cognitive function over a 3-year period (Lara et al., 2019). Connections have also been found between loneliness in mid-late life and physiological effects that could affect neurodegeneration in brain regions vulnerable to Alzheimer's Disease (Cacioppo et al., 2002; McHugh & Lawlor, 2013). Further associations have been demonstrated between loneliness and increases in brain amyloid and tau protein (d'Oleire Uquillas et al., 2018; Donovan et al., 2016) further connecting loneliness with pathological changes seen in AD.

### *1.5.2. Psychological Impacts*

Much research has demonstrated an association between loneliness and anxiety and depression (e.g., Choi, 2015) An explanation for these links is provided by the Cacioppo Evolutionary Theory of Loneliness discussed earlier. In relation to depressive symptoms, the theory posits that loneliness leads to depressive behaviours such as facial and postural displays which encourage others to provide aid and companionship. As such, depressive symptomology can be adaptive in the short term. However, the effects of loneliness on depressive states and behaviours can be deleterious in the longer term by reducing the motivation in individuals to attempt to force their way back into social groups that they feel excluded from (Cacioppo, Cacioppo, & Boomsma, 2014; Cacioppo & Patrick, 2008).

Empirical evidence in support of these associations include, a cross-sectional study of 314 older adults living in U.S. retirement communities in which it was found that loneliness was positively associated with both depression and anxiety (Bekhet & Zauszniewski, 2012). Similarly, 53% of older

adults who reported feeling lonely as part of the U.S. based Health and Retirement Study also reported experiencing depressive mood (Donovan et al., 2017).

Longitudinal studies have corroborated and extended these findings, demonstrating that increased loneliness is associated with greater depression over time. Data from the Irish Longitudinal Study of Ageing demonstrated that loneliness is related to clinical depression over a two year period (Domènech-Abella et al., 2019). Similarly findings from the Netherlands Study of Loneliness in Older Adults found those that reported baseline loneliness experienced a poorer course of depression (Jeuring et al., 2018) Likewise, results from the Chicago Health Ageing and Social Relations Study demonstrated that increased loneliness was associated with greater depression at a five year follow up (Cacioppo, Hawkley, & Thisted, 2010).

### *1.5.3. Health Behaviours*

Although much of the evidence around the association between social connections and health-related behaviours appears to be focused on social isolation as a risk factor, loneliness does appear to have an impact on certain behaviours that are known to affect health. Research has demonstrated a link between loneliness and reduced physical activity (Hawkley, Thisted, & Cacioppo, 2009), being overweight and increased levels of smoking (Lauder et al., 2006; Shankar et al., 2011), and greater levels of alcohol consumption (Åkerlind & Hörnquist, 1992; Barretta et al., 1995; Andrew Stickley et al., 2013, 2014). In addition, there is some evidence to suggest an association between loneliness and risky sexual behaviours as well as psychotropic drug use in older adults (Boehlen et al., 2021; Golub et al., 2010).

### *1.5.4. Self-harm, Suicidal Ideation and Suicide Attempts*

Both social isolation and loneliness have been implicated as contributing factors to suicide across age groups and countries in quantitative studies (De Minayo & Cavalcante, 2015). For example, a population wide study examining loneliness in those aged 15 years and over residing in Quebec was recently carried out. Findings suggested that both subjective and objective loneliness (social isolation) were strongly associated with both suicide and parasuicide (Stravynski & Boyer, 2001a). Similarly, a recent review of nine studies suggested a link between loneliness and suicide attempts and suicidal ideation in older adults (Heuser & Howe, 2019). A positive association was also found between loneliness and suicidal ideation in a review of 37 studies into loneliness among residents in nursing homes and long term care facilities between 1985 and 2013 (Mezuk et al., 2014).

Qualitative studies and studies utilising interview data have echoed this link between loneliness and self-harm in older adults (L. B. Huang et al., 2017; van Wijngaarden et al., 2015). A recent systematic review demonstrated that increased levels of loneliness was the main reported motivation for self-harm in a collective sample of 62,755 older adults (Troya et al., 2019). Interviews of 103 older adults residing in Sweden who had attempted suicide revealed strong associations between levels of loneliness and attempted suicide after controlling for depression (Wiktorsson et al., 2010). Additionally, a meta-analysis of 31 studies found that elderly adults were 57% more likely to experience suicidal ideation if they were lonely (Chang et al., 2017).

### *1.5.5. Quality of Life*

Given the negative outcomes linked to loneliness reviewed above, it is unsurprising that evidence also suggests that loneliness can have a negative impact on a person's quality of life. In older adults, research has shown that severe and moderate loneliness has a negative impact on physical and mental quality of life (Ekwall et al., 2005). For example, older adults who are not lonely show fewer depressive

symptoms and those who are lonely are likely to have reduced satisfaction with their lives and lower levels of happiness (Lim & Kua, 2011; Musich, Wang, Hawkins, & Yeh, 2015). For older adults in Italy a similar relationship between loneliness and Quality of Life was demonstrated, with this association being shown to be mediated by depression and anxiety symptoms as well as by self-reported levels of resilience (Gerino et al., 2017).

## 1.6.The Prevalence of Loneliness

As reviewed, the UK Government has allocated policy and resources to combatting loneliness given the many negative associated outcomes both at an individual and at a societal level. Despite this, loneliness remains a prevalent phenomenon in the UK and worldwide.

Although prevalence estimates vary based on the loneliness measure used and on geographical location (Ong et al., 2016), loneliness has been highlighted as a ubiquitous experience worldwide (Surkalim et al., 2006). For example, in a recent report of a national survey of adult American citizens, 36% of respondents reported feeling lonely frequently, most of the time or all of the time (Weissbourd et al., 2020). When measured via a single item with four responses based on frequency and suffering, a representative sample of German adults from the Guttenberg Health Study revealed that 11% of those sampled reported some degree of loneliness (Beutel et al., 2017). In 2017, the UK Office for National Statistics reported that 5% of adults in England reported often or always feeling lonely (Pyle & Evans, 2018). This proportion appeared to remain steady as 6% of the 10,917 adults interviewed for the Community Life Survey in England three years later reported that they often or always feel lonely (Department for Digital Culture, Media and Sport, 2021).

Geographic variation in the prevalence of loneliness has also been identified (Ong et al., 2016). Recent systematic reviews and meta-analyses showed that for Europe, northern European regions consistently reported lower levels of loneliness whereas the highest levels of loneliness were reported in

Eastern European countries (Chawla et al., 2021; Surkalim et al., 2022). The authors demonstrate that there is a paucity of research in non-European countries and in low and lower middle-income countries. Therefore, the full worldwide picture of the prevalence of loneliness is unknown. Despite this, the available research suggests that loneliness is a widespread issue that warrants investigation and intervention across the globe (Ong et al., 2016).

### *1.6.1. Loneliness and the Life Span*

Traditionally, society tends to view older adults as the population most at risk of experiencing loneliness. Evidence does exist to this effect, with a meta-analysis of European data showing that older adults report more loneliness than their younger counterparts (Surkalim et al., 2006). However, recently there have been mixed findings in this regard. Utilising only UK data from the European Social Survey, Victor and Yang (2012) demonstrated a non-linear effect of loneliness on age. In this cross-sectional survey levels of loneliness were reported to be highest for those aged 15-25 years and 65 years and over. Those aged between these age groups reported lower levels of loneliness in comparison. Similar findings were reported from data of the Gutenberg Health Study based in Germany (Beutel et al., 2017). A comparable non-linear relationship between age and levels of loneliness has alsholo been demonstrated in New Zealand (Ministry of Social Development, 2016). This distribution was also found in a meta-analytic analysis of 182 studies of loneliness prevalence (Martin Pinquart & Sörensen, 2001b) and in a review of cross-sectional studies on ageing and loneliness (Dykstra, 2009).

More recently, data collected from the Community Life Survey in the UK indicated that loneliness decreases with age. Here, those aged 16-24 years were more likely to report often or always feeling lonely comparted to all other age groups assessed (Office for National Statistics, 2018). However, it has been posited that these findings may be due to societal or cultural processes that may have affected younger and older respondents differentially. For example, the findings could be due the fact that there was more

stigma associated with reporting loneliness for older respondents when growing up compared to younger respondents (Barreto et al., 2020). Therefore, reported figures for the prevalence of loneliness in older adults may be underestimated, suggesting that this age group is the population that should be targeted when considering loneliness.

## 1.7.Loneliness and Older Adults

As discussed, the evidence suggests that loneliness is a state that can be experienced by individuals of all ages. Despite this, the increased attention that loneliness receives in relation to older adults is not without warrant due to increased risk factors for loneliness associated with older age, the ageing population worldwide and the additional impact loneliness can have on individual health as well as on economic factors when experienced by this population.

### *1.7.1. Prevalence of Loneliness in Older Adults and the Ageing Population*

Although loneliness has been shown to affect younger people equally or more so than older members of society, prevalence in older adults remains a concern. A recent systematic review and meta-analysis of data from 120,000 older adults from 29 high-income countries demonstrated that the pooled prevalence of loneliness in those aged 65 years and over was 29% (Chawla et al., 2021). In the US estimates have varied from 19.1% in over 65s to 43% in over 60s (Perissinotto et al., 2012). Upper estimates of around 57% have also been documented in community dwelling older adults residing in the US aged 60 and over (Gerst-Emerson & Jayawardhana, 2015).

In Asia, comparable estimates have been found. For a sample of 20,255 adults aged over 60 living in China, a loneliness prevalence rate of 30% was documented (Yang & Victor, 2008). For Israeli

residents living in Jerusalem aged 70 years and older loneliness was found to affect 28% of 70 year olds, 24% of 78 and 85 year olds (Stessman et al., 2014).

Similar prevalence estimates have been found in Europe. Victor and Yang (2011) examined loneliness in adults aged 60 and over in 25 European countries. They reported the highest prevalence rates in the Ukraine (34%), Russia (24%), Hungary (21%) and Poland (20%).

In the UK, loneliness has been found to be equally prevalent in older adults. For individuals aged 65 and over residing in the UK, 9% of the sample reported experiencing severe loneliness (Victor & Bowling, 2012). A report published by the Office for National Statistics stated that for the year 2006 – 2007 approximately 8% of adults aged 50 and over living in England reported often feeling lonely (Abrahams, 2018). This figure remained relatively stable at 7% for the year 2017-2018. This equated to around 1.2 million older adults reporting chronic loneliness at these time points. The same report suggested that, based on demographic trends, this number will increase to around 2.1 million by 2025 (Abrahams, 2018). Based on these findings, it is clear that loneliness is a prevalent issue in older adults in both the UK and around the world that warrants targeted intervention in this age group.

### *1.7.2. Physiological Vulnerability and Economic Impacts*

The demonstrated prevalence of loneliness in older adults combined with the ageing population is concerning for both health and economic reasons. As mentioned, the experience of loneliness is associated with increased risk of poor health outcomes. If we consider, for example, the increased risk of cardiovascular disease and stroke, such health issues can cause physical damage to the body and treatment can involve surgery. As the process of ageing can itself result in physiological changes leading to reduced resistance to illness and injury (MacNee et al., 2014), these negative health correlates of loneliness are a cause for concern for those in later adulthood.

For example, ageing has been shown to predispose individuals to developing diseases such as chronic obstetric pulmonary disease and diabetes (Mordarska & Godziejewska-Zawada, 2017). These diseases can cause physiological changes which can impair biological processes such as healing. For instance, ageing impacts immune system functioning, known as immunosenescence, such as impairing white blood cell processes which assist the healing process (Crooke et al., 2019). As well, musculoskeletal regeneration can become impaired in later life creating a barrier to healing and recovery in older adults (Roberts et al., 2016). Older adults are also more at risk of a frail health state (Rohrmann, 2020) which can all lead to longer recovery times in this age group. As well, operative mortality has been shown to increase with age (Finlayson & Birkmeyer, 2001).

Therefore, if experiencing loneliness has the potential to lead to an increased risk of issues such as cardiovascular disease, this means that those individuals are also then at increased likelihood of a longer recovery time following surgery and also of peri-operative risks. Not only can long recoveries cause distress to these individuals, delayed healing and recuperation in this age group has associated health risks such as an increased risk of infection and dehiscence (Singh et al., 2017). This also has potential knock-on effects in terms of increased healthcare service utilisation and associated economic impacts. This all suggests that addressing loneliness in this age group is of great importance.

## 1.8.Risk and Protective Factors in Older Adults

Although ageing itself does not cause loneliness, the prevalence of loneliness in older adults can be attributed to the increased likelihood of this age group experiencing many of the risk factors associated with loneliness.

### *1.8.1. Health Related Risk Factors for Loneliness in Older Adults*

As mentioned, older adults tend to be predisposed to developing certain health issues. These health issues can themselves be risk factors for experiencing loneliness. For example, there is much evidence to suggest that chronic health conditions such as cardiovascular disease and stroke can increase the risk of social isolation and loneliness. There is also evidence to indicate that this relationship may be bidirectional. It has been shown that for individuals who have cardiovascular disease, experiencing loneliness or social isolation can lead to worse outcomes (Air et al., 2016). It has also been suggested that other chronic conditions such as heart failure (Leeming et al., 2014) and chronic obstructive pulmonary disease (Castelino et al., 2018) may also increase the risk for social isolation and loneliness.

This is concerning given that many older adults experience multimorbidity of chronic conditions. In the US it has been reported that around 80% of older adults have at least one chronic health condition and 77% have two (CDC, 2022). For older adults residing in the UK, 40% of over 65s are suggested to have one long-standing illness and 54% of older adults are reported to live with two or more chronic conditions (Age UK, 2019). Thus, a high percentage of older adults may be at increased risk of experiencing loneliness.

Specific conditions linked to ageing can increase the likelihood of individuals experiencing loneliness due to associated embarrassment, stigma, or impaired functional abilities potentially limiting social interaction. For instance, functional status is bi-directionally associated with social isolation and loneliness. Older adults who reduce their activities due to a fear of falling based on functional impairment are at increased risk of becoming lonely (Finch et al., 2014; Parry et al., 2016) and loneliness is an independent risk factor for long term care admission (Hanratty et al., 2018). Urinary incontinence is linked to increased loneliness, although this effect is mediated through comorbid depression (Ramage-Morin & Gilmour, 2013; Andrew Stickley et al., 2017). Hearing loss and associated communication difficulty is linked to both social isolation and loneliness (Davis et al., 2016; Mick et al., 2014; Palmer et al., 2016).

In terms of psychological risk factors, social isolation and loneliness occur more frequently in older adults with depression and anxiety than in those without (Evans et al., 2019; Lim, Rodebaugh, Zyphur, & Gleeson, 2016). Major depression, generalised anxiety disorder and social anxiety disorder have been shown to increase the risk of developing loneliness in late adulthood (Domènech-Abella et al., 2019; Luo et al., 2012; McHugh Power et al., 2020). It has been suggested that this loneliness may be due to cognitive biases linked to depression because of which social interactions are judged as being more negative or viewed as being less rewarding (Burholt & Scharf, 2014; Lewis et al., 2017).

Loneliness appears to be more prevalent in those with dementia than in those without (Karin Holmén et al., 2000). Dementia caregivers and the spouses of those with dementia have been shown to be at greater risk of depression during the course of the condition even once caregiving activities have ceased (K. B. Adams, 2008; Eloniemi-Sulkava et al., 2002).

### *1.8.2. Social Environmental Factors*

The environment within which individuals live can impact on the likelihood of them experiencing loneliness due to its ability to help maintain social engagement. One such aspect is the availability of transportation. Being able to drive has been shown to be linked to lower feelings of loneliness and social isolation (A. E. Barrett & Gumber, 2019; Chihuri et al., 2016). For those who have stopped driving, using public transportation has been associated with reduced levels of loneliness (Matsuda et al., 2019) and using different transport modes has been linked to improved levels of loneliness (van den Berg et al., 2016). Additionally, transport initiatives have been recognised as potential important routes for alleviating loneliness by the UK Government (Department for Transport, 2022).

Many older adults are choosing to remain in their privately owned homes for a variety of personal and practical reasons. This is referred to as ‘Ageing in Place’ (Granbom et al., 2014; Herbert & Molinsky, 2019). Ageing in Place can be both a risk and a protective factor for loneliness in this age group. Ageing

in place can provide comfort and security related to memories associated with one's home with positive effects on loneliness being found in those aged 75 and over (van den Berg et al., 2016). However, doing so can also become detrimental if functional ability declines (Herbert & Molinsky, 2019). Remaining in the same home can also become isolating if transport is not readily accessible and if financial restrictions mean that social activities outside the home are not possible (Finlay & Kobayashi, 2018). It has been suggested that for ageing in place to be achieved successfully a coordinated support system is needed that holistically addresses the needs of the individual If such support systems are not in place, loneliness and depression are more likely to be reported by this age group (Herbert & Molinsky, 2019).

The condition of the local built environment has also been shown to impact levels of loneliness (e.g. Rantakokko et al., 2014). This may be because aspects of this environment can facilitate older adults' participation in out of home activities and increase opportunities for social interaction (Theis & Furner, 2011). Certain aspects of the built environment make the area more usable such as having seating areas, interesting places to visit and useful places to go. Other aspects make the area walkable such as the presence of streetlighting and incorporating pavements with no gaps or obstacles (Raggi et al., 2014). Both aspects have been shown to be beneficial in terms of loneliness. However, the beneficial effect of usability of the built environment appears to be more pronounced in those without depressive symptoms whereas the opposite appears to be true for walkability (Domènech-Abella et al., 2020). A recent review of the available literature has reproduced these findings and has demonstrated that environment quality also relates to improved levels of loneliness (Lyu & Forsyth, 2022) suggesting the utility of optimal local areas in combatting loneliness in older adults.

### *1.8.3. Personal Social Networks and Loneliness*

Given that at its core loneliness is related to social connections and interactions, it is not surprising that the personal social networks of individuals can impact on the likelihood of them experiencing

loneliness. Both structural and functional characteristics of these egocentric networks play a role in this respect.

In terms of structural network characteristics, the size of an individuals' network has been shown to predict social loneliness in adolescents (Green et al., 2001) and loneliness in adults and older adults (Beller & Wagner, 2018; Hawkley et al., 2008) with larger networks being linked to individuals experiencing lower levels of loneliness. Individuals with a denser network and with network members living in close proximity report higher levels of social connectedness which in turn has been linked to lower levels of loneliness (Ashida & Heaney, 2008). Similarly, network density has been found to be the strongest predictor of loneliness in a study examining network size, density and closeness (Stokes, 1985).

Having a romantic partner present in a network predicts emotional loneliness in both adolescents and older adults but this effect has been found to be stronger in older adults (Green et al., 2001). Likewise, the presence of positive marital relationships has been shown to be notably protective against feelings of loneliness (Hawkley et al., 2008). However, marriage can also be detrimental as an inverse relationship has been found between spousal support and loneliness (Hawkley & Kocherginsky, 2018).

Additionally, having close ties and confidants within one's network has also been linked to lower levels of loneliness (Hawkley et al., 2008; van Tilburg, 1990). Network quality, as measured by feelings of closeness to network members, is related to lower levels of loneliness in older adults (Beller & Wagner, 2018). Similarly, frequency of interaction with these strong ties has been shown to be linked to improved levels of loneliness (Y. Lee & Ko, 2018). Specifically, close friendships have repeatedly been shown to be more protective than kin-based relationships in terms of loneliness (e.g. Pinquart & Sörensen, 2001b; Shiovitz-Ezra & Leitsch, 2010; Steed, Boldy, Grenade, & Iredell, 2007). Yet, the relationship between close friendships and loneliness is yet to be explored in greater detail. This is something which may be warranted due to the fact that close friendships are indicative of high-quality relationships (Crespo et al., 2008), which have been shown to improve levels of loneliness (Martin Pinquart & Sorensen, 2003).Having more of these types of relationships may improve loneliness. However, if the relationship is

nonlinear then this may have implications for intervention approaches aiming to encourage the formation of social connections.

As well, the method of contact used to interact with network members has been shown to be important for loneliness. With higher levels of loneliness being reported by individuals who received fewer daily phone calls in comparison to those who received more (Petersen et al., 2016). Virtual contact was shown to be not as effective as in person contacts during the COVID-19 pandemic (Choi, Hammaker, DiNitto, & Marti, 2022). Additionally, those experiencing higher levels of loneliness reported engaging in less face-to-face social interaction (Jin & Park, 2010).

In terms of functional network aspects, social support appears to be important in relation to loneliness. Social support has been broadly defined as an exchange of resources between two individuals perceived by the recipient or provider to be intended to improve the well-being of the recipient (Shumaker & Brownell, 1984). There are four widely accepted domains of social support within which it is believed that all acts of support can be assigned. These are emotional support; support which conveys love, caring, empathy or trust, instrumental support; the provision of tangible goods, services or aid, appraisal support; the communication of information relevant for self-evaluation and informational support; the provision of information to assist problem solving (Langford et al., 1997). Social support in general has been shown to have an inverse relationship to levels of loneliness (Segrin & Domschke, 2011; Segrin & Passalacqua, 2010). Specifically, emotional support appears to offer the most benefit in reducing loneliness compared to informational and instrumental support (Hombrados-Mendieta et al., 2013). It is therefore clear that egocentric social network characteristics of older adults are important considerations for the prevention and improvement of loneliness in this age group. Various means of determining these aspects should be employed to confirm these findings to ensure robust contribution to loneliness intervention strategies.

## 1.9.Thesis Aims and Rationale

Given the prevalence of loneliness in older adults and the associated health, social and economic impacts demonstrated above, it is important that novel interventions comprised of the most protective factors are devised to combat these effects. To this end, the present thesis aims to identify where the knowledge gaps lie in our understanding of loneliness by:

a) Increasing our understanding of the tools available to measure loneliness in older adults
b) Exploring the effect of close friendships on loneliness in this age group in greater depth
c) Assessing the importance of particular egocentric network aspects to protect against loneliness in later adulthood

# Chapter 2. Study 1 - An Exploratory Psychometric Network Analysis of Loneliness Scales in a Sample of Older Adults

This study is currently under revise and resubmit with Current Psychology. Awaiting a decision on the revisions as of 3rd August 2022. A preprint is available here:

**PsyArXiv Preprints | An Exploratory Psychometric Network Analysis of Loneliness Scales in a Sample of Older Adults.**

## 2.1.Abstract

The current study aimed to examine the relationships within and between commonly used measures of loneliness to determine the suitability of the measures in older adults. An additional aim was to determine items of key importance to the measurement of loneliness. Data were obtained from 350 older adults via completion of an online survey. Four measures of loneliness were completed. These were the UCLA Loneliness scale (Version 3), the de Jong Gierveld Loneliness Scale, the Social and Emotional Loneliness Scale for Adults (Short Version) and a direct measure of loneliness. Analysis via a regularized partial correlation network and via clique percolation revealed that only the SELSA-S encompassed loneliness relating to deficits in social, family and romantic relationships. The remaining measures could not distinguish between loneliness associated with deficits in differing types of relationships. These were suggested to tap into a more general social loneliness dimension alone. The direct measure of loneliness had the strongest connection to the UCLA item-4 and the de Jong Gierveld item-1 exhibited the strongest bridge centrality, being a member of the most clusters. The results indicate that should researchers be interested in assessing loneliness resulting from deficits in specific relationships, then the SELSA-S would be the most suitable measure. Whereas the other measures are suitable for assessing loneliness more

generally. The results further suggest that the de Jong Gierveld item-1 may be a more suitable direct measure of loneliness than that currently employed as it taps into a greater number of relationships.

## 2.2.Introduction

As discussed prior, loneliness has been defined as an unpleasant or distressing experience resulting from a perceived qualitative or quantitative deficiency in one's social relationships (Peplau & Perlman, 1982; Russell et al., 1980). Transient experiences of loneliness are believed to be adaptive in that they provide motivation to form and maintain social connections in order to promote the survival of genes (Cacioppo et al., 2006; Cacioppo & Hawkley, 2009; Hawkley & Cacioppo, 2010). However, sustained loneliness has been repeatedly linked to negative psychological and physiological health outcomes. In terms of psychological outcomes include but are not limited to anxiety and depression (Age Uk South Lakeland, 2018; Barg et al., 2006; Hawkley et al., 2010), suicidality (Stravynski & Boyer, 2001a; Van Orden et al., 2010), maladaptive stress responses (Adam et al., 2006; Steptoe et al., 2004), cognitive decline and Alzheimer's Disease (Boss et al., 2015; Donovan et al., 2017; R. S. Wilson et al., 2007). In terms of physiological outcomes this includes cardiovascular disease (Momtaz et al., 2012; Valtorta et al., 2016, 2018), malnutrition (Ramic et al., 2011), sleep quality (B. Yu et al., 2018), functional decline (Perissinotto et al., 2012) as well as increased risk of mortality (Holt-Lunstad et al., 2010, 2015a).

Despite the widely held belief that loneliness is experienced mostly by older adults; as mentioned, research has indicated that younger people are equally as likely to report being lonely. Evidence suggests that there is an inverse curvilinear relationship between age and loneliness with younger and older people experiencing loneliness most frequently (Lasgaard et al., 2016; Luhmann & Hawkley, 2016; Victor & Yang, 2012). Other research shows that loneliness decreases with age (Barreto et al., 2020; Pyle & Evans, 2018; Schultz Jr & Moore, 1988). However, it is not clear whether the latter studies explored the possibility of a U-shaped relationship within their data. It is also possible that older adults are less inclined

to report loneliness due to the stigma attached to doing so as opposed to when they were younger. Meaning that the numbers of older adults experiencing loneliness could be higher than indicated.

Regardless of these findings, it is clear that loneliness is prevalent in older adults as well as younger age groups. For example, in excess of 1 million UK residents over the age of 50 report that they are chronically lonely (Abrahams, 2018). This figure is expected to increase to 2 million by 2025 (Abrahams, 2018). Additionally, the pooled prevalence of loneliness has been estimated to be at around 29% for adults aged 65 and over for 29 high income countries (Chawla et al., 2021). This is cause for concern given the vast array of negative outcomes associated with loneliness and the physiological vulnerability that many older adults experience (MacNee et al., 2014). As well as directly impacting the lived experiences of these older adults, there are implications in terms of increased health and social care service utilisation and associated economic costs. This potential for harm, coupled with the ageing population worldwide (UN DESA's Population Division, 2019), suggests that it is important that loneliness in this age group is understood in order to develop strategies to counteract these negative impacts.

### *2.2.1. The conceptualisation of loneliness*

When discussing loneliness and its negative impacts, it is important to note that although social isolation and loneliness are conceptually similar, they are separate constructs. Social isolation refers to an objectively measured shortfall in an individual's social relationships such as few network ties and low frequency of contact with those ties (Holt-Lunstad et al., 2015b). Loneliness is a perceived deficit between actual and desired quality or quantity of relationships (Peplau & Perlman, 1982). As such, individuals who are quantifiably socially isolated may not experience loneliness whereas those with many social connections can experience loneliness (Donovan & Blazer, 2020). The measures we discuss below are

specifically designed to assess perceived deficits in specific emotional attachments and such are indicators of loneliness rather than social isolation, although there may be some overlap between the two.

