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Research Article

Distance in Disconnection: The Varied Impact of Core Network Losses on Loneliness Among Older Europeans

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