The construct of loneliness has been conceptualised as both a unidimensional as well as a multidimensional construct. A seminal multidimensional model of loneliness was suggested by Weiss (1973). This model proposed that loneliness consisted of two dimensions: social and emotional loneliness. He suggested that loneliness in each of these dimensions resulted from a deficit in qualitatively different relationships: affiliations and attachments. Affiliations were suggested to be relationships such as friendships and work acquaintances. In contrast, attachments were suggested to be close, intimate relationships such as romantic relationships or parent-child bonds (Weiss, 1973). Later work in developing measurement instruments to assess loneliness has resulted in the creation of various constructs capturing differing facets of this experience which are discussed below.

### *2.2.2. The Measurement of Loneliness*

Multiple measures of loneliness currently exist. Some of the most commonly employed are the 11-item de Jong Gierveld Scale (dJG) (de Jong-Gierveld & Kamphuis, 1985), the University of California, Los Angeles, Loneliness Scale-Version 3 (UCLA-3) (Russell, 1996), and the shortened version of the Social and Emotional Loneliness Scale (SELSA-S) (DiTommaso et al., 2004). These measures have consistently been found to be reliable in a variety of populations (Adamczyk & DiTommaso, 2014; Buz & Pérez-Arechaederra, 2014; D Russell, 1996) but differ in terms of dimensionality, length and response categories. We now discuss each of these measures in more detail.

#### *The 11-Item de Jong Gierveld Scale*

The 11-item de Jong Gierveld Scale (dJG) aims to capture the multidimensional nature of loneliness proposed by Weiss (1973). However, there has been some debate with regards to the factorial structure of the dJG scale. The scale was originally suggested to be unidimensional with no grounds for bi-dimensionality (de Jong-Gierveld & Kamphuis, 1985). Further support has been evidenced for this

structure (e.g., Buz et al., 2014; Buz & Pérez-Arechaederra, 2014). It has alternatively been proposed to have a two-factor structure (van Baarsen et al., 2001). These factors have been suggested to either relate to the wording of the items in the subscales or to social (positively worded) and emotional (negatively worded) loneliness (Buz et al., 2014; de Jong-Gierveld & van Tilburg, 1999). Van Baarsen and colleagues (2001) further suggest the distinction may be due to emotional items relating to qualitative aspects of loneliness and the social items relating to quantitative aspects of loneliness. Penning and colleagues (2014) suggested that the scale represents a single factor but with the presence of method factors. This distinction between methodological versus factors based on content has been criticised, as it is not possible to determine whether this factor structure reflects the construct of loneliness or is simply a methodological artefact (Grygiel et al., 2019).

### *The Social and Emotional Loneliness Scale for Adults*

The Social and Emotional Loneliness Scale for Adults (SELSA) was also developed based on Weiss' (1973) typology of loneliness (DiTommaso et al., 2004). It is intended to capture both social and emotional loneliness and further subdivides emotional loneliness into romantic and family elements (DiTommaso & Spinner, 1993). The family division of the emotional loneliness subscale is believed to assess loneliness resulting from attachment relationships with family, whereas the romantic subscale is thought to concern loneliness relating to romantic relationships. A shorter version of this scale was developed in order for the resulting scale to be similar in length to other commonly used measures of loneliness and to allow for efficient measurement in clinical settings (DiTommaso et al., 2004). This 11-item scale, dubbed the SELSA-S, was originally shown to have a three-factor structure in line with the three separate subscales (DiTommaso et al., 2004). This factor structure has been later confirmed in both a Turkish version of the scale (Cecen, 2007), a Persian version (Jowkar & Salimi, 2012), and a Polish version of the scale (Adamczyk & DiTommaso, 2014).

### *The University of California Loneliness Scale (UCLA) Loneliness Scale*

The UCLA scale focuses on measuring loneliness in relation to various general social relationships rather than distinguishing specifically between social and emotional loneliness. As such, this measure was intended to capture a single global dimension of loneliness (Russell et al., 1978). The original UCLA scale consisted of 20 items which were all worded in a negative or 'lonely' direction. The first revision of the scale incorporated 10 positively worded items to avoid acquiescence bias; resulting in the UCLA-R (D Russell et al., 1980). The UCLA-R has demonstrated a unidimensional structure (e.g., Hartshorne, 1993; Newcomb & Bentler, 1986; Pretorius, 1993) as well as a multiple factor structure (Ausín et al., 2019; Dussault et al., 2009; Hawkley et al., 2005; Wilson et al., 1992). The second revision of the scale, resulting in the UCLA-3, removed any items containing double negatives to make them easier for an older adult population to understand (Russell, 1996).

As with the original version, the authors suggested that the UCLA-3 scale captures the unidimensional state of loneliness that can be reached via deficiencies in a variety of relationships (Russell, 1982, 1996). A unidimensional structure was reported in work examining the psychometric properties of the scale in a sample of Danish youth aged 13 to 17 years (Lasgaard, 2007).

From its inception there has been debate on whether loneliness as measured by this scale has a unidimensional structure or rather consists of multiple dimensions. For example, Russell (1996) examined the fit of three different factorial models of the UCLA-3 in samples of university students, nurses and teachers and older adults employing maximum likelihood estimation. The authors concluded that a model with a single global bipolar factor along with two method factors accounting for item-wording had the best fit to the data. This finding was supported by a later study examining this measure in a sample of adults with schizophrenia (Eglit et al., 2018). Work by Durak and Senol-Durak (2010) replicated this finding in two separate samples of Turkish students and Turkish older adults. The fit of three separate models to the UCLA-3 were tested via confirmatory factor analysis. It was found that a three-factor model, again consisting of a global loneliness factor and two wording factors (positive and negative), had the best fit in both samples.

An alternative three-factor model of the UCLA-3 has been demonstrated in a study by Boffo and associates (Boffo et al., 2012). Here, exploratory structural equation modelling supported the fit of a three-factor model which comprised Isolation, Relational Connectedness and Trait Loneliness. Similar results were found in a later study by Shevlin and colleagues (2015). Here, confirmatory factor analysis supported the fit of a three-factor model composed of Isolation (relating to feelings of aloneness and rejection), Related Connectedness (concerning attachments to other individuals), and Collective Connectedness (addressing group affiliation). This factorial structure, though not a good fit in absolute terms, was later found to have the best goodness of fit in comparison to a one and two-factor structure in a sample of adults from Germany, Indonesia and the United States (Hudiyana et al., 2021). It should be noted here that this structure has also been demonstrated previously in the first revision of the scale (Louise C. Hawkley et al., 2005). Despite the mixed findings surrounding the underlying structure of the UCLA-3, this measure is typically treated as measuring a unidimensional construct of loneliness as intended by the scale authors (DiTommaso et al., 2004).

### *Single Item Measures*

As well as the use of multi-item scales, it is common for loneliness to be measured using a single item with the aim of capturing a global dimension of loneliness while simultaneously reducing participant burden. For example, A study by Nicolaisen and Thorsen (2014) employed the use of the item ‘Do you feel lonely?’ with response options being ‘Often’, ‘Sometimes’, ‘Seldom’, or ‘Never’. A variety of studies have employed the use of the same question with the same response categories in older adults (e.g., Holmén & Furukawa, 2002; Routasalo et al., 2006; Tiikkainen & Heikkinen, 2010). Similarly, the UK Office for National Statistics (Snape & Martin, 2018) recommends the use of ‘How often do you feel lonely?’ with response options being ‘Often/Always’, ‘Some of the time’, ‘Occasionally’, ‘Hardly ever’ or ‘Never’. They suggested that ideally this measure should be used alongside a short multidimensional measure of loneliness, but where this is not possible, the aforementioned single item is argued to be

sufficient to use on its own. However, to our knowledge, the correspondence of this single item measure to such multidimensional measures has not been explored.

### *2.2.3. Scale Choice*

As has been discussed, a variety of measures to assess loneliness exist. This multitude of measurement options has the potential to make it difficult for practitioners and researchers to determine which measure is most suitable to use, especially in a particular population, such as in older adults.

Moreover, there is some ongoing debate regarding the underlying factorial structure of the majority of these scales. It is therefore somewhat unclear which types of loneliness each of these scales tap into or whether, in contrast, we can treat loneliness as a unitary construct. However, if loneliness is indeed multidimensional, knowledge of which type of loneliness can be assessed by which scale is important as it may have implications for the choice of measurement tool and resulting intervention. For example, loneliness resulting from a deficit in an emotional attachment is unlikely to be improved by increasing social interactions.

It is also not known whether one scale has an advantage over another in measuring loneliness in that they incorporate key items for assessing specific dimensions. Further, some items may overlap in that they are worded similarly (e.g., dJG-8 *There are enough people I feel close to* and UCLA-10 *How often do you feel close to people?)* and others may be more distinct. This overlap could further make it difficult for practitioners and researchers to decide on a measurement tool. Clarity in terms of key items and assessable domains could enable the most effective tool to be selected.

### *2.2.4. A Network Approach*

A novel way to approach this is to estimate the relationships between all items, as a network (Armour et al., 2017; Christensen et al., 2018; Manson et al., 2020; van Rooijen et al., 2017). This allows

the reciprocal relationships between the items to be estimated and visualised. Estimation of a partial correlation network allows connections (edges) between nodes (in this case scale items) to be represented as correlation coefficients after controlling for all other edges in the network. Thereby enabling the strength of these connections to be intuitively understood.

Further, this visualisation can lead to the detection of groupings within the network indicative of the presence of latent variables (Epskamp & Fried, 2018). Therefore, allowing the underlying factor structure of these scales to be explored. Moreover, this visualisation enables us to determine which scales overlap and therefore which types of loneliness each scale is able to assess. These groupings are often referred to as communities or clusters. Within the present paper these groupings will be referred to as clusters throughout.

The reciprocal nature of the connections within the network also enable us to better understand the interrelationships between loneliness 'symptoms. It may be that certain dimensions of loneliness are more strongly related to others. For example, it could be that items related to romantic loneliness, as captured with the SELSA, are more strongly connected to an item from the UCLA like: 'How often do you feel that you lack companionship?' than items relating to family loneliness. This would have important practical implications for which social relationships to target. Observing scale items (symptoms) this way has been beneficial in the field of psychopathology such as with PTSD (e.g.' Armour et al., 2017), however this has not yet been applied to loneliness.

An additional benefit over traditional factor analysis techniques is that items can be assessed to determine their centrality within the network. Whereas more commonly used methods aim to reduce cross-loading between factors, assessing this centrality between factors gives an indication of a node's connectivity between factors. Despite these benefits, such analyses appear not yet to have been applied to such measures of loneliness.

### *2.2.5. The Present Study*

As outlined above, the use of a network approach to examine the interrelationships within and between commonly utilised loneliness measures is warranted. To this end, the present study aimed to extend previous findings in the following key ways. First, we estimated a network containing all items from the four loneliness measures via a regularised partial correlation model. This allowed us to determine which items had the strongest connections; of particular interest were those relating to the direct measure of loneliness. This also allowed us to examine the underlying structure of the measures by visually assessing clustering of items. Clique percolation was used to further identify clusters within the network and to identify items with strong connections to more than one cluster. Bridge centrality statistics were also estimated to determine which items had the most connectivity between these clusters.

In terms of factorial structure, we expected to find a two factor structure for the dJG scale in line with previous findings. For the SELSA-S we expected to uncover a three factor structure in line with the three proposed subscales. Given the mixed findings for the UCLA scale in relation to factorial structure, we expected to uncover a three factor structure. However, the items belonging to each factor remain exploratory in nature. This is because a variety of differing three factor solutions have been recovered (Boffo et al., 2012; Sancho et al., 2020; Shevlin et al., 2015) (e.g., Boffo et al., 2012; Sancho, Pinazo-Hernandis, Donio-Bellegarde, & Tomás, 2020; Shevlin et al., 2015). We expected to observe some overlap between the types of loneliness that each scale is able to assess given scale item similarity and the theoretical basis of loneliness each scale was designed on. As such we tentatively expected that there may be some overlap between the social loneliness aspects of all of the scales possibly forming one cluster and overlap between the emotional loneliness aspects of the dJG scale and the SELSA-S potentially forming another cluster.

## 2.3.Method

### *2.3.1. Design*

This was a cross-sectional network analysis of scale item scores across four measures of loneliness in older adults.

### *2.3.2. Sample*

A target sample size of 400 was pre-registered, this was primarily determined by cost and a heuristic that the sample sizes would be sufficient for structural equation modelling (SEM) (e.g., Barrett, 2007)., The pre-registered sample was deemed to be sufficient for SEM (for further details see the pre-registration on the Open Science Framework (OSF) page ). A total of 350 residents of the United Kingdom aged 65 or over responded to an online questionnaire. This was advertised via the recruitment platform Prolific (Palan & Schitter, 2018), via social media posts and via word of mouth. Recruitment was terminated once further responses ceased for three consecutive days. Those that completed the questionnaire via Prolific were paid £2 upon completion (n = 290). To be eligible to take part in the study participants were required to not have had a current clinical diagnosis of depression or anxiety. The requirement for a lack of diagnosis is due to ethical concerns of these participants completing the measures in our survey, as well as potential confounding issues. The initial sample consisted of 350 respondents (138 male, 211 female and one participant did not specify).

### *2.3.3. Measures*

Four measures of loneliness were employed within this study. These were as follows:

***The 11-item de Jong Gierveld Loneliness Scale***

The 11-item de Jong Gierveld Scale (dJG) (de Jong-Gierveld & Kamphuis, 1985). This scale includes two sub-scales. An emotional loneliness sub-scale consisting of 6 negatively worded (non-lonely) items and a social loneliness subscale consisting of 5 positively worded (non-lonely) items. Respondents are asked to indicate how much each statement applies to their current situation (e.g. I miss having a really close friend). Response options were adapted from the original version (yes!, yes, more or less, no, no!) to improve their interpretation. The options were 'All of the time', 'Often', 'some of the time', 'Rarely' and 'None of the time'. Responses in the original dJG are dichotomously scored by summing the positive and neutral responses for the emotional loneliness items and by summing the negative and neutral responses for the social loneliness items. The scale can also be utilised as a global unidimensional measure of loneliness by summing the scores for both sub-scales. Greater scores indicate greater levels of loneliness. In the present study, based on previous critiques (e.g., van Baarsen et al., 2001), and as done in previous studies (e.g., Penning et al., 2014; van Tilburg et al., 2004) (we instead reverse-scored non-lonely items and did not dichotomize scores based on valence. Internal reliability has previously been found to be good for the global scale as well as for both subscales (All Cronbach's $\alpha > .80$) (Grygiel et al., 2019). Reliability for the global scale in the present study was found to be excellent (Cronbach's $\alpha = .92$). For the subscales, the internal reliability was found to be good: emotional loneliness (Cronbach's $\alpha = .89$) and social loneliness (Cronbach's $\alpha = .88$).

***The University of California Loneliness Scale Version 3***

The University of California, Los Angeles, Loneliness Scale (Version 3) (UCLA-3) (D Russell, 1996). The UCLA-3 is a 20-item self-report scale designed to measure an individual's subjective feelings of loneliness. Participants are asked how often each statement is descriptive of them (e.g., How often do you feel that you lack companionship?). Items are on a scale ranging from 1 (Never) to 4 (Often) and nine items are reverse scored (non-lonely). As the scale is intended to capture a unidimensional construct of loneliness, all items are summed to give a single loneliness score; a higher score represents greater levels of loneliness. Internal reliability has previously been found to range from good (Cronbach's $\alpha = .89$) to

excellent (Cronbach's $\alpha$ = .91) (Russell, 1996). Internal reliability for this scale in the present study was found to be excellent (Cronbach's $\alpha$ = .94). Previously reported reliability for the commonly reported three subscales has been found to be: Isolation - Cronbach's $\alpha$ = .85, Related Connectedness - Cronbach's $\alpha$ = .74, Collective Connectedness - Cronbach's $\alpha$ = .70. For the commonly reported three subscales in the present study, reliability was as follows: Isolation - Cronbach's $\alpha$ = .94, Related Connectedness - Cronbach's $\alpha$ = .94, Collective Connectedness - Cronbach's $\alpha$ = .94) (Shevlin et al., 2015).

***The Short Social and Emotional Loneliness Scale***

The shortened version of the Social and Emotional Loneliness Scale (SELSA-S) was developed in order for the resulting scale to be similar in length to other commonly used measures of loneliness and to allow for efficient measurement in clinical settings (DiTommaso et al., 2004). The SELSA-S is a 15-item multidimensional measure of loneliness designed to measure both social and emotional loneliness. The family division of the emotional loneliness subscale is believed to assess loneliness resulting from attachment relationships with family, whereas the romantic subscale is thought to concern loneliness relating to romantic relationships. The SELSA-S consists of three subscales: social, emotional family and emotional romantic loneliness. Each subscale consists of 5 items. Items are on a scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree) and three items are reverse scored for each subscale. Higher scores represent higher levels of loneliness. A total emotional loneliness score can be obtained by summing the family and romantic subscales. For the subscales, reliability has been found to range from good to excellent: family subscale (Cronbach's $\alpha$ = .89), romantic subscale (Cronbach's $\alpha$ = .87) and the social subscale (Cronbach's $\alpha$ = .90) (DiTommaso et al., 2004). Internal reliability for the total emotional loneliness scale in the present study was found to be good (Cronbach's $\alpha$ = .86) as was the reliability for the family subscale (Cronbach's $\alpha$ = .89) and the romantic subscale (Cronbach's $\alpha$ = .84). Internal reliability for the social emotional loneliness subscale was also found to be good (Cronbach's $\alpha$ = .81).

***Other Measures***

A direct measure of loneliness 'Do you feel lonely?' which has been used to assess loneliness in a variety of studies previously (e.g., Holmén & Furukawa, 2002; Nicolaisen & Thorsen, 2014; Routasalo et al., 2006). This had four response categories: Often, Sometimes, Seldom and Never. This measure was reverse scored. This question has been reported to have good predictive and face validity (Routasalo et al., 2006). Other measures were collected but are not reported here. These include the short version of the Depression Anxiety and Stress Scale (DASS-21) (Lovibond & Lovibond, 1995), the Satisfaction with Life Scale (SWLS) (Diener et al., 1985), and respondent's ideal and actual number of close friends. The design of the study, questionnaire and all variables are available from the OSF.

#### *2.3.4. Procedure*

Ethical approval was granted by the local ethics committee at Northumbria University. After informed consent was obtained, participants completed all measures via an online questionnaire hosted by ("Qualtrics Survey Software," 2020) available at https://www.qualtrics.com. The demographic measures were completed first followed by each of the loneliness scales. The order in which these scales were presented were randomised. This was followed by completion of the SWLS, DASS-21 and the participant's number of actual and ideal close friends. The whole questionnaire took no longer than 20 minutes to complete.

#### *2.3.5. Analytical Approach*

All analyses were performed using R version 3.6.1 (R Core Team, 2017). Two cases that contained missing data for some of the loneliness scale items were removed. This resulted in a final sample of 348 participants. Data and code for this manuscript are available on the OSF

### *Network Estimation*

In order to ascertain the edge weights between all items and to determine underlying factor structure, a regularized partial correlation network containing all of the items from each of the four

loneliness measures was estimated via the 'bootnet' package (Epskamp et al., 2018). Here, items were colour coded based on the theoretical loneliness scale they belong to in order to visualise clustering. The regularization technique employed was the Graphical LASSO (Least Absolute Shrinkage and Selection Operator) with EBIC (Extended Bayesian Information Criterion) tuning parameter, in line with recommendations of Epskamp and colleagues (Epskamp et al., 2018; Epskamp & Fried, 2018). The tuning parameter automatically selects the best network model by optimising the fit of the network to the data by minimising the EBIC. The EBIC hyperparameter determines how much the EBIC prefers simpler models over more complex models. In this instance, the hyperparameter was set to 0.5 which dictates a stronger preference for models which retain the fewest edges. As noted by Epskamp (2018) the choice of hyperparameter value depends on the goals of study in question. This particular hyperparameter was chosen based on the expected dense structure of the current model. Here, spurious edges shrink to exactly zero and drop out of the model resulting in a sparse model. Thus, increasing interpretability of the model. Unsurprisingly, as some of the scales only have 4 response categories, the assumption of multivariate normality was violated. In order to handle this, the 'corMethod' argument is set to 'corAuto' in bootnet, which leads to the detection of ordinal data and the computation of polychoric correlations, which are then carried forward in the network estimation algorithm. This process overcomes the need to transform the data (Epskamp & Fried, 2018).

Once the edge weights had been estimated they were bootstrapped via a non-parametric method which constructs 95% confidence intervals around the estimated edge weights. This provides an indication of the accuracy of the edge weight estimates.

### *Cluster Identification*

Many traditionally used clustering methods force nodes (in this case, items) to be part of one cluster only such as the walktrap algorithm method (Pons & Latapy, 2005). However, it is not uncommon for items to cross-load, therefore it might be unrealistic to assign items to only a single cluster. Therefore, a weighted clique percolation plot was generated using the 'CliquePercolation' package (Lange, 2019).

This allows to further elucidate the underlying factor structure and to determine which nodes may belong to more than one cluster. Here, the clusters are not explicitly defined based on the theoretical loneliness measure the items belong to and are instead determined via an algorithm. The algorithm implemented within this package requires that researchers optimise *i* (strength of the partial correlation between nodes) and *k* (minimum clique or cluster size) for the network in question. In line with recommendations, this optimisation is based on the ratio threshold exceeding a value of 2 (Fried, 2019).

***Bridge Centrality Estimation via Bridge Expected Influence***

Network centrality indices are commonly used to determine a node's (or in this case an item's) relative importance within the network (e.g., Rodrigues, 2019). Of particular interest, were the nodes which displayed the strongest connectivity with separate measures of loneliness. Here, the clusters were explicitly defined based on the theoretical loneliness scales that the items belong to (See Figure 1). Items which displayed connectivity between the separate scales (clusters) were then identified via a particular bridge centrality estimation, bridge expected influence. Bridge expected influence is a centrality measure which, in this instance, estimates a node's sum connectivity with separate measures of loneliness (Jones et al., 2019), these nodes act as a bridge between separate loneliness measures. Although the suitability of centrality estimation for psychological networks has been questioned (Bringmann et al., 2019), expected influence and strength have been proposed to be more appropriate in comparison to betweenness and closeness. Additionally, bridge expected influence and bridge strength were devised for the purpose of identifying key psychometric items which act as bridges between theoretically determined psychological communities (Jones et al., 2019).

The stability of this centrality measure was assessed via a case drop bootstrap via the 'bootnet' package. The results of this bootstrap can be summarised via a correlation stability coefficient. This coefficient indicates the proportion of cases that can be dropped to retain with 95% confidence a correlation of at least .7 with the original coefficient. Ideally, the value of this coefficient should be above .5, however, a value above .25 is deemed acceptable (Epskamp & Fried, 2018).

There are multiple other network centrality metrics which could be derived for a psychometric network analysis, these are reported in full on the OSF.

## 2.4.Results

Sample characteristics and descriptive statistics are presented in Table 1. In the final sample 60% of participants were female and 40% were male. The mean age of participants was 69 years (*SD* = 4.29). Most participants reported being married or in a civil partnership (62%) and having completed an undergraduate degree (35%). All were residents of the United Kingdom.

## Table 1

*Sample Characteristics (n = 348)*

| Characteristic | Statistic (Mean (SD) or n (%)) |
|---|---|
| **Age** | 69.44 (4.35) |
| **Gender** | |
| Female | 209 (60) |
| Male | 137 (39) |
| Undisclosed | 2 (<1) |
| **Marital Status** | |
| Single | 19 (6) |
| In a relationship | 28 (8) |
| Married/ Civil Partnership | 215 (62) |
| Separated | 5 (1) |
| Divorced | 51 (16) |
| Widowed | 29 (8) |
| Undisclosed | 1 (<1) |
| **Education** | |
| Primary school | 2 (<1) |
| Some secondary school | 30 (9) |
| GCSE's or equivalent | 67 (20) |
| A level or equivalent | 70 (20) |
| Undergraduate degree | 118 (34) |
| Postgraduate degree | 59 (17) |
| Undisclosed | 2 (<1) |
| **UCLA** | 40.17 (11.76) |
| **DJG Total** | 2.22 (1.94) |
| **DJG Emotional** | 2.19 (2.14) |
| **DJG Social** | 2.22 (1.94) |
| **SELSA Social** | 15.3 (6.44) |
| **SELSA Emotional** | 28.82 (12.95) |
| **SELSA Family** | 11.97 (6.95) |
| **SELSA Romantic** | 16.86 (6.68) |

### *2.4.1. Regularised Partial Correlation Network Estimation*

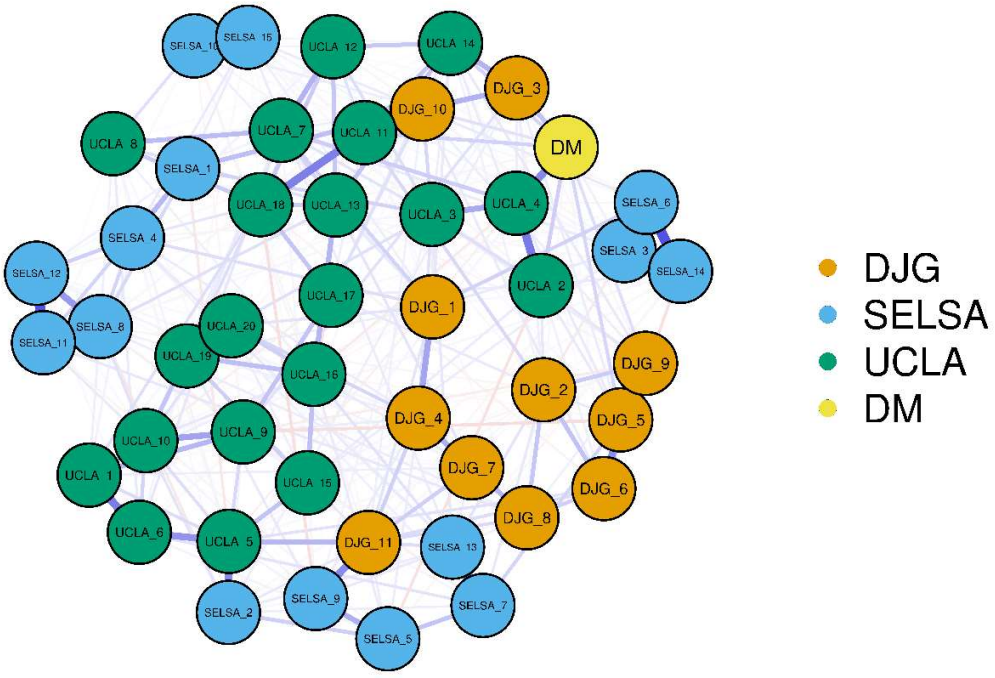
For scale item descriptions please see Appendix A. Visual inspection of the initial regularised partial correlation network revealed a mostly unitary structure for the UCLA-3 (Figure 1). For the dJG, two groupings emerged. One grouping consisted of a dyad representing the two emotional loneliness nodes examining emptiness and rejection (dJG-3 & dJG-10). The second grouping consisted of the remaining dJG nodes with no further distinction between social and emotional loneliness. For the SELSA-S, there appear to be four groupings. All social loneliness nodes comprised one group. All family emotional loneliness nodes comprised the second grouping. For romantic emotional loneliness, a further distinction was made between the positively worded and negatively worded items. The plot is displayed in Figure 1. Within this plot the items have been colour coded based on the respective scales they theoretically belong to.

Of note, the direct measure of loneliness (*Do you feel lonely?*) had the strongest partial correlation with the UCLA-4 item (How often do you feel alone?) ($r$ = .243, 95%CI [.141, .338]; raw correlation $rs$= .73 ). The next four strongest connections were with: the dJG-3 item (*I experience a general sense of emptiness*) ($r$ = .128, 95%CI [.034, .221]), the UCLA-2 item (*How often do you feel that you lack companionship?*) ($r$ = .123, 95%CI [.020, .230]), the dJG-5 item (*I miss the pleasure of the company of others*) ($r$ = .093, 95%CI [.007, .3179]), the UCLA-11 item (*How often do you feel left out?*) ($r$ = .095, 95%CI [.014, .178]).

Some overlap between the bootstrapped confidence intervals for the edge weights can be seen here, implying that the order of the edge weights should be interpreted with caution. However, the overlap is much less marked for the edge between the direct measure and the UCLA-4, suggesting some confidence that this is the most strongly connected item to the direct measure.

**Figure 1**

*Regularised Partial Correlation Network Containing Items from all Loneliness Measures. dJG = de Jong Gierveld scale, UCLA = University of California Los Angeles scale, SELSA = Social and Emotional Loneliness Scale for Adults, DM = Direct measure of loneliness.*



### *2.4.2. Clique Percolation Cluster Identification*

Inspection of the Clique Percolation plot identified five clusters as outlined below. This plot is displayed in Figure 2:

The first cluster consisted of the SELSA-S romantic loneliness nodes that were positively worded (non-lonely e.g., *I have a romantic partner with whom I share my most intimate thoughts and feelings*) which comprised one cluster as found in the previous network estimation but with the addition of the dJG-3 node ( *'I experience a general sense of emptiness'*).

The SELSA-S negatively worded romantic loneliness nodes comprised a second cluster as in the previous estimation. However, this cluster also included dJG-1.

The SELSA-S family emotional loneliness nodes made up the majority of a third cluster. This cluster also included UCLA-10 (*'How often do you feel close to people?'*) and dJG-8 (*'There are enough people I feel close to'*).

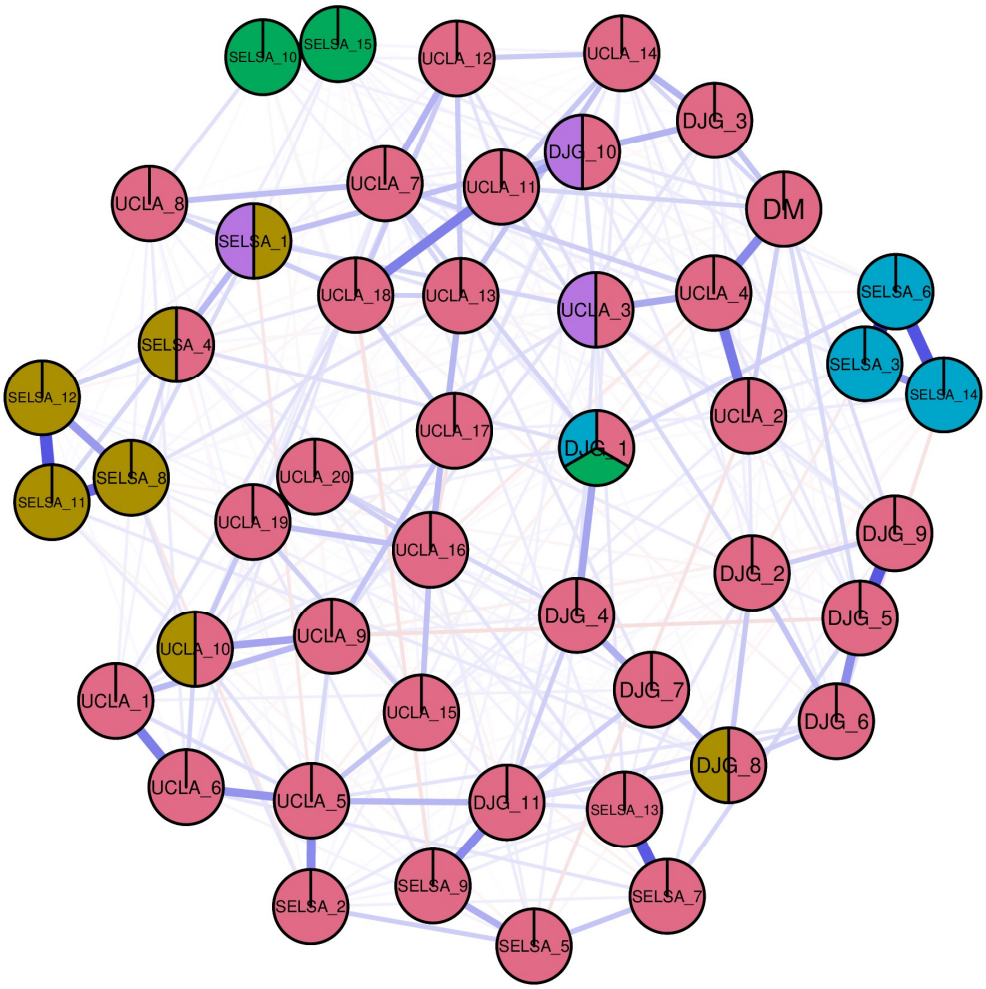
A fourth cluster consisted of nearly all of the UCLA nodes. However, this cluster also contained the SELSA-4 family loneliness item (*'There is no one in my family I can depend on for support and encouragement, but I wish there was'*), all five of the SELSA-S social loneliness nodes, the direct measure of loneliness, all of the dJG social loneliness nodes and all of the dJG emotional loneliness nodes.

A fifth cluster consisted of three items which were assigned to two clusters each. These were SELSA-1 (third and fifth clusters) (*'I feel alone when I am with my family'*), UCLA-3 (fourth fifth clusters) (*'How often do you feel there is no one you can turn to?'*) and dJG-10 (fourth and fifth clusters) (*'I often feel rejected'*).

Finally, the dJG-1 item (*'I experience a general sense of emptiness'*) is assigned to three different clusters (second, third and fourth clusters).

**Figure 2**

Clique Percolation Network Containing Items from all Loneliness Measures. dJG = de Jong Gierveld scale, UCLA = University of California Los Angeles scale, SELSA = Social and Emotional Loneliness Scale for Adults, DM = Direct measure of loneliness.



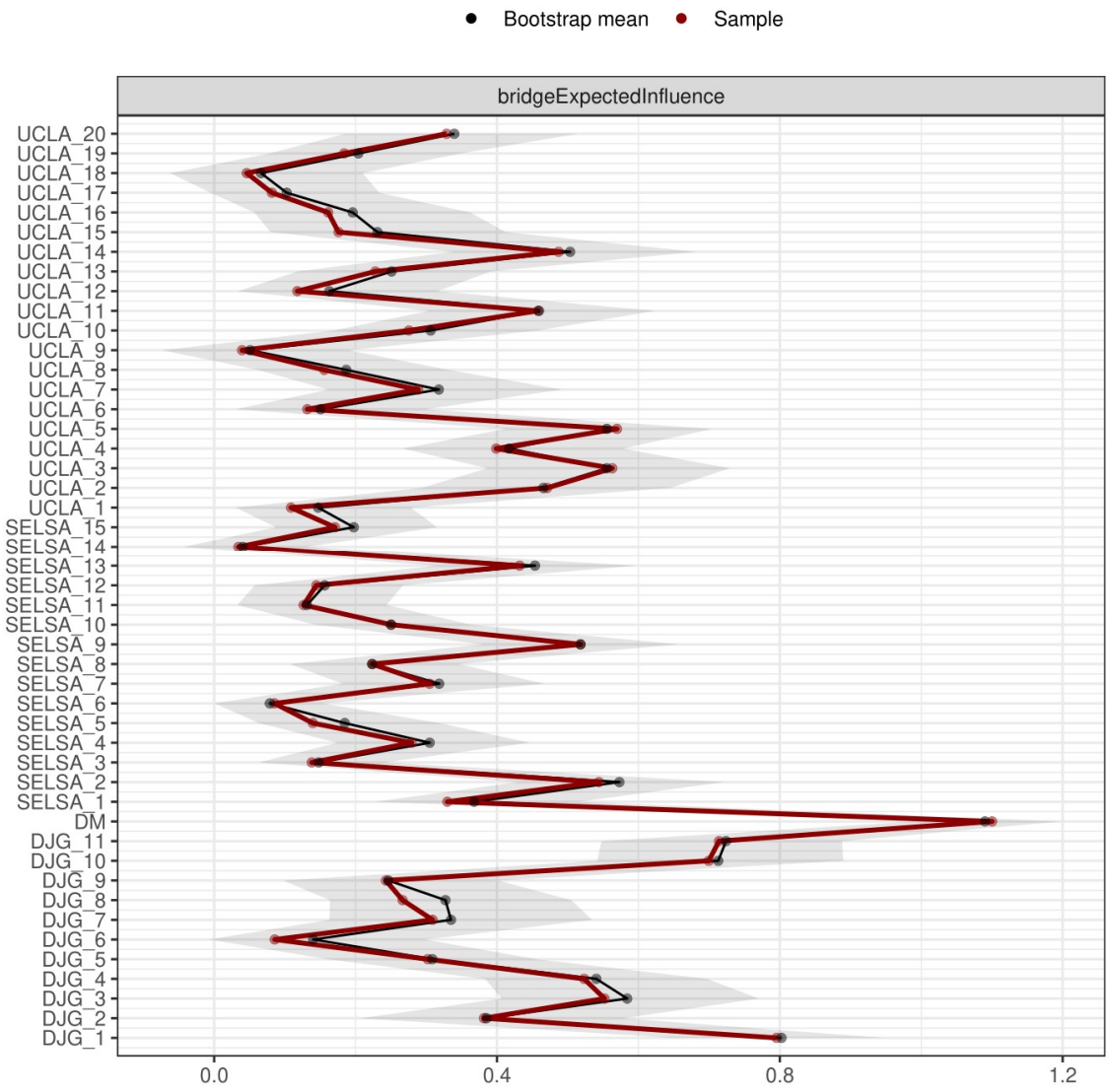

### *2.4.3. Bridge Expected Influence Estimation*

When examining bridge centrality, unsurprisingly the single item direct measure of loneliness had the strongest connectivity to all of the measures, as it is a single item and hence its own cluster. The three nodes that exhibited the next strongest bridge expected influence between the explicitly theoretically

defined scale clusters within the network in descending order are as follows: dJG-1 (*'There is always someone I can talk to about my day-today problems'*), dJG-11 (*'I can call on my friends whenever I need them'*) and dJG-10 (*'I often feel rejected'*). This suggests that these three nodes have the strongest connectivity with other loneliness measures. Following bootstrapping, the dJG-1 item was shown to have stronger bridge expected influence than the dJG-10 item. Further, the bridge expected influence estimate was found to be stable as, following a case resampling bootstrap, the centrality stability coefficient passed the accepted cut off of 0.5 (*CS*(cor = .7) = .595). See Figure 3 for bridge centrality estimates.

**Figure 3**

*Bootstrapped Bridge Expected Influence Estimates for all Measure Items.*




## 2.5.Discussion

The present study aimed to, within a sample of older adults, explore the interrelationships between all items from the UCLA-3, SELSA-S, dJG and a direct measure of loneliness via the estimation of a regularised partial correlation network. Further aims were to determine factorial structure within this

network and to determine the items with the strongest connectivity between the separate measures of loneliness.

It should be noted that the factor structure recovered for each individual scale is influenced by every scale included in the network. Different clusters (factors) may be found when performing network analysis separately for each scale. These separations may not be distinct enough to be seen when all scales are examined simultaneously, and more overarching clusters may be observed. However, our aim was to determine shared clusters (factors) between the scales and to determine similarities and differences in the types of loneliness that each scale is able to assess.

### *2.5.1. SELSA-S*

Regularised partial correlation network estimation demonstrated that the SELSA-S appears to be distinct from the other measures of loneliness. The romantic loneliness scale items were grouped together with a further distinction between the positively and negatively worded items of the SELSA-S. Clique percolation confirmed this finding by allocating these nodes to separate clusters. This is in contrast to previous work which has found no such separation (Adamczyk & DiTommaso, 2014; Ditommaso & Spinner, 1997). The SELSA-S family loneliness scale was also found to be a distinct entity in both estimations as is indicated in previous work (Adamczyk & DiTommaso, 2014; DiTommaso et al., 2004). The social loneliness subscale of the SELSA-S was also identified as a separate cluster. These findings add some credence to the previously identified three-factor structure of the SELSA-S, albeit with potentially an additional method factor for the romantic subscale. All of the above suggests the utility of the SELSA-S for researchers and clinicians in determining the type of relational deficits that are resulting in the experience of loneliness.

### *2.5.2. dJG*

For the dJG scale, a separation was observed. A dyad emerged containing the only two nodes which related to rejection and emptiness (dJG-10 & dJG-11). Notably, the two items in this cluster refer only to specific feelings or states with no explicit reference to personal relationships. The remaining nodes all refer to people, others or friends, which could explain the distinction between these two items and others. However, clique percolation did not identify these two items as a separate cluster assigning all nodes to the same cluster. This is in line with previous demonstrations of the unidimensionality of this scale (Buz et al., 2014; Buz & Pérez-Arechaederra, 2014; de Jong-Gierveld & Kamphuis, 1985).

The clique percolation plot identified that both the emotional and social loneliness subscales were incorporated into one large factor which also included all UCLA items and the SELSA social loneliness subscale, suggesting that these items all tap into a similar construct.

Clique percolation further indicated that the dJG-8 node (*'There are enough people I feel close to'*) was also part of the SELSA-S family loneliness cluster. This indicates that even though the dJG in general appears to be measuring a construct similar to that of the UCLA scale and the SELSA-S social loneliness scale, this particular item is the exception and may be more aligned to family loneliness. Similarly, the dJG-1 node (*'There is always someone I can talk to about my day-today problems'*) was part of both SELSA-S romantic loneliness clusters. As these are only single items and as none of the dJG items refer specifically to either romantic or family relationships, their usefulness in capturing these relational aspects of loneliness could be limited.

Our findings suggest that if researchers are using the dJG measure they are likely unable to identify aspects of loneliness relating to specific functional social ties. Deficits in romantic relationships, based on marital status, are known to be strong predictors of loneliness (Child & Lawton, 2019; Golden et al., 2009; Theeke, 2009), as well as its psychological and physiological health correlates (for a review see Smith & Christakis, 2008). Similarly, although research suggests that social loneliness (e.g., deficits in

friendships) is more important in relation to loneliness (e.g., Lee & Ishii-Kuntz, 1987; Shiovitz-Ezra & Leitsch, 2010; Silverstein et al., 1996), family relationships are also important in their own right (Mullins et al., 1987; Martin Pinquart & Sörensen, 2001b; Steed et al., 2007). Therefore, if researchers are interested in these relational aspects of loneliness, the dJG may not be as beneficial as other measures.

#### *2.5.3. UCLA*

The UCLA-3 scale was largely grouped together into one unitary structure. This supports the unidimensionality of the UCLA-3 scale as suggested by Russell and colleagues (Russell, 1982, 1996). Our network analyses did not support method factors based on the wording of the items leading to clustering as has been found in previous studies (Boffo et al., 2012; Durak & Senol-Durak, 2010; Russell, 1996). As mentioned above, the clique percolation network method grouped the UCLA-3 further together with the SELSA-S social loneliness subscale and the dJG social and emotional subscales. No UCLA items were part of the romantic loneliness cluster. This could suggest that, like the dJG, the UCLA scale may not capture romantic loneliness. Further, only the UCLA-10 item (*'How often do you feel close to people?'*) was part of the SELSA-S family loneliness cluster as well as the larger loneliness cluster. This indicates that this particular node may tap into the family aspect of loneliness. However, as this is only one item and none of the UCLA items explicitly mention family relationships, the usefulness of this node in capturing this family aspect is limited. The same issues mentioned above of a lack of capturing these relational aspects for the dJG thus apply here also.

It is possible that the main loneliness cluster, identified via clique percolation, could be solely measuring social loneliness. At first glance, the inclusion of the dJG emotional loneliness subscale might indicate that this cluster is indicative of both social and emotional loneliness. Yet, based on closer inspection of the dJG emotional loneliness items it is clear that none of these items explicitly refer to deficits in specific emotional attachments. Indeed, only one item refers to a close relationship, rather than a deficit in social interactions or feelings; namely emptiness or rejection. Similarly, the items from the UCLA scale only rarely refer to a close relationship and do not further refer to emotional attachment.

Based on this and the inclusion of both the UCLA scale and both subscales of the dJG we suggest that the dJG and UCLA measures of loneliness by and large assess social loneliness. It seems, therefore, that should a researcher wish to capture deficits in specific relationships, such as family or romantic attachments, that the SELSA-S should be the preferred measure. The other measures (dJG, UCLA) are suitable for research where measuring social loneliness is key.

The clique percolation estimation identified a further cluster consisting of three nodes that belonged to two groups each. These were SELSA-1 (*'I feel alone when I am with my family'*), UCLA-3 (*'How often do you feel that there is no one you can turn to?') and dJG-1 ('There is always someone I can talk to about my day-today problems'*).

### *2.5.4. Edge Weight Estimation*

In regards to specific connections within the networks, the strongest edge weight in relation to the direct measure of loneliness was found in connection to the UCLA-4 node which states '*How often do you feel alone*'. This is perhaps unsurprising given the similarity of wording between the UCLA-4 item and the direct measure of loneliness; which states 'Do you feel lonely?' with similar frequency response options. Interestingly, the wording of both the direct measure and the UCLA-4 item are aligned very closely to the single item loneliness measure recommended by the Office for National Statistics (*How often do you feel lonely?*) (Snape & Martin, 2018). Similar to the points regarding the UCLA-3 and dJG scales, the finding that this direct measure links most strongly to items which fall within the large social loneliness cluster and only very weakly, if at all, to any node from the romantic and family subscales of the SELSA-S suggests that the direct measure of loneliness may not tap into a lack of any specific personal relationship, but rather social loneliness. This recommended measure is perhaps not adequate for assessing loneliness in relation to deficits in specific emotional attachments or relationships.

### *2.5.5. Bridge Expected Influence Estimation*

The dJG-1 item (*'There is always someone I can talk to about my day-to-day problems'*) demonstrated the strongest bridge expected influence after the direct measure. This suggests that this particular node has the strongest connectivity to the other measures of loneliness (See Figure 3). Clique percolation further supported this finding, showing that this node was part of three different clusters (See Figure 2). It belonged to the large social loneliness cluster as well as both of the romantic loneliness (positively and negatively worded) clusters. Interestingly, although the direct measure of loneliness demonstrated the most bridge expected influence (See Figure 3), as mentioned above, clique percolation did not assign it to more than one cluster (See Figure 2). This further suggests that this item does not tap into the family and romantic relationship aspects of loneliness. Perhaps the dJG-1 item could thus also be suited as a direct measure of loneliness as our findings suggest that this item taps into both romantic and social loneliness. However, as with the currently used direct measure, surprisingly, this item does not seem to tap into family-based loneliness.

The dJG-11 (*'I can call on my friends whenever I need them'*) and the dJG-10 (*'I often feel rejected'*) items also demonstrated comparatively stronger bridge expected influence than others suggesting that these items have strong connectivity to the other measures. However, these findings were not further corroborated by the clique percolation plot.

### *2.5.6. Implications*

As highlighted, our findings point to the utility of the SELSA-S in assessing loneliness based on specific relational deficits. This means that should researchers and clinicians be interested in identifying the specific relational, or to assess the success of an intervention targeting specific relationships, then the SELSA-S is likely to be the most useful instrument of choice.

Importantly, it does not appear that the UCLA or dJG scales are able to tap into loneliness resulting from deficits in these specific attachments. This is despite the latter being modelled on Weiss'

typology of social and emotional loneliness. This has implications for scale choice as choosing the dJG scale may not fully capture what the researcher or practitioner is intending to assess.

### *2.5.7. Strengths and limitations*

The present study employed a novel approach to identify the associations within and between the commonly used measures of loneliness. In doing so, it has been highlighted that if particular relationships are important for a research question, then the SELSA-S may be able to provide answers that the other measures cannot. The study has also indicated that a commonly used direct measure of loneliness aligns most strongly to the UCLA-4 item and has suggested that the dJG-1 node may be a beneficial alternative as it has the strongest connectivity between measures suggesting it may tap into loneliness resulting from deficits in a greater variety of relationships. It is also important to note that for our analyses, we included multiple measures as we were primarily interested in associations between different scales and their items. The structure found could be different if analyses are conducted for each scale separately.

Despite these novel findings and implications, the study is not without limitations. Although a sample of older adults was recruited from across the United Kingdom. We limited our sample to those individuals without clinical diagnoses for anxiety and depression. It is unclear whether our findings would generalize to clinical samples. Recruitment was also limited to those with access to the internet. Many older adults do not have this access (Yu et al., 2016) and/or autonomy with internet use (Hargittai et al., 2019) and so the current findings are not wholly representative of the UK population. However, as noted by Peer and colleagues (Peer et al., 2017), the use of Prolific as a crowd sourcing participant recruitment platform may result in a more diverse sample of participants in comparison to other platforms such as MTurk. Despite this diverse sample, it is possible that only including those with internet access may have resulted in higher levels of loneliness being reported on average across the scales. This could be due to the previously established link between internet usage and lower reported levels of both social and emotional loneliness (e.g., Cotten et al., 2013; Sum et al., 2008).

Further, the present study has also not explored whether the structure of this network of loneliness measures is equivalent across gender, age or other factors, such as educational attainment. This equivalence is important should researchers wish to use such measures to draw comparisons about loneliness across these domains. Therefore, it would be beneficial for the study to be repeated incorporating a representative sample of older adults within the UK and to also test the invariance of the network across age, gender, and other relevant characteristics. Finally, the data presented here were collected prior to the start of the COVID-19 pandemic and therefore before any lockdown measures and isolation procedures were implemented in the UK. This reduction in contact with one's social network may have induced perceptions of deficits in emotional and social attachments resulting in higher levels of loneliness. The ability to determine which type of attachment deficit loneliness has resulted from via a particular scale would be beneficial here. This would allow appropriate interventions to be employed to bolster these attachments.

In summary, the present study aimed to determine which aspects of loneliness each loneliness scale was able to assess as well where the scales overlap in order to facilitate research and practitioner scale choice. Network analysis indicated that the SELSA-S may be the only of the included measures with the ability to tap into loneliness resulting from deficits in particular relationships. Should researchers be interested in investigating loneliness associated with specific relationships, it would be beneficial for them to use the SELSA-S as their chosen measure. However, if loneliness more generally is of interest, then the dJG, UCLA or the direct measure of loneliness may be suitable. The study also highlighted the importance of the dJG_1 node in having the most connectivity between the measures. Future work can explore whether this single item could be an alternative direct measure of loneliness than those currently utilised.

# Chapter 3. Friendships, Loneliness and Psychological Well-being in Older Adults: A Limit to the Benefit of number of friends

This study has been published in Ageing and Society and available as a First View article as of 11th August 2022. The article is available here:

**Friendships, loneliness and psychological wellbeing in older adults: a limit to the benefit of the number of friends | Ageing & Society | Cambridge Core**

The full reference is as follows: Thompson, A., Smith, M. A., McNeill, A., & Pollet, T. V. (2022). Friendships, loneliness and psychological wellbeing in older adults: a limit to the benefit of the number of friends. *Ageing & Society*, 1-26.

## 3.1.Abstract

As discussed previously, loneliness is linked to many negative health outcomes and places strain on the economy and the National Health Service in the United Kingdom. To combat these issues, the determinants of loneliness need to be fully understood. Although friendships have been shown to be particularly important in relation to loneliness in older adults, this association has thus far not been explored more closely. Our exploratory study examines the relationship between number of friends and loneliness, depression, anxiety, and stress in older adults. Data were obtained from 335 older adults via completion of an online survey. Measures included loneliness (UCLA Version 3), depression, anxiety and stress (DASS-21). Participants also reported their number of close friends. Regression analyses revealed an inverse curvilinear relationship between number of friends and each of the measures tested. Breakpoint analyses demonstrated a threshold for the effect of number of friends on each of the measures (loneliness

= 4, depression = 2, anxiety = 3, stress = 2). The results suggest that there is a limit to the benefit of increasing the number of friends in older adults for each of these measures. The elucidation of these optimal thresholds can inform the practice of those involved in loneliness interventions for older adults. These interventions can become more targeted, focusing on either establishing four close friendships, increasing the emotional closeness of existing friendships or concentrating resources on other determinants of loneliness in this population.

## 3.2.Introduction

Loneliness has been defined as an unpleasant or distressing experience resulting from a perceived qualitative or quantitative deficiency in one's social relationships (Perlman & Peplau, 1981; Russell et al., 1980). As such loneliness can be emotional or social. Emotional loneliness is derived from a perception of inadequate intimacy in relationships, whereas social loneliness is due to deficits in the quantity of social relationships (Hawkley & Cacioppo, 2010).

Transient experiences of loneliness are believed to be adaptive in that they provide motivation to form and maintain social connections in order to promote the survival of genes (Cacioppo et al., 2006; Cacioppo & Hawkley, 2009; Hawkley & Cacioppo, 2010). However, sustained loneliness has been repeatedly linked to many negative psychological and physiological health outcomes across age groups. These outcomes include anxiety and depression (Age Uk South Lakeland, 2018; Barg et al., 2006; Hawkley et al., 2009; Lee et al., 2021), suicidality (Stravynski & Boyer, 2001b; Van Orden et al., 2010), maladaptive stress responses (Adam et al., 2006; Steptoe et al., 2004), cognitive decline and Alzheimer's Disease (Boss et al., 2015; Donovan et al., 2017; Wilson et al., 2007), cardiovascular disease (Momtaz et al., 2012; Valtorta et al., 2016, 2018), malnutrition (Ramic et al., 2011), sleep quality (Yu et al., 2018), functional decline (Perissinotto et al., 2012) as well as increased risk of mortality (Holt-Lunstad et al., 2010, 2015b).

These negative impacts have associated economic costs. The cost of loneliness to UK employers has been estimated as being £2.5 billion due to increased staff turnover, reduced productivity, the impact of caring responsibilities and sickness absence related to ill health (New Economics Foundation, 2017). The monetised impact of severe loneliness has been estimated as £9,900 per person due to its impact on well-being, health, and productivity (Simetrica, 2020).

Further, loneliness is becoming increasingly prevalent in later life with in excess of 1 million UK residents over the age of 50 reporting that they are chronically lonely (Abrahams, 2018). This figure is expected to increase to 2 million by 2025 (Abrahams, 2018). Importantly, as the worldwide population is ageing (UN DESA's Population Division, 2019), the negative health correlates of loneliness are linked to increased strain on the National Health Service in the UK. For example, loneliness in older adults was consistently and positively associated with the number of General Practitioner visits in both cross-sectional and longitudinal analyses as well as with Emergency Department visits for women (Burns et al., 2020).

Due to the multiple negative impacts demonstrated above, the UK government has implemented, or is planning to implement several initiatives with the goal of reducing loneliness in this age group. This includes strengthening their 'Tackling Loneliness' charity network, the awarding of £31.3 million of funding to charities supporting people who experience loneliness and the announcement of an additional £7.5 million to tackle loneliness during winter (Department for Digital Culture Media & Sport, 2021a).

Clearly loneliness has a negative impact on both individuals and society as a whole. Therefore, it is important to fully understand contributors to this experience in order to reduce its deleterious impact.

### *3.2.1. Friendships in Later Life*

At its core, loneliness relates to a perceived lack of meaningful social connections and interactions (Cacioppo & Patrick, 2008; Reichmann, 1959; Townsend, 1968). Friendships are a type of social connection which appear to be particularly important to older adults with evidence indicating that this age

group are more satisfied with their friendships than their younger counterparts (Nicolaisen & Thorsen, 2017). Additionally, research has shown that a preference for emotionally close social partners increases with age (Carstensen, 1992).

Socioemotional selectivity theory (Carstensen et al., 1999) provides a framework for this observation. This theory posits that the perception of time causes individuals to prioritise particular social goals which are in competition with one another. Younger individuals who perceive time to be expansive focus on the pursuit of future oriented knowledge-based goals. In contrast, those that perceive time as limited, such as older adults, become more focused on present oriented goals. These present focussed goals include the aim of emotional satisfaction. As such, selectivity of social partners in this age group is increased with a preference for high quality relationships emerging. Older adults are thought to construct their social world to match these social goals. This leads to a reduction in social network size beginning in early adulthood and results in a network which excludes novel social partners and maintains those that are already emotionally close (English & Carstensen, 2014). Thus, highlighting the notion that existing close friendships become more important with age.

### *3.2.2. Friendship and Loneliness in Older Adults*

Studies have repeatedly shown that in older adults, friendships are a greater determinant of loneliness than relationships with family members (e.g., Shiovitz-Ezra & Leitsch, 2010) For example, it has been shown that interactions with friends reduce loneliness to a greater extent than interactions with close relatives including children, grandchildren and neighbours (Lee & Ishii-Kuntz, 1987; Mullins et al., 1987; Pinquart & Sörensen, 2001b; Steed et al., 2007). Having close friends who reside in close proximity is more important than having relatives that do (Eshbaugh, 2009) and those with networks composed mainly of kin appear to be more vulnerable to loneliness and negative psychological well-being (Silverstein et al., 1996). Additionally, 50% of those who report having no friends also report feeling lonely (Holmén et al., 1992) suggesting that social connections which are not friendships, such as kinship, may be less important in terms of loneliness in some cases.

As pointed out by Pinquart and Sörensen (Martin Pinquart & Sörensen, 2001b), an explanation for a stronger association between friendships and loneliness in comparison to familial relationships and loneliness may lie in the quality of those relationships. Friendships tend to be of higher quality than familial relationships, as the latter are more likely based on obligation and may also involve caregiving responsibilities (Bengston et al., 1985). Given the importance of shared experiences, interests, attitudes and lifestyle for friendships, these relationships may offer more insight into understanding loneliness than family relationships (Rawlins, 1995).

Further evidence for the importance of friendships in relation to loneliness has been demonstrated. For example, Eshbaugh and colleagues (Eshbaugh, 2009) found that in older women living alone, having close friends who reside within 50 miles was a significant negative predictor of loneliness. A similar finding was evident in work by Mullins and associates (Mullins & Dugan, 1990) in older adults living in independent living facilities. Further, a lack of friends was reported as a reason for feeling lonely in Finnish older adults (Savikko et al., 2005). Additionally, frequency of contact with friends has been evidenced as having a negative relationship with loneliness in older adults across marital statuses (Martin Pinquart & Sorensen, 2003).

### *3.2.3. Quantity of Friends and Loneliness*

As outlined above, friendships are clearly important in terms of reducing loneliness. In this context it is important to note that research has consistently demonstrated that the quantity of friends has a negative association with loneliness. This has been found in adolescents (Lodder et al., 2017), children (Nangle et al., 2003), sophomore high school students (Russell et al., 2012) and older adults (Shiovitz-Ezra & Leitsch, 2010). The association between this objective parameter and subjective loneliness has repeatedly been found despite the consensus being that loneliness is a subjective experience. Despite this association, there has been limited investigation of the ways in which the number of friends contributes to this. One notable exception is research exploring the discrepancy between an individual's ideal and actual number of friends (Russell et al., 2012) which finds a curvilinear relationship between this discrepancy

and loneliness in college students. Here, loneliness decreases as the number of actual friendships rises towards the number of ideal friendships. Once the ideal number of friendships is passed, loneliness begins to increase again. The authors explain this non-linear relationship in relation to the cognitive-discrepancy model of loneliness (Thibaut & Kelley, 2017). Here, a loss or gain of a friend when the number of friendships is close to an individual's ideal number may be especially important for determining loneliness. However, a loss or gain may be less important when the number is far above or below this ideal number.

Studies, apart from that of Russell and colleagues (Russell et al., 2012), have overlooked the possibility that the relationship between the quantity of friends and loneliness may be curvilinear. The presence of a non-linear relationship may be indicative of a limit to the effect of increasing friends on loneliness. Work by Brummet and colleagues (2001) suggests that the link between the number of social contacts and risk of mortality in coronary patients is non-linear. Here, the mortality rate was highest in those with three or fewer social contacts. When four social contacts were present, the risk was reduced by more than half and remained at a similar level with further additions of social contacts. It is possible that a similar relationship may be present between the number of friends and loneliness, given the previously established links between loneliness and coronary heart disease (Valtorta et al., 2016). The presence of a limit makes theoretical sense as it has previously been established that there is a constraint on the number of emotionally close relationships an individual can maintain within their social network with an increase in emotional closeness linked to a reduction in network size (Roberts et al., 2009). Additionally, studies have shown that intimacy in friendships differentiates between those who are lonely and those who are not (Drageset et al., 2011; Hamid, 1989; Williams & Solano, 1983) although not in all cases (Mullins & Mushel, 1992). It is therefore plausible that, as more friends are added to a person's network, the emotional closeness within the network is decreased, which in turn impacts on how lonely the individual feels. Thus, creating a natural limit. It is also possible that individuals experiencing loneliness may surround themselves with acquaintances as a coping strategy which could suggest a curved association between number of friends and loneliness.

As mentioned above, there are a variety of negative psychological outcomes associated with loneliness. Similarly to loneliness, previous research has shown that friendships have been linked to improved mental health. Quantity of friends is related to reduced levels of depression in older adults (Potts, 1997). Friendship support has been linked to better affect balance in the same age group (Montpetit et al., 2017). Subjective isolation from friends is linked to a greater increase in both depression and psychological distress than subjective isolation from family (Taylor et al., 2018). An increase in the number of friends is linked to a reduction in stress (van der Horst & Coffé, 2012). Older adult friendships are linked to better psychological well-being in comparison to family relationships (Nussbaum, 1994). Similarly, friendship networks have been shown to have a stronger relationship with psychological well-being than kin-based networks (Cable et al., 2013). Finally, a lower number of social relationships has been linked to the maintenance of low negative affect and high negative affect (Huxhold et al., 2020).

Of note, friendship closeness has also been associated with reduced levels of depression in both older adults (Bishop, 2008) and adults. As outlined previously, increasing a person's number of friendships may reduce levels of this closeness within their social network. This reduction in closeness to network contacts may in turn lessen the impact of the number of friends on depression creating a natural limit. However, as with loneliness, there has been little exploration of whether the number of friends relates to psychological health outcomes and there has been no exploration of what an optimal number of friends may be in terms of these outcomes in this age group.

#### *3.2.4. Quantity vs Quality*

It is important to note here that quality of friendships has often been indicated as being important in terms of loneliness. Higher quality friendships are related to lower levels of loneliness. This association has been found in the oldest old (Long & Martin, 2000), during adolescence (Lodder et al., 2017) and in children (Parker & Asher, 1993). This relationship has also been found for social relationships more generally in older adults; with higher quality social relationships predicting lower levels of loneliness (Martin Pinquart & Sörensen, 2001b).

Quality within friendships is therefore clearly important with regards to loneliness. As it is known that relationship closeness is correlated with relationship quality (e.g., Crespo et al., 2008), we argue that it is more appropriate to focus on the ways in which close, and therefore high quality, friendships impact loneliness rather than more peripheral, low quality, friendships. This allows the exploration of the impact of these arguably more important friendships in relation to loneliness in older adults. Further, this encompasses both the theoretical quantitative social and qualitative emotional aspects of loneliness as highlighted above.

It is evident that having close friendships is protective against feelings of loneliness as documented above. Examining the relationship between the number of close friendships and loneliness more closely can illuminate how this type of relationship can best be leveraged in interventions aimed at reducing loneliness. For example, if the relationship between the two is linear then interventions aiming to simply increase the number of close friendships would be the most beneficial. However, if the relationship is nonlinear then interventions would be more beneficial when considering other aspects of social connection such as maintaining current friendships.

#### *3.2.5. The Present Study*

As illustrated, a closer inspection of the relationship between number of close friends and loneliness and its psychological health correlates is warranted. To this end, the present study aimed to extend previous findings in the following key ways. First, the study aimed to determine the relationship between the number of close friends and loneliness along with three of its associated psychological health outcomes: depression, anxiety and stress. Crucially, the existence of a non-linear relationship was explored. A further aim was to determine the optimal number of close friends for each of these parameters. As outlined above, a negative relationship between number of close friends and loneliness and each of the associated psychological well-being measures has previously been established. Here, we expected to replicate those findings. However, no hypothesis was made in relation to a potential curvilinear relationship. Instead, we posed the research question, Is there a curvilinear relationship

between number of close friends and loneliness in older adults? As the second aim was exploratory no hypothesis was made in this regard either. Again, a research question was posed of, what is the optimal number of close friends in terms of loneliness in this age group?

## 3.3.Method

### *3.3.1. Design*

The present study was an exploratory, cross-sectional, and correlational investigation into the relationship between number of close friends and loneliness, depression, anxiety and stress in older adults.

### *3.3.2. Participants*

A target sample size of 400 was pre-registered, this was primarily determined by cost. Due to time constraints this number fell somewhat short of the target. However, this number is still sufficient to perform the analysis (1 predictor pre 25 cases, Austin & Steyerberg, 2015; Harrell, 2015; Roscoe, 1975; Schmidt, 1971; Tabachnik & Fidell, 2009). A total of 350 residents of the United Kingdom aged 65 or over responded to an online questionnaire. This was advertised via the recruitment platform Prolific (Palan & Schitter, 2018), Facebook adverts and via word of mouth. The Facebook and Prolific adverts were targeted specifically to UK residents aged 65 plus. Those that completed the questionnaire via Prolific were paid £2 upon completion. To be eligible to take part in the study participants were required to not have had a current clinical diagnosis of depression or anxiety. The initial sample consisted of 350 respondents (138 male, 211 female and one participant did not specify).

### *3.3.3. Measures*

**Key Dependent Variables**

***Loneliness.*** There were four dependent variables examined in this study. The first was loneliness. Within this study we were interested in assessing a feeling of general social loneliness rather than investigating loneliness resulting from deficits in various specific attachments. As such we employed the University of California, Los Angeles, Loneliness Scale-Version 3 (UCLA-3) (Russell, 1996) as the findings of study suggested that that is the type of loneliness that this scale measures and because it is one of the most commonly used measures of loneliness making the study more comparable across published research. The UCLA-3 is a 20-item self-report scale designed to measure an individual's subjective feelings of loneliness. Participants are asked how often each statement is descriptive of them (e.g., How often do you feel that you lack companionship?). Items are on a scale ranging from 1 (Never) to 4 (Often) and nine items are reverse scored. All items are summed to give one loneliness score; a higher score represents greater levels of loneliness. Version 3 of this scale has demonstrated good internal reliability (Cronbach's $\alpha$ = .96) (e.g., Russell, 1996), with the reliability for the present study being .94, and has demonstrated a unidimensional factor structure (Russell, 1996).

***Psychological Well-being.*** The three psychological well-being measures were all assessed via the short version of the Depression Anxiety and Stress Scale (DASS-21) (Lovibond & Lovibond, 1995). The DASS-21 consists of 21 items and consists of three 7-item subscales measuring depression, anxiety and stress separately. Participants are asked how much each statement has applied to them over the past week (e.g., I found it hard to wind down). Items are on a scale ranging from 0 (Never) to 3 (Almost Always). Items are summed for each scale separately and multiplied by two to allow comparison to the original 42-item DASS scale. No items are reverse scored. A higher score in a subscale represents a greater level of that particular psychological state. The separate depression, anxiety and stress scales have all repeatedly demonstrated good internal reliability (all Cronbach's $\alpha$ > .80) (Osman et al., 2012). Reliability for the

present study is as follows: Anxiety (Cronbach's $\alpha$ = .80), Stress (Cronbach's $\alpha$ = .88) and Depression (Cronbach's $\alpha$ = .90). The DASS-21 scale has repeatedly demonstrated a three-factor structure representing the three separate scales (e.g., Crawford & Henry, 2003; Norton, 2007; Scholten et al., 2017; Sinclair et al., 2012). Table 1 contains the descriptive statistics for each of the dependent variables.

**Key Independent Variable**

The main independent variable of interest was the number of friends participants reported having. This variable was elicited by asking participants to 'Please indicate how many close friends you currently have'. The question eliciting the number of close friends was modelled after Russell and colleagues (Russell et al., 2012). However, instead of asking participants to indicate this number on a 7-point Likert scale ranging from 'none' to '11+', we asked participants to provide the actual number, as the number of friends is better operationalised as a count variable. The definition of a close friend was left to the interpretation of the participant based on previous findings that friendships are not easily defined in older adults (Adams et al., 2000).

**Covariates**

Four demographic covariates were included in this study as they have previously been linked to one or more of the dependent variables. Age was included as a continuous variable. Gender was included as a categorical variable with female being the reference category. Marital status was included as a categorical variable with response options being 'In a relationship', 'Married/Registered civil partnership', 'Separated but still married or in a registered civil partnership', 'Divorced' and 'Widowed'. The reference category for this variable was 'Single, never married or in a civil partnership'. Highest attained level of education was also included as a categorical variable with response options being 'Some secondary school', 'GCSE or equivalent', 'A level or equivalent', 'Undergraduate degree'. The reference category for this variable was 'Primary School'.

Other measures were collected as part of a separate study, (the ideal number of friends, the Satisfaction with Life Scale (Diener et al., 1985), as well as three other measures of loneliness - the short De Jong Gierveld Scale (de Jong-Gierveld & van Tilburg, 1999), the short Social and Emotional Loneliness Scale for Adults (DiTommaso et al., 2004) and a direct measure of loneliness) but are not reported on here. Please see the following link for a study containing this information OSF.

### *3.3.4. Procedure*

Ethical approval was granted by the local ethics committee. Data were collected between May and July 2019. Once informed consent was obtained, participants completed all measures via an online questionnaire hosted by Qualtrics (Qualtrics, 2020) available at https://www.qualtrics.com. The demographic measures were completed first followed by each of the scales. The order these were presented in were randomised. The questions relating to the number of ideal and actual friends were completed last. The whole questionnaire took no longer than 20 minutes to complete.

### *3.3.5. Analytical Approach*

All analyses were performed using R version 3.6.1 (R Core Team, 2017). Observations which contained missing data for the independent variable and dependent variables were removed (13 cases) as were two outliers where the number of friends was listed as 105 (30 *SD* away from mean) and age as 66,123 years. Finally, due to the presence of extreme values and asymmetry (skewness = -1.37), the data were winsorized to 3 standard deviations for the number of friends (12 friends) variable (12 cases). This resulted in a final sample of 335 participants; 290 of which were recruited via Prolific and 45 via social media.

The data met the assumptions of non-multicollinearity, homoscedasticity, and non-autocorrelation. The loneliness data met the assumption of normally distributed residuals. The three DASS variables all exhibited some skew in the distribution of residuals. However, this is to be expected given

that most respondents were not currently experiencing high levels of depression, anxiety or stress. However, regression is relatively robust, therefore we used this technique (Berry, 1993) and we further assessed the robustness of these models with other techniques (e.g., segmented regression).

Prior to performing regression analyses, some demographic factor levels were grouped to result in a more equal n per cell. For marital status, single and undisclosed were combined into one level. As were separated and divorced. For education, primary and secondary school were combined. Based on a visual inspection of the data and a plot of residuals, the fit of polynomial regression models were assessed for all dependent variables. It was found that a quadratic model had the best fit to the data in each case. This was based on the model with a statistically significant reduction in residual sum of squares as indicated by a Chi-Squared difference test. A Davies test was then employed to test for a non-constant regression parameter in the predictor. This was followed by segmented regression via the segmented package (Muggeo, 2008) and multivariate adaptive regression spline analysis ('mars') via the earth package (Milborrow et al., 2011) to determine and confirm a breakpoint in the data. The segmented package utilises an algorithm which determines the breakpoint iteratively. Similarly, the earth package uses an algorithmic approach to examine breakpoints in the data. We also performed additional analyses including robustness checks - these can be found at OSF

## 3.4.Results

### *3.4.1. Sample Characteristics*

Sample characteristics and descriptive statistics are presented in Table 1. In the final sample 60% of participants were female and 40% were male. The mean age of participants was 69 years (*SD* = 4.29). Most participants reported being married or in a civil partnership (62%) and having completed an undergraduate degree (35%). The average number of close friends reported was four. All were residents of the United Kingdom. The mean loneliness score in this sample was 40.22. This is comparable to the scores demonstrated in samples of nurses and students in Russell's original validation but is somewhat

higher than the mean scores in samples of teachers and older adults in the same study (Russell, 1996). This could perhaps be due to the differing ways the survey was presented with Russell's sample completing the survey face to face with researchers and completing it as part of a longitudinal health and well-being study. The mean scores for the depression, anxiety and stress scales were also comparable to previously published means (Crawford & Henry, 2003).

**Table 2**

*Sample Characteristics (n = 335)*

| **Characteristic** | **Statistic (Mean (SD) or n (%))** |
|---|---|
| **Age** | 69.36 (4.29) |
| **Gender** | |
| Female | 201 (60) |
| Male | 134 (40) |
| **Marital Status** | |
| Single | 19 (6) |
| In a relationship | 26 (8) |
| Married/ Civil Partnership | 207 (62) |
| Separated | 4 (1) |
| Divorced | 50 (15) |
| Widowed | 28 (8) |
| Undisclosed | 1 (0) |

| | |
|---|---|
| **Education** | |
| Primary School | 2 (1) |
| Some secondary school | 28 (8) |
| GCSE's or equivalent | 66 (20) |
| A level or equivalent | 67 (20) |
| Undergraduate Degree | 116 (35) |
| Postgraduate Degree | 56 (17) |
| **Number of Friends** | 4.26 (4.11) |
| **Loneliness** | 40.22 (11.64) |
| **Depression** | 6.99 (8.01) |
| **Anxiety** | 3.68 (5.42) |
| **Stress** | 8.23 (8.12) |

### *3.4.2. Main Analysis*

**Correlations**

The bivariate correlations are presented in Table 2. Number of friends was significantly negatively associated with each of the dependent variables. Loneliness was significantly positively associated with each of the psychological well-being variables.

**Table 3**

*Zero-order Correlations for Study Variables (n = 335)*

| | No. of Friends | UCLA Loneliness | DASS Depression | DASS Anxiety |
|---|---|---|---|---|
| UCLA | -0.50*** | | | |
| DASS Depression | -0.26*** | 0.59*** | | |
| DASS Anxiety | -0.16** | 0.37*** | 0.56*** | |
| DASS Stress | -0.13* | 0.44*** | 0.72*** | 0.62*** |

*$p < .05$, **$p < .01$, ***$p < .001$

**Regressions**

Hierarchical OLS regression analysis with the inclusion of a quadratic term was performed for each of the outcome measures to test for a curvilinear relationship.

***Loneliness.*** After adjusting for all demographic information the final model was significant ($F(12,322) = 15.09$, $p < .001$). In this model both the linear term for number of close friends (B = -4.78, $p < .001$) and the quadratic term (B = .27, $p < .001$) remained significant. As quadratic relationships are difficult to interpret from coefficients alone, please see Figure 1.

Of the demographic covariates, only being married or in a civil partnership, in comparison to being single, was a significant predictor of loneliness (B = -6.29, $p = .006$). Those with this particular marital status reported less loneliness than those who were single. This final model explained 34% of the variance in loneliness scores (Table 3).

As suggested by the plot, there appears to be a point at which the effect of the number of close friends on loneliness is greatly reduced. A Davies Test indicated that there was a significant difference between the slopes when segmenting the regression line at 3.90 friends ($p < .001$). Breakpoint analysis via the 'segmented' package further supported that a breakpoint could be elicited at this point ($\psi = 3.86$, 95%CI [2.77, 4.94]). Multivariate adaptive regression spline analysis further suggested a knot at 4 close friends. This analysis suggests that the effect of additional close friends on loneliness is diminished once around four close friends are reached.

**Table 4**

*Hierarchical OLS Regression Analysis to Predict Loneliness (+/- SE)*

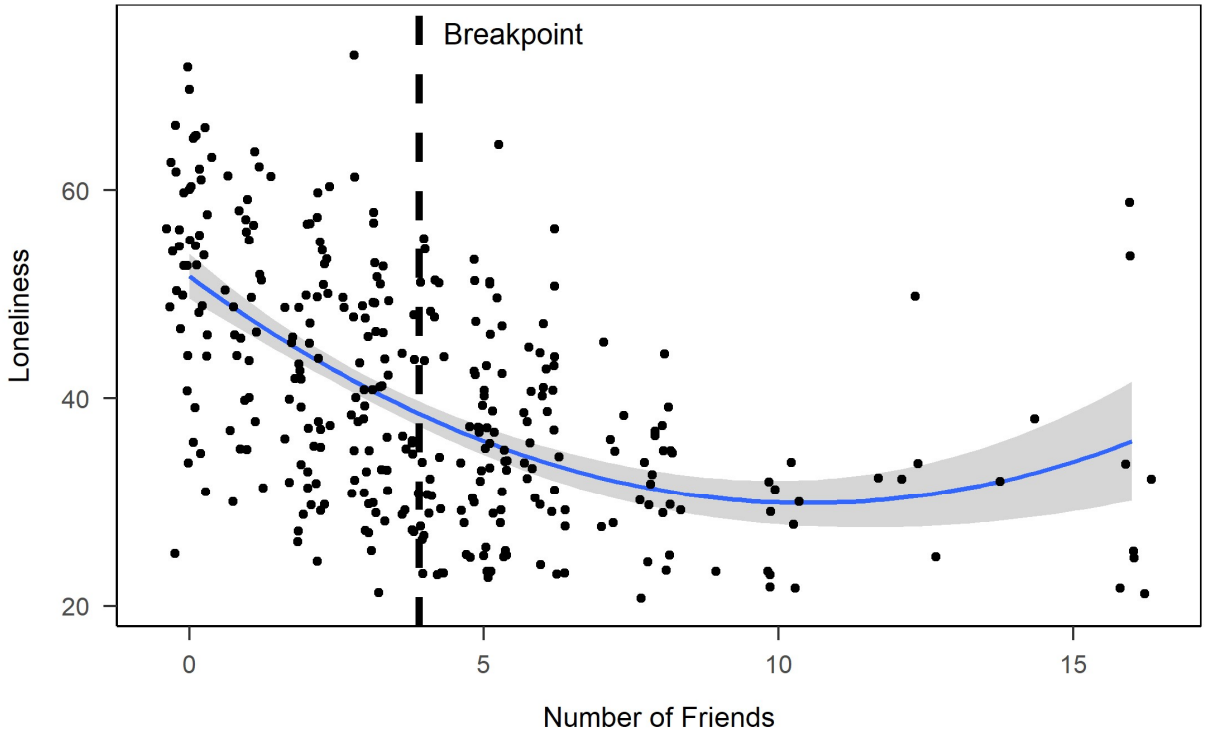
| | Loneliness | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Number of friends | -4.591*** (0.499) | -4.725***(0.496) | -4.757*** (0.498) | -4.705*** (0.501) | -4.783*** (0.500) |
| Number of friends$^2$ | 0.253*** (0.044) | 0.268*** (0.044) | 0.272*** (0.044) | 0.266*** (0.045) | 0.274*** (0.045) |
| Marital Status: In a relationship | | -6.151* (2.858) | -6.235* (2.862) | -6.401* (2.867) | -5.243$^+$ (2.899) |
| Marital Status: Married/ Civil Partnership | | -6.946** (2.243) | -6.896** (2.245) | -7.139** (2.259) | -6.290** (2.285) |
| Marital Status: Separated or Divorced | | -3.958 (2.505) | -3.882 (2.508) | -3.738 (2.513) | -3.198 (2.520) |
| Marital Status: Widowed | | -4.347 (2.814) | -3.953 (2.863) | -3.861 (2.865) | -3.022 (2.871) |
| Age | | | -0.096 (0.127) | -0.115 (0.128) | -0.090 (0.131) |

| | | | | | |
|---|---|---|---|---|---|
| Gender (Female -> Male) | | | | 1.123 (1.138) | 0.622 (1.158) |
| Education: GCSE or equivalent | | | | | -1.938 (2.133) |
| Education: A Level or Equivalent | | | | | 1.734 (2.151) |
| Education: Undergraduate Degree | | | | | 1.849 (2.026) |
| Education: Postgraduate Degree | | | | | 0.636 (2.228) |
| Constant | 52.212*** (1.156) | 58.144*** (2.467) | 64.784*** (9.088) | 65.734*** (9.139) | 62.786*** (9.917) |
| *N* | 335 | 335 | 335 | 335 | 335 |
| $R^2$ | 0.316 | 0.342 | 0.343 | 0.345 | 0.360 |
| Adjusted $R^2$ | 0.312 | 0.330 | 0.329 | 0.329 | 0.336 |
| Residual Std Error | 9.656 (df = 332) | 9.528 (df = 328) | 9.534 (df = 327) | 9.535 (df = 326) | 9.486 (df = 332) |
| F Statistic | 76.766*** (df = 2; 332) | 28.443*** (df = 6; 328) | 24.430*** (df = 7; 327) | 21.497*** (df = 8; 326) | 15.091*** (df = 12; 322) |

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001: Reference categories: marital status = single or undisclosed, gender = female, education = primary or some secondary school

**Figure 4**

*Loneliness as a Function of the Number of Close Friendships (Curvilinear Fit with 95% CI). Breakpoint is Determined by Segmented Regression.*




***Depression.*** After adjusting for all demographic information the final model was significant, ($F(12,322) = 4.43$, $p < .001$). In this model both the linear term for number of close friends (B = -2.16, $p < .001$) and the quadratic term (B = .15, $p < .001$) remained significant. The plot in Figure 2 demonstrates this relationship.

Table 4 summarises all models on depression. Of the demographic covariates, gender was a significant predictor of depression (B = -2.72, $p < .01$), with men reporting less depression than women. Educational attainment was also a significant predictor of depression (Table 4: all dummy variables $p <$

.01). Those who reported that they had received an education past primary school level reported less depression than those that had not. This model explained 11% of the variance in depression scores.

Similar to the effect for loneliness, there appeared to be a point at which the effect of number of close friends on depression is greatly reduced. A Davies Test indicated that there was a significant difference between the slopes when segmenting the regression line at 2.16 friends ($p < .001$). Breakpoint analysis via the 'segmented' package in R confirmed that a breakpoint could be elicited at this point ($\psi = 2.17$, SE = .491, 95%CI [1.19, 3.12]). Multivariate adaptive regression spline analysis further suggested a knot at 2 close friends. This analysis suggests that the effect of additional close friends on depression is diminished once a cut-off of around two close friends is reached.

**Table 5**

*Hierarchical OLS Regression Analysis to Predict Depression (+/- SE)*

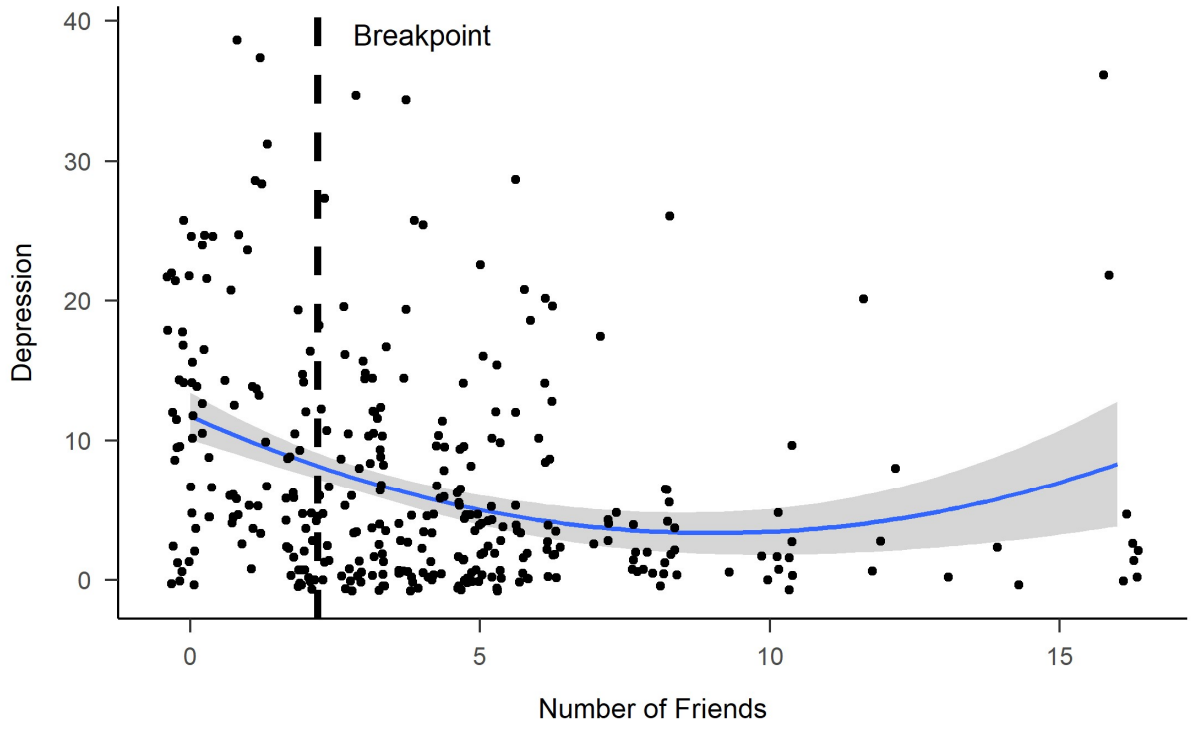
| | Depression | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Number of friends | -2.096*** (0.393) | -2.066*** (0.397) | -2.016*** (0.397) | -2.136*** (0.395) | -2.162*** (0.39) |
| Number of friends$^2$ | 0.135*** (0.035) | 0.135*** (0.035) | 0.130*** (0.035) | 0.143*** (0.035) | 0.146*** (0.035) |
| Marital Status: In a relationship | | 1.973 (2.287) | 2.105 (2.284) | 2.490 (2.262) | 2.809 (2.309) |
| Marital Status: Married/ Civil Partnership | | 0.132 (1.794) | 0.053 (1.792) | 0.617 (1.782) | 0.822 (1.820) |
| Marital Status: Separated or Divorced | | -0.195 (2.004) | -.314 (2.002) | -0.649 (1.983) | -0.501 (2.008) |
| Marital Status: Widowed | | 1.164 (2.252) | 0.543 (2.285) | 0.328 (2.261) | 0.600 (2.287) |
| Age | | | 0.152 (0.101) | 0.196$^+$ (0.101) | 0.196$^+$ (0.104) |

| | | | | | |
|---|---|---|---|---|---|
| Gender (Female -> Male) | | | | -2.606** (0.898) | -2.721** (0.922) |
| Education: GCSE or equivalent | | | | | -1.142 (1.699) |
| Education: A Level or Equivalent | | | | | -0.059 (1.713) |
| Education: Undergraduate Degree | | | | | 0.088 (1.614) |
| Education: Postgraduate Degree | | | | | -0.357 (1.775) |
| Constant | 11.982*** (0.910) | 11.564*** (1.974) | 1.083*** (7.252) | -1.120*** (7.211) | -0.940*** (7.900) |
| *N* | 335 | 335 | 335 | 335 | 335 |
| $R^2$ | 0.105 | 0.110 | 0.116 | 0.139 | 0.142 |
| Adjusted $R^2$ | 0.100 | 0.094 | 0.097 | 0.117 | 0.110 |
| Residual Std Error | 7.599 (df = 332) | 7.623 (df = 328) | 7.609 (df = 327) | 7.524 (df = 326) | 7.556 (df = 332) |
| F Statistic | 19.488*** (df = 2; 332) | 6.776*** (df = 6; 328) | 6.153*** (df = 7; 327) | 6.559*** (df = 8; 326) | 4.434*** (df = 12; 322) |

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001: Reference categories: marital status = single or undisclosed, gender = female, education = primary or some secondary school

**Figure 5**

*Depression as a Function of the Number of Close Friendships (curvilinear fit with 95%CI). Breakpoint is Determined by Segmented Regression.*




***Anxiety***. After adjusting for all demographic information the final model was significant, ($F$(15,319) = 1.74, $p$ = .043). In the final model, both the linear term for number of close friends (B = -.74, $p$ = .001) and the quadratic term (B = .04, n$p$ = .014) remained significant. This quadratic relationship is illustrated in Figure 3. None of the demographic covariates were significant predictors of anxiety. This model explained 3.2% of the variance in anxiety scores. See Table 5 for all coefficients.

Figure 3 suggests a breakpoint after which there is no additional reduction from adding close friends. A Davies Test indicated that there was a significant difference between the slopes when segmenting the regression line at 2.51 friends ($p$ < .01). Breakpoint analysis confirmed that a breakpoint could be elicited at this point ($\psi$ = 2.51, 95%CI [ 1.02, 4.0]). Multivariate adaptive

regression spline analysis further suggested a knot at 3 close friends. This analysis suggests that the effect of additional close friends on anxiety is diminished once a threshold of approximately three close friends is reached.

**Table 6**

*Hierarchical OLS Regression Analysis to Predict Anxiety (+/- SE)*

| | Anxiety | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Number of friends | -0.980*** (0.275) | -0.944*** (0.276) | -0.941*** (0.278) | -0.976*** (0.279) | -0.970*** (0.280) |
| Number of friends$^2$ | 0.066** (0.024) | 0.064** (0.024) | 0.064** (0.025) | 0.068** (0.025) | 0.067** (0.025) |
| Marital Status: In a relationship | | 3.207* (1.591) | 3.213* (1.595) | 3.322* (1.597) | 2.905$^+$ (1.620) |
| Marital Status: Married/ Civil Partnership | | 1.400 (1.249) | 1.397 (1.251) | 1.588 (1.258) | 1.185 (1.277) |
| Marital Status: Separated or Divorced | | 0.988 (1.394) | 0.983 (1.398) | 0.887 (1.399) | 0.720 (1.408) |
| Marital Status: Widowed | | 0.749 (1.567) | 0.723 (1.596) | 0.662 (1.596) | 0.444 (1.604) |
| Age | | | 0.006 (0.071) | 0.019 (0.071) | -0.015 (0.073) |

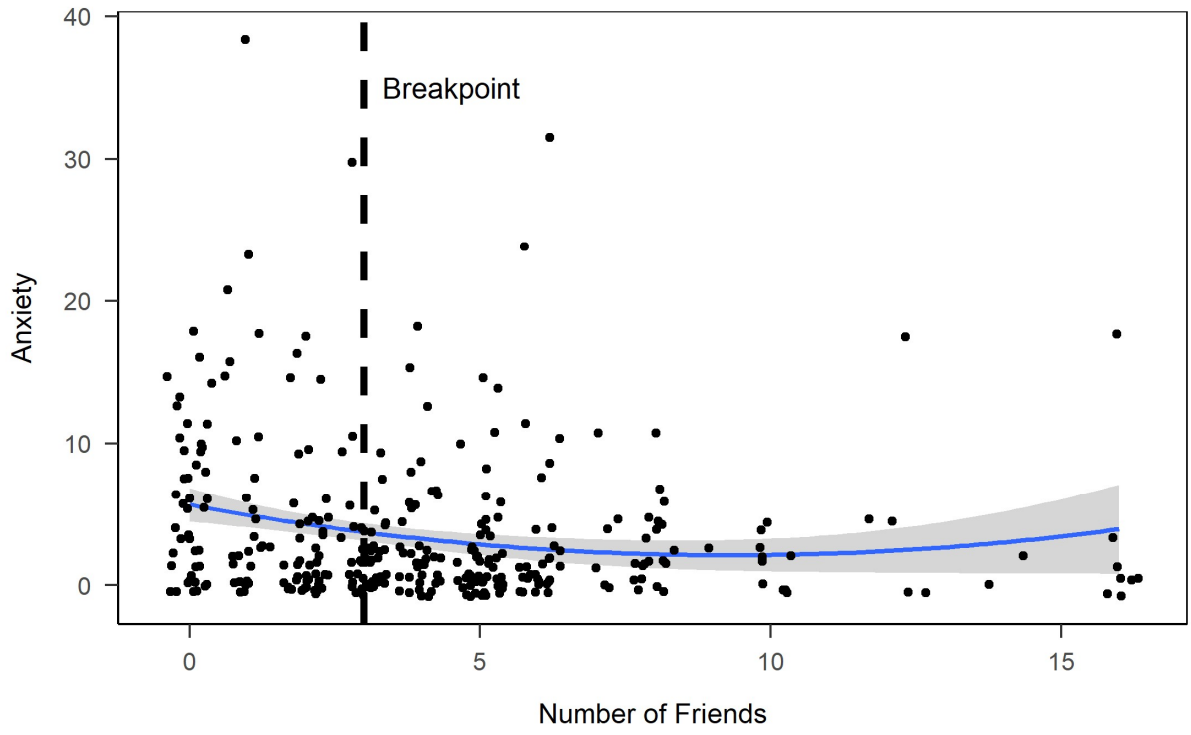
| | | | | | |
|---|---|---|---|---|---|
| Gender (Female -> Male) | | | | -7.45 (0.634) | -0.469 (0.647) |
| Education: GCSE or equivalent | | | | | -1.230 (1.192) |
| Education: A Level or Equivalent | | | | | -2.142$^{+}$ (1.201) |
| Education: Undergraduate Degree | | | | | -2.305* (1.132) |
| Education: Postgraduate Degree | | | | | -1.397 (1.245) |
| Constant | 5.943*** (0.636) | 4.508** (1.373) | 4.069 (5.064) | 3.440 (5.089) | 7.716 (5.540) |
| *N* | 335 | 335 | 335 | 335 | 335 |
| $R^2$ | 0.046 | 0.061 | 0.061 | 0.065 | 0.080 |
| Adjusted $R^2$ | 0.040 | 0.043 | 0.041 | 0.042 | 0.045 |
| Residual Std Error | 5.313 (df = 332) | 5.305 (df = 328) | 5.313 (df = 327) | 5.310 (df = 326) | 5.299 (df = 332) |

| | | | | | |
|---|---|---|---|---|---|
| F Statistic | 8.026*** (df = 2; 332) | 3.529** (df = 6; 328) | 3.017** (df = 7; 327) | 2.815** (df = 8; 326) | 2.327*** (df = 12; 322) |

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001: Reference categories: marital status = single or undisclosed, gender = female, education = primary or some secondary school

**Figure 6**

*Anxiety as a Function of the Number of Close Friendships (Curvilinear Fit with 95% CI). Breakpoint is Determined by Segmented Regression.*




***Stress.*** After adjusting for all demographic information, the final model was significant, ($F(12,322) = 2.448$, $p < .001$). In this model both the linear term for number of close friends (B = -1.51, $p < .01$) and the quadratic term (B = .11, $p < .05$) remained significant. This relationship is illustrated in Figure 4.

Of the demographic covariates, being in a relationship was a significant predictor of stress (B = 6.15, $p < .05$). Those who were in a relationship reported more stress than those who were single. This model explained 4.9% of the variance in stress scores. See Table 6 for all coefficients.

Figure 4 suggests the presence of a threshold above which there is no further reduction in stress with a further increase of reported close friends. A Davies Test indicated that there was a significant difference between the slopes when segmenting the regression line at 2.05 friends ($p <$

.05). Breakpoint analysis confirmed that a breakpoint could be elicited at this point ($\psi$ = 2.05, *SE* = .64, 95%CI [0 .80, 3.30]). Multivariate adaptive regression spline analysis further suggested a knot at 2 friends. This analysis suggests that the effect of additional close friends on stress is diminished once around two friends are reached.

**Table 7**

*Hierarchical OLS Regression Analysis to Predict Stress (+/- SE)*

| | Stress | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Number of friends | -1.462*** (0.412) | -1.396*** (0.413) | -1.374** (0.415) | -1.454*** (0.416) | -1.511*** (0.418) |
| Number of friends$^2$ | 0.104*** (0.037) | 0.103*** (0.037) | 0.100** (0.037) | 0.109** (0.037) | 0.112** (0.037) |
| Marital Status: In a relationship | | 5.440* (2.380) | 5.499* (2.384) | 5.754* (2.380) | 6.148 (2.421) |
| Marital Status: Married/ Civil Partnership | | 1.607 (1.868) | 1.571 (1.871) | 1.946 (1.875) | 2.249 (1.908) |
| Marital Status: Separated or Divorced | | 0.726 (2.086) | 0.672 (2.089) | 0.450 (2.086) | 0.741 (2.104) |
| Marital Status: Widowed | | 1.760 (2.344) | 1.482 (2.385) | 1.339 (2.378) | 1.563 (2.397) |
| Age | | | 0.068 (0.105) | 0.097 (0.106) | 0.089 (0.109) |

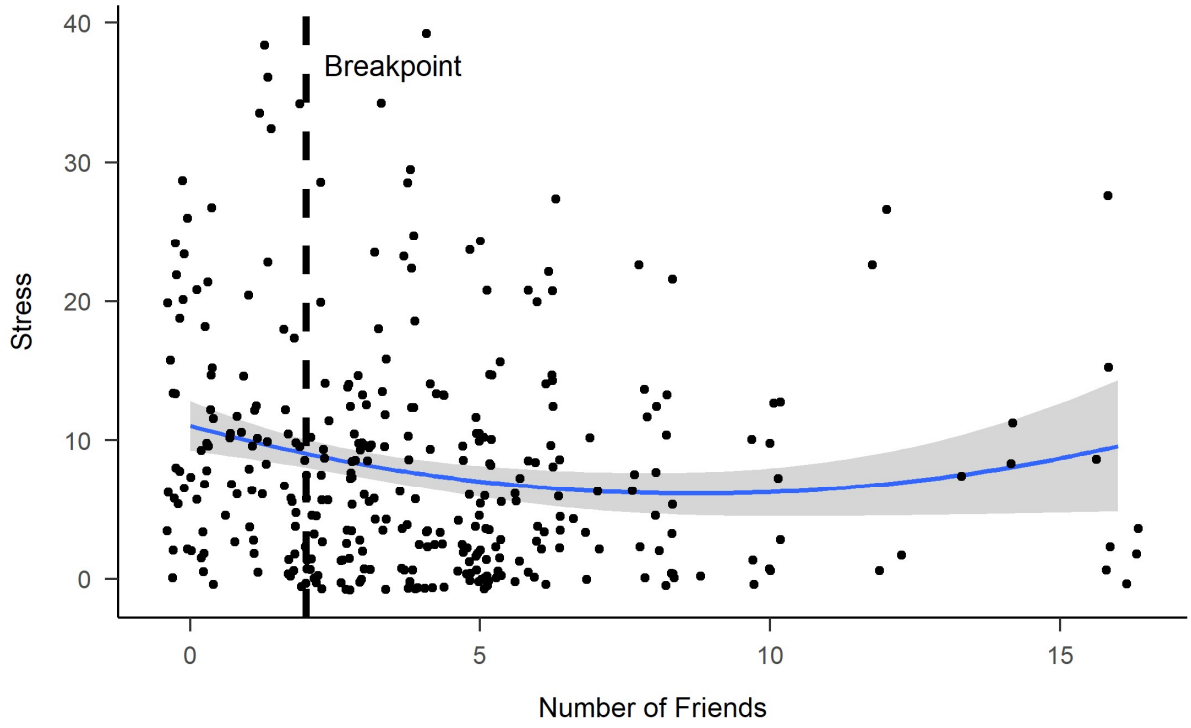
| | | | | | |
|---|---|---|---|---|---|
| Gender (Female -> Male) | | | | -1.732$^{+}$ (0.945) | -1.797 (0.967) |
| Education: GCSE or equivalent | | | | | -1.582 (1.781) |
| Education: A Level or Equivalent | | | | | -0.132 (1.796) |
| Education: Undergraduate Degree | | | | | -0.909 (1.691) |
| Education: Postgraduate Degree | | | | | 0.935 (1.860) |
| Constant | 11.449*** (0.955) | 9.555*** (2.055) | 4.858 (7.571) | 3.394 (7.586) | 4.349 (8.280) |
| *N* | 335 | 335 | 335 | 335 | 335 |
| $R^2$ | 0.042 | 0.063 | 0.064 | 0.074 | 0.084 |
| Adjusted $R^2$ | 0.036 | 0.046 | 0.044 | 0.051 | 0.049 |
| Residual Std Error | 7.976 (df = 332) | 7.936 (df = 328) | 7.943 (df = 327) | 7.914 (df = 326) | 7.920 (df = 332) |

| | | | | | |
|---|---|---|---|---|---|
| F Statistic | 7.194*** (df = 2; 332) | 3.661** (df = 6; 328) | 3.192** (df = 7; 327) | 3.233** (df = 8; 326) | 2.448** (df = 12; 322) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, gender = female, education = primary or some secondary school

**Figure 7**

*Stress as a Function of the Number of Close Friendships (Curvilinear Fit with 95% CI). Breakpoint is determined by Segmented Regression.*




### 3.5.Discussion

The purpose of this study was to explore the relationship between the reported number of close friends and loneliness, depression, anxiety, and stress in older adults. Our findings demonstrated significant inverse curvilinear relationships between the number of close friends and each of these parameters. These findings support those of previous studies which demonstrated a negative relationship between the quantity of friends and loneliness (Lodder et al., 2017; Mullins & Dugan, 1990; Nangle et al., 2003; Russell et al., 2012; Shiovitz-Ezra & Leitsch, 2010). The present findings are also in line with previous work demonstrating that having a greater quantity of friends is associated with better self-reported mental health (Bishop, 2008; Cable et al., 2013; Huxhold et al.,

2020; Montpetit et al., 2017; Nussbaum, 1994; Potts, 1997; Taylor et al., 2018; van der Horst & Coffé, 2012). Russell and colleagues (2012) have previously demonstrated that there is an inverse curvilinear relationship between the discrepancy between the number of actual and ideal friendships and loneliness in college students. However, we believe a curvilinear relationship for the effect of close friends on each outcome measure has gone previously untested.

Inspection of the plots for each of the outcome measures shows that there are relatively few individuals who report having many friends whilst simultaneously experiencing high levels of loneliness, depression, anxiety or stress. We have discussed the notion that having a large social network may reduce emotional closeness across the relationships within it (Roberts et al., 2009) and in turn this lack of emotional closeness may increase feelings of loneliness (Drageset et al., 2011; Hamid, 1989; Williams & Solano, 1983). It may be that whilst these individuals report having many close friends, these relationships are not actually providing the closeness, connection, and understanding needed to stave off loneliness and its maladaptive correlates due to the size of their networks. However, further work, ideally of a longitudinal nature, is needed to corroborate this.

It is therefore possible that a small cluster of observations could be driving the quadratic fit. However, we believe that this is unlikely to be the case. Bootstrapping, which reduces the weight of extreme cases, further supported the curvilinear relationship (see supplementary materials). Further, we conducted segmented regression using both the 'segmented' and 'earth' packages to determine breakpoints in the data. These approaches reduce the effect of outliers and consistently detected breakpoints in the data (please see OSF).

Thus, each of our mental health related variables demonstrated that there was a point past which the addition of more close friends no longer has a substantial beneficial effect. An increase of close friends was associated with a decrease in loneliness until four close friends were reached, for depression this number was found to be two close friends, for anxiety three close friends and for stress the threshold was two close friends. A slightly larger threshold value for loneliness in comparison to the other mental health variables is to be expected, as loneliness is more directly related to social

connections and interactions than the other psychological well-being outcomes. The presence of a friendship threshold in terms of loneliness could be due to a reduction in emotional closeness to network members as network size is increased (Roberts et al., 2009).

It is encouraging that the threshold for the number of close friends in each instance appears to be relatively low. Making and maintaining meaningful social connections takes time and effort (Lang et al., 2013). However, given that on average a person's closest group of contacts, known as their support group, has been found to include around five members (R. I.M. Dunbar & Spoors, 1995), it is possible that many older adults will already have met this number, or be close to it. The elucidation of these thresholds for close friendships is important as they can allow those involved in loneliness and mental health interventions to focus their limited resources on increasing social interaction opportunities for those with few or no close friends. This would be with the ultimate aim of reducing the negative physical and psychological impacts of loneliness as well as reducing the economic cost and strain on health services associated with loneliness. As research has previously shown that perceived quality of relationships has a protective effect against loneliness (Hawkley et al., 2008; Pinquart & Sorensen, 2003), those with more friendships than a threshold could be encouraged to improve the quality and closeness of their friendships, rather than increase the number of friends they have.

A successful intervention to reduce loneliness could include elements of the previously successful 'Friendship Program' (Hamid, 1989). This program encourages reflection on one's own aspirations for friendships as well as reflection on current friendships. It also incorporates education around attitudes and experiences in the process of building friendship. This includes actively utilising those already established but lesser used connections for support and by encouraging a proactive approach to maintaining and deepening friendships. The program has been found to both improve the quality of current friendships as well to increase the number of friendships. Further benefits of improving the quality of these relationships include this having increased resilience to adversity (Graber et al., 2016) and a more adaptive stress response (Calhoun et al., 2014).

Alternatively, these individuals could be included in interventions with the aim of improving the other contributing factors to loneliness and psychological well-being such as health status and mobility (Theeke, 2009). These could include cognitive based interventions to improve mobility (Marusic et al., 2018) and physical activity interventions to improve mobility (Yeom et al., 2009) and health status (Hwang & Braun, 2015). As well as directly targeting psychological well-being with the aim of reducing loneliness in tandem. In this regard, a variety of interventions have been shown to be successful including psychotherapy and behavioural interventions (Pinquart et al., 2007). In particular, reminiscence therapy has repeatedly demonstrated a positive outcome in relation to depressive symptoms and subjective wellbeing (Yen & Lin, 2018). This type of therapy involves recalling events from the past and sharing them with an observer or group who listen without making comment.

The present study has a number of strengths. To our knowledge, it is the first to explore the possibility of a curvilinear relationship between the quantity of close friends and loneliness, as well as its associated psychological well-being outcomes in an older adult population. It is also the first to assess the presence of breakpoints within this relationship. As mentioned previously, for both of these analyses robust techniques were employed to increase confidence in our findings.

We also explicitly focussed on close friendships and did not include any peripheral friendships. This is because emotional closeness has repeatedly been shown to be more important than network size and frequency and contact with friends in terms of loneliness (Drageset et al., 2011; Hamid, 1989; Williams & Solano, 1983). Close friends also appear to be more important than less close friends in regards to subjective well-being (van der Horst & Coffé, 2012). We asked participants specifically to include only friends that they thought of as close, although the interpretation of a close friend was left to the participant, this reduced any confusion about who to include in this number. This clarity has not always been present in previous studies (Pinquart & Sorensen, 2003; Savikko et al., 2005; Steed et al., 2007).

However, the current study is not without its limitations. Firstly, the present research was an online study only available to those with access to the internet. Many older adults do not have this

access (Yu et al., 2016) and/or autonomy with internet use (Hargittai et al., 2019) and so the current findings are not representative of the UK population. Second, the definition of a close friend was left to each participant's own interpretation. Respondents were able to decide what a close friend meant to them, and to allocate their personal contacts accordingly. Although in previous studies, similar to ours, no definition for friendships has been given (Mullins & Dugan, 1990; Russell et al., 2012), individual interpretations may differ between participants and providing an explicit definition, such as in Williams and Solano's study (Williams & Solano, 1983), may have resulted in different findings. However, we believe that leaving this concept open to interpretation allows for more accurate inclusion of those whom respondents feel close to, rather than forcing them to exclude contacts based on a definition which may be incompatible with respondents' own views. This is something that has been cautioned against previously by Adams and colleagues (2000) who outline that it is not suitable to assign a definition of friendship to individuals as many do not share the same criteria for this type of relationship. Therefore, future research may benefit from repeating the study to include face-to-face data collection for those without access to the internet and potentially the incorporation of an established definition of a close friend and comparing if this differs from a respondent's definition.

As mentioned previously we focused on only close friendships. Doing so allowed the determination of the number of high quality and rewarding friendships that individuals should focus on to reduce loneliness and improve psychological well-being. This is important as these emotionally close friendships require bilateral effort, time and other resources to initiate and maintain and as such are more costly in comparison to less emotionally close relationships (Roberts et al., 2009). However, despite the importance of these close relationships in terms of loneliness, more peripheral friendships could still be having an impact on our outcome measures. It may be beneficial for future work to take into account these friendships also.

Further, the present study did not explicitly take into account the impact of the quality of friendships on loneliness and mental health. Although we have mentioned the minority of participants who may have been experiencing low levels of closeness in the friendships they reported, as participants were asked *specifically* about close friends, it is likely that many of these contacts

represent high quality relationships. Regardless, as the quality of friendships has been linked to loneliness and mental health (Mullins & Dugan, 1990; Wheeler et al., 1983), future studies would benefit from also including the quality or emotional closeness of these friendships explicitly as a covariate to determine whether the effect of the number of friends remains after adjusting for this.

Similarly, the present study did not account for the types of support that can be exchanged within friendships. Both emotional and instrumental support within social networks have been shown to predict levels of loneliness (e.g., Sanchez et al., 2012). Including the type of support both given and received within close friendships in future analyses could assist in unpicking the aspects of these friendships which are most optimal in preventing loneliness in this age group.

It is important to note that the number of close friendships is not the only aspect of an individual's social network with implications for loneliness within this age group. Structural and compositional aspects of this network can also explain loneliness and its associated negative outcomes. For example, it has been demonstrated that social network size as well as brokerage and embeddedness can predict loneliness in older adults (Kim et al., 2021). Compositionally, the presence of a romantic partner is protective against loneliness (Martina, 2021). This could potentially be due to the increased opportunity for accruing additional friends within a social network. The inclusion of such parameters in the above analyses would provide a deeper understanding of the effect of the number of close friendships on loneliness in older adults after controlling for these aspects.

In terms of additional future directions, as well as a replication, and taking into account the aforementioned issues, future research should establish who these close friends are. We know that these are emotionally close relationships but is there a difference in the impact on loneliness and psychological well-being in terms of the length of the relationship and whether these contacts belong to a dense network? Is it preferable to have contact with these friends in a certain way for a certain length of time or at a particular frequency? Or is the content of the interactions more important? Previous research suggests that network density is important in terms of happiness and subjective well-being (Huang et al., 2019) and that frequency of contact has a differential effect on subjective

well-being dependent on the mode utilised (Horst & Coffé, 2012). Therefore, these nuances are possible and should be explored in order to further inform interventions. Importantly, the current investigation was cross-sectional in nature. It may well be possible that there is a limit to the benefit of increasing the number of friendships over time. It also may be possible that having a larger number of friends leads to improved well-being. However, we cannot rule out the possibility of reverse causation. A longitudinal design would be necessary to determine this in future.

For now, we conclude that there is a nonlinear relationship between the reported number of friends and loneliness, depression, anxiety and stress in older adults. We further conclude that based on the present data there appears to be a limit to the beneficial effect of increasing the number of friends in this population. The findings are in need of corroboration incorporating a more representative sample of this population and future work is necessary to further qualify the nature of these friendships. However, these findings have important implications in the development and provision of loneliness and psychological well-being interventions.

# Chapter 4. The Relationship between Egocentric Social Network Characteristics and Loneliness and wellbeing in Older Adults.

## 4.1.Abstract

The aim of the present study was to confirm the presence of a negative curvilinear relationship between the number of friends and loneliness, and psychological well-being as reported in previous literature as well as to explore whether certain personal social network characteristics may protect against loneliness in older adults given their established importance in other populations. Data were obtained from 219 older adults via completion of a postal survey. Measures included loneliness (UCLA Version 3), depression, anxiety and stress (DASS-21), and physical symptoms (CHIPS). Name generator questions elicited comprehensive details about participants personal social networks to determine the network size of their sympathy group, number of friends and emotional closeness to their friends. Regression analyses revealed a negative relationship between each of the predictors and loneliness. Network size was found to additionally be a predictor of depression and anxiety. No relationship was found between any of the predictors and physical symptoms. The average sympathy group size in our sample was found to be 13 members. We could not replicate the curvilinear relationship reported in Chapter 3. The results suggest that friendships, emotional closeness to friends and the size of our sympathy group are important network aspects that can help stave off loneliness and improve psychological well-being. This therefore adds weight to the suggestions in Chapter 2 on the importance of building, maintaining, and deepening emotionally close social connections and the necessity of incorporating this into loneliness interventions aimed at this age group.

## 4.2.Introduction

As discussed in previous chapters, loneliness is associated with many deleterious psychological and physical health outcomes (e.g., for a review see Courtin & Knapp, 2017), with older adults having particular vulnerability to such health concerns (e.g., Rohrmann, 2020). This warrants the exploration of possible predictors of loneliness due to their potential as routes to protect against these effects.

Study 2 explored the impact of a particular egocentric social network characteristic, the number of close friends, in relation to loneliness, depression, anxiety and stress in this population. Friendships have been suggested as key protective relationships in terms of loneliness and psychological well-being (Pinquart & Sörensen, 2001; Shiovitz-Ezra & Leitsch, 2010). Our findings added further evidence to this notion, demonstrating that for older adults, having more close friends predicted lower levels of loneliness and better psychological well-being (Thompson et al., 2022). Further, the study also indicated that the benefit of increasing the number of close friends is limited. For loneliness, increasing this number past four close friends does not appear be associated with any further improvements in these outcomes. The same is true for the psychological well-being parameters examined, but with lower optimal numbers.

However, we noted some limitations which were suggested to be addressed in future replication and expansion of this work. We stated in the previous chapter that replication employing a sample with greater variation in certain characteristics is necessary. The previous sample of older adults was recruited primarily through the recruitment platform Prolific (Palan & Schitter, 2018). Although it has been suggested that the employment of this platform can result in a more diverse sample compared to other platforms (Peer et al., 2017), recruiting in this way still has some issues. Primarily, as this is an online method it means that only those with access to, and the ability to use IT equipment and the internet, were able to participate. This therefore excludes the large proportion of older adults in the UK without such resources (Hargittai et al., 2019; Yu et al., 2016).

Similarly, for Study 2, we did not direct recruitment towards particular geographic locations or the socioeconomic status of participants. Given the established link between socioeconomic status over the life course and internet use in older adulthood (Silver, 2014), there was the potential of recruitment bias towards those from areas of increased socioeconomic status. As deprivation is associated with increased levels of loneliness (Victor & Pikhartova, 2020) and poor mental health outcomes (Delgadillo et al., 2018), there is the potential that we have missed a key characteristic of our target population.

In addition, in our previous study, a direct question based on previous literature was used to elicit the number of close friends of participants (Russell et al., 2012). However, it is possible that the elicitation method employed could impact on the number of close friends reported. Name generator techniques offer a more in depth and holistic process of recalling members of our social networks. As name generator techniques have been shown to elicit an individual's stronger ties, they may be beneficial in capturing a person's close friendships, potentially resulting in more accurate quantities (Marin, 2004).

We also highlighted that in the previous study we did not explicitly assess the emotional closeness of the close friendships being reported, rather intending to capture this by including the word 'close' in the question. Asking respondents to explicitly state how close they feel to each of the members of the network they list requires a deeper level of processing, potentially increasing the precision of the numbers reported. Furthermore, this provides an additional measure of relationship closeness which can ensure that only emotionally close friendships are included in analysis when required. Emotional closeness in and of itself has been shown to be negatively linked to loneliness with closeness to significant others reducing loneliness in older adults (Drageset et al., 2011). This variable provides an indication of relationship quality (Litwin et al., 2015), an aspect previously established to be important in relation to loneliness (Mullins & Dugan, 1990; Wheeler et al., 1983), and the lack of inclusion of it was noted as a limitation of the methods in Study 2.

Additionally, as mentioned in the previous chapter, it is possible that more peripheral friendships and relationships could also be playing a role in the effects reported. As such overall subjective network size (Kim et al., 2021), rather than the networks of specific relationships, has previously been linked to lower levels of loneliness. Therefore, as well as exploring only the number of close friends reported, assessing the total number of subjective network connections allows these potential effects of peripheral relationships to be examined. If peripheral relationships are having an effect here, then this could highlight the utility of increasing all types of social contact as a means to counter loneliness and its effects rather than just focusing on particular core relationships.

Loneliness has also been repeatedly shown to be associated with a variety of physical health outcomes (For a review see Park et al., 2020). However, our previous study did not include any exploration of the benefit of close friendships to physical health. Including a measure of physical health would therefore be advantageous in research exploring these potential predictors to see whether interventions which target loneliness may also be beneficial in improving associated well-being outcomes.

In line with Dunbar's Social Brain Hypothesis (Dunbar, 1998), much work has demonstrated that an individual's social network consists of a series of hierarchically inclusive layers which increase in size, and which decrease in emotional closeness (Hill & Dunbar, 2003; Roberts et al., 2009; Sutcliffe et al., 2012; Zhou et al., 2005). This pattern indicates a tradeoff between the number of relationships within a network and the emotional intensity experienced; thought to be due to the time and cognitive constraints of maintaining these relationships.

The two innermost layers have been coined the support group and the sympathy group. Support groups consist of contacts that you would turn to in times of severe emotional or financial distress and the sympathy group includes those who are contacted monthly (Dunbar & Spoors, 1995; Dunbar, 1998; Stiller & Dunbar, 2007) whose sudden death would be greatly upsetting (Buys & Larson, 1979). The average group sizes for these layers have consistently been shown to be around 5 members (Binder et al., 2012; Dunbar & Spoors, 1995; Molho et al., 2016) and around 12 members

(Binder et al., 2012; Molho et al., 2016; Stiller & Dunbar, 2007) respectively. These innermost layers have also been termed personal communities by some researchers (e.g., Binder et al., 2012; Pahl & Spencer, 2010).

However, to date no work has examined whether these groupings are different in the social networks of older adults. Differences in these group sizes are plausible given the likelihood of losing network members from various layers with age (Bhattacharya et al., 2016; Carstensen, 1992) and decreasing mobility (Wrzus et al., 2013). Determining these groupings in this population would be beneficial in order to know where deficits lie in the personal networks of older adults experiencing loneliness, potentially allowing loneliness interventions to be targeted accordingly.

### *4.2.1. The Present Study*

As evidenced, further exploration of aspects relating to the social networks of older adults, loneliness and well-being is justified. The inclusion of  However, to address the limitations outlined above, the present study to aims capture data from a more diverse sample than in Study 2, specifically by recruiting participants via mail adverts targeted to those aged 65 and over from across areas of differing socioeconomic status in the UK.

Additionally, a pen and paper method will be utilised in order to include those without access to IT equipment or the internet. To more comprehensively capture the social networks of participants, we employed a name generator technique to obtain the personal relationships of participants. Included in the information captured will be a question relating to how emotionally close each participant feels to each of the members of their network they list to act as corroboration of the closeness of the friendships reported. This will also allow assessment of the importance of emotional closeness with the network in relation to the outcome variables. This in turn will further act as an indicator of

relationship quality. To assess the effects of the more peripheral relationships within the network, overall subjective network size will also be captured.

Therefore, the present study aims to explore the relationship between specific egocentric network characteristics of older adults (number of friendships, network size and average emotional closeness to friends) and five outcome variables of interest (loneliness, depression, anxiety, stress, and physical symptoms) in older adults. An additional aim is to determine the size of the sympathy group of older adults, inclusive of the support group. It was hypothesised that having more friendships, a larger network and increased emotional closeness within the network would be associated with reduced levels of loneliness, better psychological well-being and physical health. It was further hypothesized that the size of the sympathy group in the present sample may be lower than those reported in previous studies involving the general population. The inclusion of the additional indicators described above will allow optimal elements of the personal social networks of older adults to be incorporated into interventions with the aim of reducing loneliness in this age group.

## 4.3.Method

### *4.3.2. Design*

The present study was an exploratory cross-sectional and correlational investigation into the relationship between egocentric network characteristics of older adults and loneliness, depression, anxiety, stress and physical health symptoms. The predictors of interest were: Number of friends, average emotional closeness to friends and network size. The full booklet of the survey is available the OSF repository. Data were collected between September 2020 and January 2021.

### *4.3.3. Participants*

A target sample of 300 was preregistered. The study was advertised via word of mouth, through Facebook adverts and a mail shot campaign. The Facebook Adverts and the mail shot

campaign were targeted to adults aged 65 and over and to those residing across different areas of socioeconomic status in the United Kingdom. Response booklets were sent to 293 individuals who responded to the recruitment adverts. Of the booklets sent out, 219 were returned. This is still sufficient to perform the required analyses (Austin & Steyerberg, 2015; Roscoe, 1975; Tabachnik & Fidell, 2009) and studies investigating similar parameters have done so with a smaller sample size (e.g., Cheyne et al., 2021; Roberts et al., 2009). Those that took part were entered into a prize draw to win one of four £250 prizes. Due to ethical considerations, participants were required to not have a current clinical diagnosis of depression or anxiety to be eligible to take part in the study.

#### *4.3.4. Measures*

Each participant received a booklet which collected demographic data and measures of physical and psychological well-being. As well, a name generator question was included. Participants were asked to list all individual's that they had any type of contact with during the past month that they felt they had a personal relationship with. This question was used in order to elicit the inner sympathy group layer of the networks of participants as employed in previous research (e.g., Stiller & Dunbar, 2007). For each person listed, participants were required to provide information about how long they had known the individual, the type of relationship (selected from a list of categories such as 'friend', 'child', and 'grandchild' with a free text entry option for categories not included in the list), their age and gender, as well as information about the last and usual contact they had had with them. Not all network information is reported on in this study (but is available at https://osf.io/mxnpj/?view_only=03827a0f2f6c448a82f49651ae2391fe). Participants were then required to complete the survey measures listed below.

***Loneliness***. There were five dependent variables examined within this study. The first was loneliness as measured by the University of California, Los Angeles, Loneliness Scale-Version 3 (UCLA-3). The UCLA-3 is a 20-item self-report scale designed to measure an individual's subjective feelings of loneliness. Participants are asked how often each statement is descriptive of them (e.g., How often do you feel that you lack companionship)? Items are on a scale ranging from 1 (Never) to

4 (Often) and nine items are reverse scored. All items are summed to give one loneliness score; a higher score represents greater levels of loneliness. Version 3 of this scale has demonstrated excellent internal reliability (Cronbach's alpha = .96) (Russell, 1996). The reliability for the present study is excellent at alpha = .98.

***Psychological Well-being***. The three psychological well-being aspects were all assessed via the short version of the Depression, Anxiety and Stress Scale (DASS-21) (Lovibond & Lovibond, 1995). The DASS-21 consists of 21 items and includes three 7-item subscales measuring depression, anxiety and stress separately. Participants are asked how much each statement has applied to them over the past week (e.g., I found it hard to wind down). Items are on a scale ranging from 0 (Never) to 3 (Almost Always). Items are summed for each scale separately and multiplied by two to allow comparison to the original 42-item DASS Scale. No items are reverse scored. A higher score in a subscale represents a greater level of that particular psychological state. The separate depression, anxiety and stress scales have all repeatedly demonstrated good internal reliability (All Cronbach's alpha > .90) (E.g., Osman et al., 2012). Reliability for the present study is as follows: Anxiety (Cronbach's alpha = .73), Stress (Cronbach's alpha = .89) and Depression (Cronbach's alpha = .91). The DASS-21 scale has repeatedly demonstrated a three-factor structure representing the three separate scales (Crawford & Henry, 2003; Norton, 2007; Scholten et al., 2017; Sinclair et al., 2012).

***Physical Symptoms.*** The Cohen-Hoberman Inventory of Physical Symptoms (CHIPS) was used to assess perceived burden of physical symptoms. The CHIPS contains a list of 39 common physical symptoms. Participants are asked how much each symptom has bothered or distressed them during the past two weeks. Items are on a scale ranging from 0 (Not at all) to 4 (An extreme bother). None of the items are reverse scored. The CHIPS has demonstrated good internal reliability (e.g., Cronbach's alpha = .88) (Cohen & Hoberman, 2006). Reliability for the present study is alpha = .87. Table 1 contains the descriptive statistics for each of the dependent variables.

**Key Independent Variables**

***Number of friends.*** This variable was elicited via the name generator process which asked participants to list all individual's that they felt they had a personal relationship with and that they had contact with during the past month. Participants then stated what relationship they had with each of these individuals. Only those described as friends were included in this measure.

***Network Size.*** This variable was calculated as the total number of individual's that participant's listed via the name generator. This number reflects the size of participants sympathy group inclusive of the support group and includes both friends and non-friends.

***Average Emotional Closeness to Friends***. Participants were asked to indicate on a scale of 1-10 how emotionally close they felt to each person that they listed via the name generator. This rating was restricted to only friends and then averaged.

**Covariates**

Five demographic control variables were included in this study as they have previously been linked to one or more of the dependent variables. Marital status was included as a categorical variable with response options being 'In a relationship', 'Married/Registered civil partnership', 'Separated but still married or in a registered civil partnership', 'Divorced' and 'Widowed'. The reference category for this variable was 'Single, never married or in a civil partnership'. Age was included as a continuous variable. Gender was included as a categorical variable with male being the reference category. Highest attained level of education was also included as a categorical variable with response options being 'Secondary school', 'First degree or equivalent', 'Master's Degree or equivalent', 'Doctoral Degree'. The reference category for this variable was 'Primary School'. Financial security was included as a categorical variable with response options being 'Have to cut back', 'Enough but no extra', 'Comfortable with extra'. The reference category for this variable was 'Cannot make ends meet'.

### *4.3.5. Procedure*

Ethical approval was granted by the local ethics committee. Once informed consent was documented, participants completed all measures within a paper booklet that was posted out to them. The demographic measures were completed first. This was followed by a name generator and associated information was requested. Subsequently, each of the well-being scales were presented. The whole booklet should have taken no longer than 60 minutes to complete.

### *4.3.6. Analytical Approach*

All analyses were performed using R version 3.6.1 (R Core Team, 2017) (For further details see OSF). Four cases in which participant ages had been listed below the minimum age of 65 were removed. This resulted in a final sample size of 214 participants.

The data met the assumptions of non-multicollinearity, homoscedasticity, and non-autocorrelation. The loneliness data met the assumption of normally distributed residuals. The three DASS variables all exhibited some skew in the distribution of residuals. However, this is to be expected given that most respondents were not currently experiencing high levels of depression, anxiety or stress. However, regression is relatively robust to skew (especially as sample sizes become larger), therefore we used this technique (Berry, 1993).

Prior to performing regression analyses, some demographic factor levels were grouped to result in a more equal n per cell and to avoid very low frequencies. For marital status, being married or in a civil partnership and being in a relationship were combined into one level. As were separated and divorced. For education, primary and secondary school were combined along with responses not stated. Masters and doctoral degrees were also combined.

## 4.4.Results

### *4.4.7. Sample Characteristics*

Sample characteristics and descriptive statistics are presented in Table 1. In the final sample 69% of participants were female and 31% were male. The mean age of participants was 72 years (*SD* = 5.04). Most participants reported being married or in a civil partnership (57%), having completed an undergraduate degree (53%), having a comfortable financial situation (70%) and their nationality being British (98%). The average size of the sympathy group of respondents was 13. All were residents of the United Kingdom.

**Table 8**

*Sample Characteristics (n = 214)*

| **Characteristic** | **Statistic (Mean (SD) or n (%))** |
|---|---|
| **Age** | 71.55 (5.04) |
| **Gender** | |
| Female | 148 (69) |
| Male | 66 (31) |
| **Marital Status** | |
| Single | 15 (7) |
| In a relationship or married | 130 (61) |
| Separated or divorced | 38 (18) |
| Widowed | 31 (14) |

| | |
|---|---|
| **Education** | |
| Primary or Secondary School or not stated | 51 (24) |
| First degree or equivalent | 113 (53) |
| Postgraduate Degree | 50 (23) |
| **Financial Status** | |
| Have to cut back, can't make ends meet or not stated | 7 (3) |
| Enough but no extra | 58 (27) |
| Comfortable with extra | 149 (70) |
| **Nationality** | |
| British | 210 (98) |
| Other | 3 (1) |
| Not Stated | 1 (1) |
| **Number of Friends** | 6.61 (5.57) |
| **Network Size** | 12.92 (7.60) |
| **Emotional Closeness to Friends** | 6.63 (1.43) |
| **Loneliness** | 39.76 (11.04) |
| **Depression** | 3.68 (4.47) |
| **Anxiety** | 1.62 (2.52) |
| **Stress** | 3.30 (4.15) |

| | |
|---|---|
| **Physical Symptoms** | 13.10 (12.09) |

### *4.4.8. Main Analyses*

**Correlations**

The bivariate correlations are presented in Table 2. Number of friends, network size and average emotional closeness to friends were significantly all negatively associated with loneliness.

**Table 9**

*Zero-order Correlations for Study Variables (n = 179)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|
| 1. No. of friends | | | | | | | |
| 2. Network size | .8*** | | | | | | |
| 3. Emotional closeness to friends | -.06 | -.04 | | | | | |
| 4. Loneliness | -.17* | -.23** | -.23** | | | | |
| 5. Depression | -.13$^{+}$ | -.16* | -.01 | .48*** | | | |
| 6. Anxiety | -.09 | -.12$^{+}$ | .04 | .38*** | .72*** | | |
| 7. Stress | -.14$^{+}$ | -.14$^{+}$ | .01 | .47*** | .74*** | .73*** | |
| 8. Physical Symptoms | -.11 | .09 | .04 | .33*** | .62*** | .70*** | .65*** |

+ < .1, *$p$ < .05, **$p$ < .01, ***$p$ < .001. note: n =179 due to listwise deletion.

**Regression Analyses**

Based on inspection of the bivariate correlations, hierarchical OLS regression analysis was performed for all variables showing significant or approaching significant correlations with dependent variables of interest. As no predictors of interest demonstrated a significant correlation with physical symptoms, no regression analysis was performed on this outcome measure. For each of these predictors and outcomes, the presence of a curvilinear relationship was evaluated visually. Comparisons between a linear model and polynomial model were assessed via a $Chi^2$ test using the anova function in R. None of the polynomial models demonstrating a better fit than the linear models. Therefore, only the linear models are reported here.

**Loneliness**

***No. of Friends.*** After adjusting for all demographic information, the final model was significant ($F(11,168) = 3.009$, $p = .002$). No. of friends remained a significant negative predictor in this model (B = -0.37, $p = .001$).

Of the demographic covariates, only having enough financially (B = -10.23, $p = .044$) and being financially comfortable with extra were significant negative predictors of loneliness (B = -14.30, $p = .004$). Those with these levels of financial stability reported less loneliness than those who could not make ends meet. Having a first degree or equivalent was a significant positive predictor of loneliness (B =5.09, $p = .009$) compared to being primary or secondary school educated. This final model explained 11% of the variance in loneliness ratings (Table 3).

***Network Size.*** After adjusting for all demographic information, the final model was significant ($F(11,190) = 3.675$, $p = .0002$). Network size remained a significant negative predictor in this model (B = -0.30, $p < .003$).

Of the demographic covariates, having a first degree in comparison to being primary or secondary school educated was a significant positive predictor of loneliness (B = 4.96, $p = .007$). Being financially comfortable with extra (B = -13.07, $p = .002$). Those with this level of financial

stability reported less loneliness than those who could not make ends meet. This final model explained 13% of the variance in loneliness ratings (Table 4).

***Average Emotional Closeness to Friends.*** After adjusting for all demographic information, the final model was significant ($F(11,166) = 3.287$, $p = 0004$). Average emotional closeness to friends remained a significant negative predictor in this model (B = -2.01, $p = .0006$).

Of the demographic covariates, only being financially comfortable with extra was a significant negative predictor of loneliness (B = -14.23 $p = .004$). Those with this level of financial stability reported less loneliness than those who could not make ends meet. This final model explained 12% of the variance in loneliness ratings (Table 5).

**Regression - Depression**

***Network Size.*** After adjusting for all demographic information, the final model was significant ($F(19,182) = 1.958$, $p = .005$). Network size remained a significant negative predictor in this model (B = -0.09, $p = .021$).

Of the demographic covariates, being female was associated with more depression than being male (B = 1.49, $p = 0.36$). Having enough financially (B = -3.88, $p = .028$) and being financially comfortable with extra was a significant negative predictor of depression (B = -5.45, $p = .002$). Those with these levels of financial stability reported less loneliness than those who could not make ends meet. This final model explained 8% of the variance in depression ratings (Table 6).

**Table 10**

*Hierarchical Regression Analysis to Predict Loneliness from Number of Friends (+/- SE)*

| | Loneliness | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Number of friends | -0.334* (0.144) | -0.360* (0.146) | -0.349* (0.145) | -0.349* (0.416) | -0.377* (0.145) | -0.361* (0.141) | -0.369* (0.142) |
| Marital Status: In a relationship or married | | -6.744* (3.316) | -6.710* (3.308) | -7.078* (3.360) | -7.726* (3.330) | -6.010$^{+}$ (3.374) | -5.943 (3.376) |
| Marital Status: Separated or Divorced | | -4.819 (3.698) | -4.814 (3.689) | -4.941 (3.700) | -5.535 (3.709) | -6.034 (3.658) | -5.761 (3.665) |
| Marital Status: Widowed | | -4.944 (3.782) | -4.226 (3.810) | -4.233 (3.816) | -4.667 (3.832) | -3.661 (3.815) | -3.415 (3.821) |
| Age | | | -0.219 (0.161) | -0.241 (0.164) | -0.195 (0.163) | -0.120 (0.161) | -0.105 (0.161) |
| Gender (Male -> Female) | | | | -1.239 (1.877) | -0.961 (1.885) | -1.407 (1.841) | -1.292 (1.850) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | 5.101* (1.977) | 5.154** (1.930) | 5.091** (1.933) |
| Education: Postgraduate Degree | | | | | 4.275$^{+}$ (2.377) | 4.434$^{+}$ (2.330) | 4.332$^{+}$ (2.333) |
| Financial Status: Enough but no extra | | | | | | -10.477* (5.048) | -10.235* (5.054) |
| Financial Status: Comfortable with extra | | | | | | -14.454** (4.967) | -14.296** (4.971) |
| Nationality: British -> Other | | | | | | | -7.118 (6.157) |
| Constant | 41.663*** (1.252) | 47.521*** (3.307) | 62.983*** (11.825) | 65.717*** (12.547) | 59.329*** (12.617) | 65.982*** (12.870) | 64.705*** (12.911) |
| *N* | 181 | 181 | 181 | 181 | 181 | 181 | 180 |
| $R^2$ | 0.029 | 0.054 | 0.064 | 0.066 | 0.102 | 0.158 | 0.165 |
| Adjusted $R^2$ | 0.024 | 0.033 | 0.037 | 0.034 | 0.060 | 0.108 | 0.110 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 10.947 (df = 179) | 10.899 (df = 176) | 10.872 (df = 175) | 10.890 (df = 174) | 10.741 (df = 172) | 10.464 (df = 170) | 10.469 (df = 168) |
| F Statistic | 5.400* (df = 1; 179) | 2.512* (df = 4; 176) | 2.390* (df = 5; 175) | 2.058$^{+}$ (df = 6; 174) | 2.444* (df = 8; 172) | 3.181*** (df = 10; 170) | 3.009** (df = 11; 168) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

***No. of Friends***. In the first model containing only no. of friends as a predictor variable, the model was approaching significance ($p$ = .078). After controlling for all other demographic variables, the final model was approaching significance *(*$F$(11, 168) = 1.841, $p$ = .051*)*. In this model no. of friends was approaching significance as a negative predictor of depression (B = -0.11, $p$ = .056). Of the demographic covariates, only being financially comfortable with extra was a significant negative predictor of depression (B = -4.05, $p$ = .040) compared to not being able to make ends meet and having to cut back. This final model explained 5% of the variance in depression ratings (Table 7)

**Table 11**

*Hierarchical Regression Analysis to Predict Loneliness from Network Size (+/- SE)*

| | Loneliness | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Network Size | -0.331** (0.100) | -0.323** (0.101) | -0.319** (0.101) | -0.318** (0.101) | -0.340** (0.101) | -0.295** (0.098) | -0.300** (0.099) |
| Marital Status: In a relationship or married | | -4.280 (3.174) | -4.363 (3.168) | -4.451 (3.210) | -4.967 (3.179) | -3.317 (3.148) | -3.250 (3.150) |
| Marital Status: Separated or Divorced | | -3.789 (3.526) | -3.785 (3.518) | -3.793 (3.527) | -4.514 (3.526) | -5.319 (3.443) | -5.087 (3.449) |
| Marital Status: Widowed | | -4.556 (3.594) | -3.992 (3.610) | -3.971 (3.620) | -4.186 (3.612) | -3.038 (3.544) | -2.820 (3.549) |
| Age | | | -0.211 (0.154) | -0.217 (0.157) | -0.171 (0.157) | -0.103 (0.153) | -0.089 (0.153) |
| Gender (Male -> Female) | | | | -0.330 (1.760) | -0.016 (1.762) | -2.17 (1.705) | -1.292 (1.850) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | 5.074** (1.882) | 4.997** (1.821) | 5.091** (1.933) |
| Education: Postgraduate Degree | | | | | 3.668 (2.249) | 3.409 (2.192) | 4.332$^{+}$ (2.333) |
| Financial Status: Enough but no extra | | | | | | -8.392$^{+}$ (4.260) | -8.188+ (4.265) |
| Financial Status: Comfortable with extra | | | | | | -13.211** (4.177) | -13.065** (4.182) |
| Nationality: British -> Other | | | | | | | -7.605 (6.099) |
| Constant | 44.101*** (1.503) | 47.965*** (3.214) | 63.023*** (11.434) | 63.699** (12.016) | 57.427*** (12.091) | 62.580*** (12.111) | 61.452*** (12.144) |
| *N* | 203 | 203 | 203 | 203 | 203 | 203 | 202 |
| $R^2$ | 0.051 | 0.060 | 0.069 | 0.069 | 0.103 | 0.169 | 0.175 |
| Adjusted $R^2$ | 0.047 | 0.041 | 0.046 | 0.041 | 0.066 | 0.126 | 0.128 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 10.837 (df = 201) | 10.866 (df = 198) | 10.841 (df = 197) | 10.868 (df = 196) | 10.725 (df = 194) | 10.376 (df = 192) | 10.380 (df = 190) |
| F Statistic | 10.859** (df = 1; 201) | 3.183* (df = 4; 176) | 2.934* (df = 5; 197) | 2.439* (df = 6; 196) | 2.789** (df = 8; 194) | 3.908*** (df = 10; 192) | 3.675*** (df = 11; 190) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

**Regression - Anxiety**

***Network Size.*** Although the correlation between network size and anxiety was only approaching significance ($p$ = .098) the first model containing only network size as a predictor was significant ($p$ = .018). After controlling for all other demographic variables, the final model was significant *(*$F(11, 190) = 1.884$, $p$ = .044). In this model network size remained a significant negative predictor of anxiety (B = -0.06, $p$ = .013). Of the demographic covariates, being female compared to male was associated with greater levels of depression (B = 1.06, $p$ = .011). This final model explained 5% of the variance in anxiety ratings (Table 8).

**Regression - Stress**

***No. of Friends.*** In the first model containing only number of friends as a predictor variable, the model was approaching significance ($p$ = .07). After controlling for all other demographic variables, the final model was also approaching significance *(*$F(11, 168) = 2.072$, $p$ = .023). In this model no. of friends was approaching significance as a negative predictor of stress (B = -0.11, $p$ = .061). Of the demographic covariates only being comfortable with extra financially (B = -3.88, $p$ = .044) was a significant negative predictor of stress compared to not being able to make ends meet. This final model explained 6% of the variance in anxiety ratings (Table 9).

***Network Size.*** In the first model containing only network size as a predictor variable, the model was approaching significance ($p$ = .066). After controlling for all other demographic variables, the final model was also approaching significance *(*$F(11, 190) = 2.145$, $p$ = .019). In this model network size was approaching significance as a negative predictor of stress (B = -0.07, $p$ = .081). Of the demographic covariates only being comfortable with extra financially (B = -3.97, $p$ = .016) was a significant negative predictor of stress compared to not being able to make ends meet. This final model explained 6% of the variance in anxiety ratings (Table 10).

**Table 12**

*Hierarchical Regression Analysis to Predict Loneliness from Average Emotional Closeness to Friends (+/- SE)*

| | Loneliness | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Av emotional closeness to friends | -1.745** (0.564) | -1.980*** (0.578) | -2.088*** (0.580) | -2.072*** (0.582) | -1.968*** (0.586) | -2.009*** (0.569) | -2.007*** (0.574) |
| Marital Status: In a relationship or married | | -6.421* (3.240) | -6.395* (3.228) | -6.654* (3.281) | -7.185* (3.284) | -5.093 (3.314) | -5.085 (3.330) |
| Marital Status: Separated or Divorced | | -2.746 (3.672) | -2.840 (3.659) | -2.935 (3.672) | -3.923 (3.721) | -0.172 (0.166) | -4.117 (3.678) |
| Marital Status: Widowed | | -3.346 (3.719) | -2.441 (3.751) | -2.464 (3.760) | -3.159 (3.809) | -0.938 (1.818) | -1.757 (3.799) |
| Age | | | -0.256 (0.167) | -0.269 (0.170) | -0.245 (0.170) | 3.597$^{+}$ (1.935) | -0.171 (0.167) |
| Gender (Male -> Female) | | | | -0.875 (1.844) | -0.515 (1.871) | -0.938 (1.818) | -1.292 (1.850) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | 3.593$^{+}$ (1.991) | 3.597$^{+}$ (1.935) | 5.091** (1.933) |
| Education: Postgraduate Degree | | | | | 1.938 (2.368) | 2.015 (2.313) | 4.332$^{+}$ (2.333) |
| Financial Status: Enough but no extra | | | | | | -9.466$^{+}$ (4.973) | -9.434 (5.054) |
| Financial Status: Comfortable with extra | | | | | | -14.217** (4.879) | -14.228** (4.902) |
| Nationality: British -> Other | | | | | | | 0.448 (7.487) |
| Constant | 51.186*** (3.823) | 57.658*** (4.808) | 76.535*** (13.224) | 78.199*** (13.711) | 73.765*** (13.904) | 80.258*** (13.946) | 80.026*** (14.057) |
| *N* | 179 | 179 | 179 | 179 | 179 | 179 | 178 |
| $R^2$ | 0.051 | 0.085 | 0.097 | 0.098 | 0.116 | 0.179 | 0.179 |
| Adjusted $R^2$ | 0.046 | 0.064 | 0.071 | 0.067 | 0.074 | 0.130 | 0.124 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 10.759 (df = 177) | 10.658 (df = 174) | 10.617 (df = 173) | 10.641 (df = 172) | 10.600 (df = 170) | 10.275 (df = 168) | 10.323 (df = 166) |
| F Statistic | 9.566** (df = 1; 177) | 4.037** (df = 4; 174) | 3.724** (df = 5; 173) | 3.127** (df = 6; 172) | 2.777** (df = 8; 170) | 3.657*** (df = 10; 168) | 3.287** (df = 11; 166) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

## 4.5.Discussion

The purpose of the present study was to explore the relationship between certain egocentric network aspects and loneliness, depression, anxiety, stress and physical health in older adults while addressing the limitations of the work presented in Study 2. The characteristics investigated were number of friends, network size and average emotional closeness to friends within the networks of participants. A further aim was to assess the average size of the sympathy group in older adults.

For the number of friends, our findings demonstrated a negative linear relationship with loneliness. This relationship was approaching significance for depression and stress. For network size, our findings demonstrated a significant negative relationship for loneliness, depression, anxiety. The relationship for network size and stress was approaching statistical significance. For average emotional closeness to friends, our findings demonstrated a significant negative relationship for only the loneliness outcome. None of our predictors of interest demonstrated a significant relationship with the measure of physical symptoms (All $p > .07$).

Our finding that an increased number of friendships is beneficial for loneliness and psychological well-being in older adults supports the findings of Study 2 and of previous literature in the area. Our friendships are believed to be important protective relationships, over and above that of kin relationships for these negative experiences (e.g., Eshbaugh, 2009; Holmén et al., 1992; Steed et al., 2007), potentially due to their increased quality in comparison to other relationships within our networks (Pinquart & Sörensen, 2001), the role of friends as confidantes (Hawkley et al., 2008) and their provision of social support (e.g., Hombrados-Mendieta et al., 2013).

As noted, number of friendships was not found to be a significant (or approaching significant) predictor of anxiety. This is interesting, as in Study 2 we found that the number of close friendships was a significant negative predictor of anxiety. It is possible that the association is weaker in the present sample, reflected in the smaller correlation coefficients here than in Study 2. This could be due to the participants in the present sample reporting much lower

**Table 13**

*Hierarchical Regression Analysis to Predict Depression from Network Size (+/- SE)*

| | Depression | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Network Size | -0.101* (0.041) | -0.102* (0.041) | -0.101* (0.041) | -0.109** (0.041) | -0.106* (0.041) | -0.090* (0.041) | -0.094* (0.041) |
| Marital Status: In a relationship or married | | -0.250 (1.291) | -0.262 (1.294) | 0.164 (1.294) | 0.168 (1.305) | 0.683 (1.299) | 0.723 (1.298) |
| Marital Status: Separated or Divorced | | 0.406 (1.434) | 0.406 (1.436) | 0.444 (1.422) | 0.422 (1.447) | 0.026 (1.420) | 0.124 (1.421) |
| Marital Status: Widowed | | -0.443 (1.462) | -0.357 (1.474) | -0.459 (1.460) | -0.509 (1.483) | -0.181 (1.462) | -0.089 (1.462) |
| Age | | | -0.032 (0.063) | 0.004 (0.063) | 0.005 (0.064) | 0.021 (0.063) | 0.027 (0.063) |
| Gender (Male -> Female) | | | | 1.593* (0.710) | 1.608* (0.723) | 1.526* (0.704) | 1.486* (0.705) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | -0.232 (0.773) | -0.257 (0.751) | -0.227 (0.752) |
| Education: Postgraduate Degree | | | | | -0.376 (0.923) | -0.421 (0.904) | -0.465 (0.904) |
| Financial Status: Enough but no extra | | | | | | -3.980* (1.757) | -3.883* (1.994) |
| Financial Status: Comfortable with extra | | | | | | -5.549** (1.723) | -5.448** (1.723) |
| Nationality: British -> Other | | | | | | | -3.536 (2.513) |
| Constant | 4.967*** (0.610) | 5.128*** (1.307) | 7.439 (4.669) | 4.175 (4.845) | 4.424 (4.964) | 6.995 (4.996) | 6.605 (5.003) |
| *N* | 203 | 203 | 203 | 203 | 203 | 203 | 202 |
| $R^2$ | 0.030 | 0.033 | 0.035 | 0.059 | 0.060 | 0.120 | 0.128 |
| Adjusted $R^2$ | 0.025 | 0.014 | 0.010 | 0.030 | 0.021 | 0.074 | 0.078 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 4.394 (df = 201) | 4.419 (df = 198) | 4.427 (df = 197) | 4.382 (df = 196) | 4.403 (df = 194) | 4.281 (df = 192) | 4.276 (df = 190) |
| F Statistic | 6.126* (df = 1; 201) | 1.710 (df = 4; 198) | 1.416 (df = 5; 197) | 2.044$^{+}$ (df = 6; 196) | 1.540 (df = 8; 194) | 2.626** (df = 10; 192) | 2.541** (df = 11; 190) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

levels of anxiety on average than the sample in the previous study (a mean of 1.62 here compared to 3.68 in Study 2). Here floor effects could be masking the true strength of this relationship. However, it should be noted that the majority of previous literature has found associations mainly with depression, stress and non-specific psychological distress rather than anxiety (Taylor et al., 2018; van der Horst & Coffé, 2012). This is perhaps due to the qualitatively different nature of anxiety in comparison to stress and depression. Friends can ease stress in practical ways, can discuss past events and offer camaraderie to lift mood. However, the internal stressors characterised by excessive worrying associated with feelings of anxiety may be more difficult to ameliorate via external processes such as friendships. Therefore, it may be that particular friendship qualities were driving the effect seen in Study 2 that are not being captured here. For example, the stipulation in Study 2 of reporting *close* friends may have also elicited friendships that provide particularly beneficial types of support for anxiety.

As overall subjective network size has also been implicated as a predictor of lower levels of loneliness (Beller & Wagner, 2018; Green et al., 2001; Hawkley et al., 2008), and as we noted that more peripheral, less close relationships could be playing a role in the effects observed in Study 2, we also examined overall subjective network size, which here relates to the size of the sympathy group. The finding that a larger network was associated with reduced loneliness is in line with the findings of this earlier literature (Kim et al., 2021). A greater number of network connections could indicate a more diverse network with the ability to offer the different social provisions thought to stave off loneliness as outlined by Weiss (1974). Thus, a larger network may be able to offer the optimal social support and as such reduce feelings of loneliness. Network size demonstrated a significant negative relationship with depression and anxiety and was approaching significance in relation to stress; associations that have been demonstrated in previous literature (Litwin et al., 2015). Here, the total network may contain the particular relationship qualities and types of social support for anxiety alluded to above. Therefore, having a beneficial impact on anxiety as well as the other psychological well-being outcomes.

The methodology used to capture the number of close friends in Study 2 did not include an explicit measure of emotional closeness or relationship quality to further corroborate that

**Table 14**

*Hierarchical Regression Analysis to Predict Depression from Number of Friends (+/- SE)*

| | Depression | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| No. of Friends | -0.098$^{+}$ (0.055) | -0.111* (0.056) | -0.111$^{+}$ (0.057) | -0.111* (0.056) | -0.110$^{+}$ (0.057) | -0.105$^{+}$ (0.056) | -0.107* (0.041) |
| Marital Status: In a relationship or married | | -1.252 (1.282) | -1.250 (1.286) | -0.801 (1.291) | -0.702 (1.302) | 0.016 (1.332) | 0.046 (1.332) |
| Marital Status: Separated or Divorced | | -0.142 (1.430) | -0.142 (1.434) | 0.013 (1.422) | 0.171 (1.451) | 0.127 (1.444) | 0.225 (1.446) |
| Marital Status: Widowed | | -0.630 (1.462) | -0.591 (1.481) | -0.582 (1.466) | -0.428 (1.499) | 0.050 (1.507) | 0.142 (1.507) |
| Age | | | -0.012 (0.062) | 0.016 (0.063) | 0.010 (0.064) | 0.034 (0.063) | 0.039 (0.064) |
| Gender (Male -> Female) | | | | 1.514* (0.721) | 1.434$^{+}$ (0.737) | 1.297$^{+}$ (0.727) | 1.263$^{+}$ (0.730) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | -0.580 (0.773) | -0.588 (0.762) | -0.570 (0.763) |
| Education: Postgraduate Degree | | | | | -0.173 (0.930) | -0.176 (0.920) | -0.228 (0.920) |
| Financial Status: Enough but no extra | | | | | | -2.529 (1.994) | -2.433 (1.994) |
| Financial Status: Comfortable with extra | | | | | | -4.132* (1.961) | -4.049* (1.961) |
| Nationality: British -> Other | | | | | | | -3.472 (2.429) |
| Constant | 4.146*** (0.481) | 5.113*** (1.279) | 5.956 (4.596) | 2.616 (4.822) | 3.323 (4.935) | 4.771 (5.083) | 4.349 (5.093) |
| *N* | 181 | 181 | 181 | 181 | 181 | 181 | 180 |
| $R^2$ | 0.017 | 0.031 | 0.031 | 0.055 | 0.058 | 0.99 | 0.108 |
| Adjusted $R^2$ | 0.012 | 0.008 | 0.003 | 0.022 | 0.014 | 0.046 | 0.049 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 4.207 (df = 179) | 4.217 (df = 176) | 4.225 (df = 175) | 4.185 (df = 174) | 4.201 (df = 172) | 4.133 (df = 170) | 4.130 (df = 168) |
| F Statistic | 3.148$^{+}$ (df = 1; 179) | 1.384 (df = 4; 176) | 1.109 (df = 5; 175) | 1.676 (df = 6; 174) | 1.327 (df = 8; 172) | 1.873$^{+}$ (df = 10; 170) | 1.841$^{+}$ (df = 11; 168) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

these were, in fact, close relationships. In the present study, we included a measure of emotional closeness in our name generator questions as a proxy, as indicated in other literature (e.g., Litwin et al., 2015), to assess whether relationship quality itself was important in terms of loneliness and well-being.

Our finding that average emotional closeness to friends predicted lower levels of loneliness is in line with previous literature. Emotionally close ties, indicative of relationship quality, have previously been shown to be protective in terms of loneliness (Beller & Wagner, 2018). This makes sense as emotional closeness has been shown to be correlated with frequency of interaction with network members (Hill & Dunbar, 2003). Further, network alters designated as core ties, characterized by a greater emotional closeness to ego, engage on average in more friendship maintenance behaviours and a greater exchange of social provisions such as emotional support, companionship and reassurance of worth (Binder et al., 2012). All of these are acts which are likely to ameliorate perceptions of social disconnection (Russell et al., 1984a; Weiss, 1974).

Average emotional closeness to friends did not predict any of the psychological well-being outcomes. This is surprising as in Study 2 we demonstrated a negative association between close friendships and depression, anxiety, and stress. Additionally, literature has indicated that emotional closeness within social networks is protective in relation to depressive symptoms (Litwin et al., 2015). It could be that the number of close friends you have is more important for psychological well-being than how emotionally close you feel, on average, to all of the friends in your network. Our findings could also reflect the 'strength of weak ties'. This theory posits that interacting with a diverse network of peripheral ties provides social capital which in turn enhances well-being (Fingerman, 2009; Granovetter, 1973). In the present study, it may therefore be that the cumulative emotional well-being benefit of these less close relationships is stronger than that of emotionally close friendships.

We were unable to replicate our finding from Study 2 in which a curvilinear relationship was demonstrated for the number of friends and loneliness and each of the psychological well-being outcomes. There could be a number of reasons for this. For example, we used different methods to

elicit the number of friends in each study. Study 2 involved a direct question about how many close friends a participant had whereas Study 3 utilised a name

**Table 15**

*Hierarchical Regression Analysis to Predict Anxiety from Network Size (+/- SE)*

| | Anxiety | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Network Size | -0.056* (0.023) | -0.057* (0.023) | -0.057* (0.023) | -0.062** (0.023) | -0.062* (0.023) | -0.059* (0.024) | -0.060* (0.024) |
| Marital Status: In a relationship or married | | -0.715 (0.734) | -0.714 (0.736) | -0.424 (0.733) | -0.438 (0.739) | -0.399 (0.756) | -0.395 (0.760) |
| Marital Status: Separated or Divorced | | 0.412 (0.815) | 0.412 (0.815) | 0.438 (0.805) | 0.411 (0.819) | 0.283 (0.827) | 0.289 (0.832) |
| Marital Status: Widowed | | -0.349 (0.831) | -0.353 (0.839) | -0.423 (0.826) | -0.442 (0.840) | -0.437 (0.851) | -0.432 (0.856) |
| Age | | | 0.001 (0.036) | 0.020 (0.036) | 0.021 (0.036) | 0.027 (0.037) | 0.028 (0.037) |
| Gender (Male -> Female) | | | | 1.083** (0.402) | 1.097* (0.723) | 1.077* (0.410) | 1.064* (0.413) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | 0.088 (0.437) | 0.086 (0.438) | 0.095 (0.440) |
| Education: Postgraduate Degree | | | | | 0.008 (0.523) | -0.028 (0.527) | -0.026 (0.530) |
| Financial Status: Enough but no extra | | | | | | -1.215 (1.024) | -1.207 (1.029) |
| Financial Status: Comfortable with extra | | | | | | -1.378 (1.004) | -1.366 (1.009) |
| Nationality: British -> Other | | | | | | | -0.278 (1.029) |
| Constant | 2.359*** (0.351) | 2.786*** (0.743) | 2.689 (2.657) | 0.469 (2.742) | 0.351 (2.810) | 1.191 (2.910) | 1.179 (2.931) |
| *N* | 203 | 203 | 203 | 203 | 203 | 203 | 202 |
| $R^2$ | 0.028 | 0.056 | 0.056 | 0.090 | 0.090 | 0.099 | 0.098 |
| Adjusted $R^2$ | 0.023 | 0.037 | 0.032 | 0.062 | 0.053 | 0.052 | 0.046 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 2.532 (df = 201) | 2.513 (df = 198) | 2.519 (df = 197) | 2.480 (df = 196) | 2.493 (df = 194) | 2.493 (df = 192) | 2.505 (df = 190) |
| F Statistic | 5.703* (df = 1; 201) | 2.952* (df = 4; 198) | 2.350* (df = 5; 197) | 3.233** (df = 6; 196) | 2.407* (df = 8; 194) | 2.117* (df = 10; 192) | 1.884* (df = 11; 190) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

generator technique to obtain all alters within the personal communities of participants. Participants were subsequently asked to state what type of relationship they had with each person listed and to provide an emotional closeness score. As mentioned earlier, name generator techniques have been shown to elicit the stronger ties within an individual's network compared to free recall techniques (Marin, 2004), it could be that this led to differences in the number of friends being reported between the two studies.

Additionally, it may be that the curvilinear effect of friends on loneliness is only observed in *close* friendships and not more peripheral friendships. However, supplementary analysis including only friends with an emotional closeness score of 6 and above revealed this not to be the case. Here, a polynomial model demonstrated a worse fit to the data compared to the linear model (see supplementary materials). Also, here, the subsequent allocation of an emotional closeness score following the elicitation of the relationship could require more in-depth processing and result in more accurate levels of closeness compared to Study 2.

As well, the two studies employed samples which likely differed in various ways. For example, the current study targeted mail adverts to individuals residing across the UK specifying differing areas of socioeconomic status with potential reimbursement being in the form of a prize draw. This allowed those without access to the internet or IT equipment to be recruited. Whereas Study 2 employed an online only sample from any location within the UK through recruitment platform Prolific. Here, participants proactively sign up to take part in studies in return for monetary reward. The prolific sample is therefore likely to be somewhat self-selecting in comparison to the postal sample. The samples further differed in terms of how many friends they reported, with respondents in the present study reporting significantly more friends, even when restricting to only emotionally close friends, in comparison to the respondents of study 3 (See OSF for analysis). These sample differences could reflect real differences in the effect of friends on loneliness in these two populations or differences in the accuracy of reporting loneliness and number of friends between these two groups.

Despite this, on inspection of the study sample characteristics, it can be seen that regardless of the intention to do so, the samples for study 3 and study 2 do not appear to differ in some other respects. We had hoped to recruit participants with varying socioeconomic status with the aim of incorporating a sample at risk of loneliness and poor mental health outcomes. However, the average levels of loneliness and experiences of mental health outcomes appear to be comparable across the samples. More robust methods of recruitment should be employed to investigate the variables of interest in such populations. However, the average levels of loneliness and m

We also did not find associations between any of our predictor variables and self-reported physical symptoms. The is somewhat surprising given the previous established link between loneliness and physical health (For a review see Park et al., 2020) which our weak

**Table 16**

*Hierarchical Regression Analysis to Predict Stress from Number of Friends (+/- SE)*

| | Stress | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| No. of Friends | -0100$^{+}$ (0.054) | -0.106$^{+}$ (0.055) | -0.103$^{+}$ (0.056) | -0.103$^{+}$ (0.055) | -0.109$^{+}$ (0.056) | -0.102$^{+}$ (0.054) | -0.103$^{+}$ (0.054) |
| Marital Status: In a relationship or married | | -0.289 (1.263) | -0.296 (1.264) | -0.701 (1.272) | -0.887 (1.276) | 1.898 (1.291) | 1.909 (1.297) |
| Marital Status: Separated or Divorced | | 0.796 (1.408) | 0.797 (1.410) | 0.937 (1.401) | 1.352 (1.421) | 1.454 (1.400) | 1.481 (1.409) |
| Marital Status: Widowed | | 0.124 (1.441) | 0.284 (1.456) | 0.292 (1.445) | 0.733 (1.468) | 1.464 (1.460) | 1.490 (1.469) |
| Age | | | -0.049 (0.061) | -0.024 (0.062) | -0.033 (0.063) | -0.007 (0.061) | -0.055 (0.062) |
| Gender (Male -> Female) | | | | 1.367$^{+}$ (0.711) | 1.149 (0.722) | 1.005 (0.705) | 0.975 (0.711) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | -0.752 (0.758) | -0.795 (0.739) | -0.779 (0.743) |
| Education: Postgraduate Degree | | | | | 0.498 (0.911) | 0.426 (0.892) | 0.407 (0.896) |
| Financial Status: Enough but no extra | | | | | | -1.716 (1.932) | -1.686 (1.942) |
| Financial Status: Comfortable with extra | | | | | | -3.912* (1.901) | -3.882* (1.910) |
| Nationality: British -> Other | | | | | | | -1.224 (2.366) |
| Constant | 3.952*** (0.471) | 3.656*** (1.260) | 7.103 (4.519) | 4.088 (4.751) | 4.965 (4.834) | 5.674 (4.926) | 5.565 (4.962) |
| *N* | 181 | 181 | 181 | 181 | 181 | 181 | 180 |
| $R^2$ | 0.019 | 0.022 | 0.025 | 0.045 | 0.060 | 0.120 | 0.119 |
| Adjusted $R^2$ | 0.013 | -0.001 | -0.003 | 0.012 | 0.016 | 0.069 | 0.062 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 4.122 (df = 179) | 4.151 (df = 176) | 4.155 (df = 175) | 4.124 (df = 174) | 4.115 (df = 172) | 4.005 (df = 170) | 4.023 (df = 168) |
| F Statistic | 3.389$^{+}$ (df = 1; 179) | 0.972 (df = 4; 176) | 0.902 (df = 5; 175) | 1.379 (df = 6; 174) | 1.377 (df = 8; 172) | 2.324* (df = 10; 170) | 2.072* (df = 11; 168) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

correlations in the present study also support. However, it may be that the types of health issue reported on the inventory employed (Cohen & Hoberman, 2006) are more transitory than those most often implicated in the literature. For example, the inventory includes many acute complaints such as pulled muscles, headaches and bruising. However, the physical health issues most often implicated in the literature tend to be more chronic in nature such as high cholesterol, diabetes and hypertension (Richard et al., 2017). It may be that our predictors of interest are more effective in protecting against such chronic morbidities with a stronger relationship with loneliness and future research should examine these links.

In relation to the size of the sympathy group of older adults, our study has demonstrated that this network layer includes around 13 members. This number is comparable in size to that that has been reported in literature pertaining to the general adult population (Binder et al., 2012; Molho et al., 2016; Stiller & Dunbar, 2007). This finding tentatively suggests that the size of the innermost layers of our social networks could remain at a relatively stable size as we age. As it is established that we lose network members as we get older (Bhattacharya et al., 2016; Carstensen, 1992), the size of the sympathy group in this sample could possibly indicate that, as we age, we lose members from the more peripheral layer of contacts rather than from our core personal communities. This is in line with Socioemotional Selectivity Theory which posits that we place more value on emotionally close relationships as we age and time feels more limited (Carstensen et al., 1999). However, it may be possible that the individual members of our support and sympathy groups change over time. For example, grandchildren may become close contacts in later life. Future research would need to employ longitudinal methods to determine if this is the case.

**Table 17**

*Hierarchical Regression Analysis to Predict Stress from Network Size (+/- SE)*

| | Stress | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| Network Size | -0.071$^{+}$ (0.038) | -0.073$^{+}$ (0.039) | -0.072$^{+}$ (0.039) | -0.078* (0.039) | -0.081* (0.039) | -0.066$^{+}$ (0.038) | -0.068$^{+}$ (0.039) |
| Marital Status: In a relationship or married | | 0.940 (1.219) | 0.924 (1.220) | 1.255 (1.226) | 1.415 (1.229) | 2.101$^{+}$ (1.225) | 2.116$^{+}$ (1.230) |
| Marital Status: Separated or Divorced | | 0.888 (1.353) | 0.889 (1.355) | 0.918 (1.347) | 1.268 (1.363) | 1.084 (1.340) | 1.114 (1.347) |
| Marital Status: Widowed | | 0.333 (1.380) | 0.441 (1.391) | 0.361 (1.383) | 0.660 (1.396) | 1.169 (1.379) | 1.197 (1.386) |
| Age | | | -0.041 (0.059) | -0.019 (0.060) | -0.030 (0.061) | -0.008 (0.059) | -0.006 (0.060) |
| Gender (Male -> Female) | | | | 1.240$^{+}$ (0.672) | 1.061 (0.681) | 0.999 (0.664) | 0.965 (0.669) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Education: First Degree or Equivalent | | | | | -0.724 (0.727) | -0.755 (0.709) | -0.732 (0.712) |
| Education: Postgraduate Degree | | | | | 0.420 (0.869) | 0.274 (0.853) | 0.263 (0.857) |
| Financial Status: Enough but no extra | | | | | | -2.076 (1.658) | -2.044 (1.665) |
| Financial Status: Comfortable with extra | | | | | | -4.015* (1.626) | -3.973* (1.633) |
| Nationality: British -> Other | | | | | | | -1.160 (2.382) |
| Constant | 4.253*** (0.576) | 3.503** (1.234) | 6.401 (4.405) | 3.861 (4.590) | 4.924 (4.673) | 6.068 (4.714) | 5.977 (4.743) |
| *N* | 203 | 203 | 203 | 203 | 203 | 203 | 202 |
| $R^2$ | 0.017 | 0.022 | 0.024 | 0.041 | 0.053 | 0.111 | 0.110 |
| Adjusted $R^2$ | 0.012 | 0.002 | -0.001 | 0.011 | 0.014 | 0.064 | 0.059 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Residual Std Error | 4.150 (df = 201) | 4.171 (df = 198) | 4.177 (df = 197) | 4.151 (df = 196) | 4.145 (df = 194) | 4.039 (df = 192) | 4.054 (df = 190) |
| F Statistic | 3.419$^{+}$ (df = 1; 201) | 1.099 (df = 4; 198) | 0.971 (df = 5; 197) | 1.386 (df = 6; 196) | 1.369 (df = 8; 194) | 2.387* (df = 10; 192) | 2.145* (df = 11; 190) |

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** p<0.001: Reference categories: marital status = single or undisclosed, financial status: cannot make ends meet or have to cut back, gender = male, education = primary or secondary school, or undisclosed, nationality = British

connections within these networks to help tackle loneliness and improve mental health outcomes in this population.

The present study addressed many of the limitations observed in Study 2 while still demonstrating that the number of friends is protective in terms of loneliness and psychological well-being in older adults. The study further highlighted the importance of other egocentric network variables, namely network size and average emotional closeness to friends, in this respect also. However, the present study is not without limitation. Firstly, although we hope to have captured a diverse sample with the recruitment strategy in the present study, it is likely that the sample reported on is not representative of the older adult population within the UK. Additionally, our network size variable only includes network members allocated to the innermost support and sympathy groups of our networks. It could still be that even more peripheral relationships are important in relation to loneliness and well-being. Employing a measure of total network size could address this question, although the process of eliciting all network members can be time consuming and burdensome to participants. Further, we have highlighted that specific types of social support may be differentially beneficial for loneliness and mental health. It would be useful for future research to include indicators of social support to confirm this.

Despite these limitations, the current study has indicated that the number of meaningful social connections, characterised as friendships and being a member of an individual's sympathy group, as well as the strength of emotional closeness to those friends is important in relation loneliness and mental health outcomes in older adults. The findings suggest that increasing the number of both core and significant ties for older adults could be protective against loneliness and therefore its negative correlates. Emphasis should be placed on emotional closeness, particularly when it comes to friendships. Although further work could determine whether either core or significant ties would benefit most from expansion. Emphasis should be placed on greater emotional closeness, particularly when it comes to friendships as this type of relationship quality may also have a protective effect in this regard.

This further highlights the need for effective interventions and loneliness strategies to maintain, deepen and increase these types of relationships to reduce feelings of loneliness and associated psychological well-being in this population. This is rather than simply encouraging and providing opportunities for 'any' social interaction. Real social connection involving an emotionally close dynamic needs to be achieved for interventions to have a beneficial effect.

# Chapter 5. Overall Discussion

## 5.1. Summary of Findings

The first aim of this thesis was to increase our understanding of commonly employed loneliness scales and their appropriateness and ability to measure loneliness in older adults. Specifically, we aimed to explore the interrelationships within and between the scales to determine groupings indicative of similarities and differences in the domains of loneliness that the scales are able to measure and to determine any items which are key to the measurement of loneliness. In a sample of older adults, we found that, of the three scales included, the SELSA-S was the only measure that demonstrated ability to capture loneliness resulting from specific relationships, namely, family, romantic and social loneliness. Therefore, suggesting that this scale may offer the most utility in identifying loneliness associated with specific relational deficits. The dJG and UCLA scales appeared to tap into only one similar domain of loneliness which seemed to result from deficits in social connections more generally. Additionally, we found that Item 1 from the DJG scale ('*I always have someone to talk to about my day-to-day problems'*) demonstrated the strongest connectivity with the separate loneliness domains.

The second aim of this thesis was to explore the effects of close friendships on loneliness and associated psychological well-being correlates in this age group in greater depth than reported in previous literature. We found that, as demonstrated in earlier research, there was a negative relationship between the number of close friendships and loneliness, depression, anxiety, and stress. We also found that this relationship was curvilinear in nature and our analysis indicated that, on average in our sample, once approximately four close friends were obtained, the addition of further close friends was associated with little benefit to feelings of loneliness and psychological well-being.

The final aim of this thesis was to further examine particular network characteristics in relation to loneliness and psychological well-being in later life. We aimed to: i) expand the findings of Study 2 by including a more diverse and more representative sample, ii) replicate the findings using alternative methods of elicitation of close friendships, iii) examine more peripheral relationships via the inclusion subjective network size, and iv) investigate links with physical health and to determine the size of the sympathy group network layer, in reference to Dunbar's Social Brain Hypothesis, in this age group. Similar to Study 2, we found that having more friends, a larger overall subjective sympathy group network size, and increased emotional closeness to friends was linked to reduced feelings of loneliness and differentially better psychological well-being outcomes. However, we found no evidence of any associations between our variables of interest and self-reported physical symptoms. We further demonstrated that, for our sample, the size of the reported sympathy group, encompassing the two innermost emotionally close network layers, is comparable to that reported in the general adult population at around 13 members. We did not find any evidence to support the curvilinear relationship between number of friends and loneliness or any of the other outcome measures in this study.

## 5.2. Contribution, Practical and Policy Implications

As discussed within each of the previous study chapters, this thesis has expanded the previously existing literature around loneliness in older adults. This includes knowledge relating to

the tools we have available to measure loneliness in this age group and the ways in which the characteristics of social networks may impact on loneliness and psychological well-being in later life. For example, previous literature has quite extensively explored the dimensionality of individual loneliness scales separately in an attempt to better understand what those loneliness tools independently measure (e.g., Adamczyk & DiTommaso, 2014; Shevlin et al., 2015; van Baarsen et al., 2001). However, corroboration of the domains of loneliness these scales are able to tap into via assessment of similarities and differences in measurement ability did not appear to have been previously undertaken. The findings reported on in Chapter 1 form the first steps to elucidate where these scales overlap in terms of measurement and where they are different. Interestingly, the findings indicated that, even though it was developed to assess social and emotional loneliness domains as outlined in the typology proposed by Weiss (1973), the dJG scale appears unitary in assessment ability. It appears to tap into a state of loneliness resulting from deficits in general social connections rather than being able to distinguish between social and emotional loneliness. Further, it does not appear to measure loneliness resulting from romantic or family relationship deficits.

This has implications for scale choice by clinicians and researchers. It is possible that such investigators may be interested in assessing whether loneliness results from a specific type of relational deficit. Determining whether feelings of loneliness result from disconnections from general social or more specific relational emotional attachments mean that practitioners can refer individuals to the most appropriate interventions and programmes available. If emotional disconnection within one's family relationships is at the root of such feelings, it would be potentially misguided to encourage the building of new social connections alone. Although such connections may assist with feelings of loneliness, it might be more prudent to determine whether family relationships could be improved perhaps through the involvement of counselling or the mere involvement of family members in existing loneliness interventions. Either way it seems clear that a deeper investigation of the cause would be necessary to guide the individual to the most effective route. Employing an instrument which measures this specific type of loneliness would also allow for more insightful and effective monitoring of changes in feelings of loneliness as a result of any such intervention.

In addition, the findings of the first study have highlighted which item from all three scales is most central to the measurement of loneliness in this age group as it demonstrated the most connectivity between loneliness domains. Our findings therefore suggest that Item 1 from the dJG scale (‘*There is always someone I can talk to about my day-to-day problems’*) may be a good choice if researchers wish to capture loneliness via a brief single item question. Single item measures have been employed previously and such an item is included in the gold standard measure of loneliness for adults recommended by the Office for National Statistics (Snape & Martin, 2018). This national indicator of loneliness adopted by the UK government includes one single item direct measure of loneliness explicitly mentioning loneliness alongside a 3-item shortened version of the UCLA Loneliness Scale which assesses loneliness indirectly. However, the recommendation for situations in which time and survey space are limited is to employ the direct measure alone. Our findings lead us to suggest that Item 1 from the dJG scale could be a useful alternative to the recommendations by the ONS if an indirect question which does not explicitly mention loneliness is deemed preferable in the particular circumstances. This could be particularly beneficial when assessing loneliness in older adults as it has been suggested that this age group may be less willing to disclose loneliness due to stigma around such feelings when they were younger (Barreto et al., 2020) and direct questions may lack sensitivity in this respect (Van As et al., 2021).

The findings reported in Chapter 3 have expanded knowledge and increased our understanding of the relationship between self-reported number of friendships and loneliness. Previous research has highlighted the importance of social connections in respect to loneliness, with many studies indicating that friendships are a key type of relationship with protective effects in this regard and in relation to psychological well-being (e.g., Martin Pinquart & Sörensen, 2001b; Steed et al., 2007). This appears to be the first study to show that the relationship is more complex than the negative linear relationship reported previously. The elucidation of an inverse curvilinear association along with a breakpoint past which no further benefit is seen does not appear to have been assessed before. The knowledge that, for older adults, obtaining approximately four close friends is most beneficial in staving off loneliness has a variety of implications. Importantly, it allows for the tailoring

and potentially increased effectiveness of loneliness interventions and initiatives. A variety of interventions exist such as the installation of 'happy to chat' benches, which have been piloted in locations around the globe (BBC, 2021), however these offer likely fleeting and superficial increases in social connection. If the older adults experiencing loneliness already have four or more emotionally close friends, interventions such as these seem unlikely to improve loneliness in these individuals. It would therefore be prudent in such cases for interventions to tackle other potential determinants of loneliness. This could be in relation to improving mobility (Marusic et al., 2018) and health status (Hwang & Braun, 2015) as suggested in Chapter 3, as previously established determinants of loneliness. However, interventions could also focus on repairing family relationships, if possible and appropriate, and on improving mental health parameters, particularly depression, as this has also been identified as a predictor of both social and emotional loneliness (e.g., McHugh Power et al., 2020). Therefore, again, this knowledge could inform the types of interventions that individuals are referred to and help to inform the types of intervention developed and funded by charitable organisations and focused on in governmental policy.

The association of a larger network (e.g., Kim et al., 2021), having more friends (e.g., Shiovitz-Ezra & Leitsch, 2010) and experiencing increased emotional closeness within our social networks (e.g., Drageset et al., 2011) with improved loneliness and well-being has been reported frequently. Our findings reported on in Chapter 4 further emphasise the importance of these network aspects and highlight the significance of increased emotional closeness within our friendships in this respect. Our observations suggest that loneliness interventions should not only aim to increase the number of social connections that older adults have, but to also deepen the emotional connection within existing relationships in order to protect against feelings of loneliness and to improve psychological well-being. This information could again inform the types of loneliness interventions that are developed and supported, suggesting a focus on deepening current relationships as well as on creating new emotionally close connections. The elicitation of the sympathy group number in this age group means that attention can be placed on whether older adults have a sympathy group of around this number and observation of overall network size. If individuals have a small network size,

interventions could first focus on increasing the number of connections. If the network size appears large, the size of the sympathy group could become the focus with efforts made to increase emotional closeness either with current relationships or with new connections.

Overall, the main recommendations from this thesis are that government policy and strategies should continue their trajectory of taking a cross-departmental and cross-sector approach to tackling loneliness. A variety of valuable strategies and opportunities have been created and are suggested moving forward such as the creation of transport solutions like the 'happy cabs' in Leeds and the creation of volunteering opportunities in disadvantaged areas (Department for Digital Culture Media and Sport, 2023). However, real consideration needs to be given to how to effectively involve harder to reach members of older adult communities who may not be aware of such opportunities and importantly how to encourage the development and sustainability of real emotionally close connections in this population.

## 5.3. Strengths and Limitations

One of the main strengths of this thesis is that it has employed a range of novel methods in order to answer the research questions posed. For example, the study reported on in Chapter 2 utilised a psychometric network approach in order to elucidate the measurement ability of commonly used loneliness scales, where their measurement ability overlaps and to determine any items from these scales that are central to the measurement of loneliness in older adults. Unlike traditional factor analytic methods in which latent variables are thought to explain the correlations between scale items, the regularized network estimation employed here allows the assumption that these scale items can causally influence each other. This conceptualisation and methodological approach are therefore more likely to accurately represent psychological symptoms and behaviour due to the often reciprocal and cyclical nature of the relationship between these psychological variables (Borsboom & Cramer, 2013). In terms of the loneliness symptoms that are assessed with the instruments included in Chapter

2, wishing that you had a more satisfying romantic relationship (SELSA-10) could lead to feelings of not having people to lean on when you need them (dJG-4) which in turn could make you feel alone (UCLA-4). Feeling alone could equally influence feelings of having few people to lean on. These potentially mutual associations suggest that the network approach may be more suitable to model loneliness symptoms.

Additionally, the network estimation and visualisation techniques allowed us to demonstrate clusters of scale items showing where the scales overlap and where there were differences. This is indicative of the presence of latent variables within the network (Epskamp & Fried, 2018). Further, the network bridge centrality estimation methods employed allowed items central to the measurement of loneliness to be determined. Specifically, bridge expected influence enabled us to determine which item had the most connectivity between the scale clusters. Therefore, determining which item is able to tap into the greatest number of loneliness domains and therefore which item may be an important item for researchers and clinicians to consider. Despite this network approach having been employed in various psychological contexts such as perceptions of quality of life (Kossakowski et al., 2016) and the interplay of schizophrenia symptoms (Levine & Leucht, 2016), our study appears to be the first to apply these methods to the investigation of loneliness.

Further, the analytic choices that were made in Chapter 2 enabled us to ensure robustness of our findings and determine accuracy of certain parameters. For example, the network techniques utilising the bootnet package (Epskamp et al., 2018) that were reported on in Chapter 2 enabled us to construct bootstrapped confidence intervals around the estimated edge weights which depict the strength of the relationship between scale items. The narrow width of the confidence intervals allowed us to have some assurance of accuracy of the strength of the edge weights that we reported on. In terms of the bridge centrality estimation, the same package allowed us to assess the stability of the order of the centrality indices by conducting a case-dropping subset bootstrap. The technique allowed the estimation of a correlation stability coefficient which indicates the maximum number of cases that can be dropped, such that with 95 % probability the correlation between original centrality indices and

centrality of networks based on subsets is 0.7 or higher. As this coefficient was above the proposed cutoff of .5, we were able to infer that our bridge centrality estimate order was indeed stable.

Novel methods were also used in terms of its exploration and demonstration of a curvilinear effect of close friendships on loneliness and psychological well-being assessed in Chapter 3. As mentioned above, a negative relationship has already been widely documented, but no in-depth exploration of this relationship has been performed. Here, we employed techniques to identify breakpoints in the data which included the use of the segmented regression and multivariate adaptive regression spline analysis in R (Milborrow et al., 2011; Muggeo, 2008). These techniques employ an iterative algorithmic approach to determine knots or breakpoints in nonlinear data. Given the visual inspection of the data and the good fit of a quadratic model, these techniques were best suited to determine the point at which the negative relationship between number of close friends and loneliness and psychological well-being plateaued, offering little or no further benefit. As such our study appears to be the first to use these novel approaches to offer insight into the potential maximum number of close friends that may offer protection against loneliness and poor psychological well-being.

A further strength is that the thesis took steps to confirm the findings reported on in Chapter 2 whilst addressing the observed methodological limitations. In this way we were able to further highlight the importance of close friendships in relation to loneliness and psychological well-being in older adults. Although we were unable to replicate the inverse curvilinear relationship demonstrated in Chapter 3, the replication using alternative methods allowed us to emphasise the importance of consideration of the methods employed when eliciting egocentric network data. Specifically, we noted potential differences in findings when asking explicitly about emotional closeness to alters rather than by attempting to capture this in a more indirect question and also in the number of friends reported by respondents.

The thesis is not, however, without limitations. Although steps were taken in the final study to recruit a more representative sample of the population of older adults within the UK, financial and time constraints meant that a fully representative sample was not able to be investigated. A more

targeted approach to the recruitment of older adults from across regions of the UK with a representative distribution of age, educational attainment and socioeconomic status would allow more accurate inferences about the findings relating to this population as a whole. Ensuring such samples across studies would mean that more accurate comparisons could be made between the findings of Study 2 and Study 3. The majority of the participants that took part in Study 2 were recruited by online means via the recruitment platform Prolific. Whereas Study 3 involved a postal survey. These recruitment techniques may have led to differences in the composition of these respective samples. As noted within the individual study discussions, online recruitment may exclude older adults who are not literate with or do not have access to the internet and IT equipment. Similarly, the samples may also reflect differences in aspects such socioeconomic status and the age of respondents. All of which could account for the differences in our findings between the two studies.

Another inherent limitation to the data collection methods used in this thesis is that the research is cross-sectional in nature. As such it is not possible to make inferences about causal relationships between the variables that have been investigated. For example, we have suggested that having very few close friends is linked to high levels of loneliness and poor well-being. Of course, it could be that feeling lonely and potentially experiencing hypervigilance to social threat, as discussed in Chapter 1, could lead one to distance themselves from social connections resulting in few close friendships. Similarly, poor psychological well-being could impact on an individual's motivation to pursue social relationships, particularly the effort and motivation, discussed in Chapter 2, that is essential to maintain these friendships. Indeed, there is little consensus around related concepts such as depressive symptomology and its association with loneliness, with mixed findings related to directionality having been frequently reported (Dahlberg et al., 2022; Erzen & Çikrikci, 2018; McHugh Power et al., 2020), suggesting that these relationships could actually be bidirectional in nature (Van As et al., 2021). Further research employing robust longitudinal methodology is needed to elucidate these relationships further. Regardless of the direction of causality, it is clear that ensuring fulfilling and meaningful relationships are created and maintained will have a positive impact on the well-being of older adults.

## 5.4. Future Directions

A variety of potential avenues for future research arise from the findings of the present thesis. In terms of the thesis limitations we have identified, it would be useful to repeat the study reported on in Chapter 4 including a representative sample of the older adult population within the UK. This would allow the findings to be generalised to this population with more confidence. Additionally, in order to determine the direction of the effect involving friendships and loneliness and psychological well-being, longitudinal methods should be employed when carrying out this replication. Further, due to the differences in findings we reported between studies utilising differing network data collection methodology, further exploration of the impact of methods on the accuracy of reported networks may be beneficial.

Within this thesis we have highlighted that a specific type of social connection is important in relation to loneliness and psychological well-being. We have suggested that this may be due to the increased engagement in friendship maintenance behaviours and the provision of emotional social support and other social provisions that these core emotionally close relationships offer (Binder et al., 2012). It was beyond the scope of this thesis to report on any findings relating to social support provided by friendships and its potentially mediatory nature in this association. However, there is evidence which suggests that social provisions (Ditommaso & Spinner, 1997) such as emotional support (Stickley et al., 2015) and emotional closeness (Binder et al., 2012) within our networks should reduce feelings of loneliness. Future research should therefore expand on our findings and assess the importance of different types of social support within these close relationships to determine the mechanism behind this effect. It is possible that these mechanisms could be extrapolated to other relationships and employed within loneliness interventions.

Similarly, we were unable to offer any further insight in relation to the ways in which relationships with social network alters are experienced and how this may impact on loneliness. For example, it may be that the frequency, duration and mode of contact as well as aspects such as length of relationship and the type of network they are embedded in are particularly important in terms of

being protective against loneliness. Previous research has established that network density is important in terms of happiness and subjective well-being and that frequency of contact has a differential effect on subjective well-being dependent on the method of contact utilised (van der Horst & Coffé, 2012). In addition, recent evidence suggests that mobile phone contact is especially protective against loneliness in older adults (Teater et al., 2021). Further research on these parameters could allow them to be deployed within loneliness and psychological well-being interventions with the aim of making them more impactful.

### 5.5. General Conclusion

In summary, the present thesis aimed to i) increase our understanding of the commonly utilised tools available to measure loneliness in older adults, ii) explore the effect of close friendships on loneliness in this age group in greater depth than in previous literature, and iii) assess the importance of particular egocentric network aspects in protecting against loneliness and poor psychological well-being in later adulthood. Our findings have highlighted the ability of commonly employed loneliness scales to tap into the various loneliness domains, suggesting that the SELSA-S is the most suited to assess loneliness resulting from deficits in specific social relationships. Item-1 from the dJG scale was shown to be the most central to the measurement of loneliness with the scales assessed suggesting its utility as a single item measure of loneliness in this age group. Our findings have also indicated the benefit of having an increased number of close friendships in order to protect against loneliness and improve psychological well-being. We have also suggested that having a larger sympathy group is beneficial for loneliness and well-being, as well as having increased emotional closeness to friends within a network. We also tentatively suggest that the optimal number of close friendships in relation to loneliness is four, past which no further benefit is seen. However, as we were unable to replicate this finding in our final study using a different methodology, replication is needed employing a more representative sample of UK based older adults, as well as a triangulation of methods. We also suggest employing longitudinal methods to determine the direction of the relationship between close friendships, loneliness and psychological well-being parameters in order to

effectively inform loneliness interventions. The findings of this thesis have implications in terms of scale choice for researchers and clinicians interested in loneliness. In addition, these findings can inform loneliness interventions by focusing on ways to create and maintain close social connections and by potentially deferring to other strategies once the number of close friendships in the networks of older adults has reached or surpassed four friendships.

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# Appendix A

Scale Items

**The 11 item de Jong Gierveld Loneliness Scale**

1. There is always someone I can talk to about my day-to-day problems
2. I miss having a really close friend
3. I experience a general sense of emptiness
4. There are plenty of people I can lean on when I have problems
5. I miss the pleasure of the company of others
6. I find my circle of friends and acquaintances too limited
7. There are many people I can trust completely
8. There are enough people I feel close to
9. I miss having people around me
10. I often feel rejected
11. I can call on my friends whenever I need them

**The University of California Los Angeles Loneliness Scale Version 3**

1. How often do you feel that you are “in tune” with the people around you?
2. How often do you feel that you lack companionship?
3. How often do you feel that there is no one you can turn to?
4. How often do you feel alone?
5. How often do you feel part of a group of friends?
6. How often do you feel that you have a lot in common with the people around you?
7. How often do you feel that you are no longer close to anyone?
8. How often do you feel that your interests and ideas are not shared by those around you?
9. How often do you feel outgoing and friendly?
10. How often do you feel close to people?
11. How often do you feel left out?
12. How often do you feel that your relationships with others are not meaningful?
13. How often do you feel that no one really knows you well?
14. How often do you feel isolated from others?
15. How often do you feel that you can find companionship when you want it?
16. How often do you feel that there are people who really understand you?
17. How often do you feel shy?
18. How often do you feel that people are around you but not with you?
19. How often do you feel that there are people you can talk to?
20. How often do you feel that there are people you can turn to?

**The Short Social and Emotional Loneliness Scale**

1. I feel alone when I am with my family

2. I feel part of a group of friends

3. I have a romantic partner with whom I share my most intimate thoughts and feelings

4. There is no one in my family I can depend on for support and encouragement, but I wish there was

5. My friends understand my motives and reasoning

6. I have a romantic or marital partner who gives me the support and encouragement I need

7. I don't have any friends who share my views, but I wish I did

8. I feel close to my family

9. I am able to depend on my friends for help

10. I wish I had a more satisfying romantic relationship

11. I feel part of my family

12. My family really cares about me

13. I do not have any friends who understand me, but I wish I did

14. I have a romantic partner to whose happiness I contribute

15. I have an unmet need for a close romantic relationship

**A Direct Measure of Loneliness**

‘Do you feel lonely?’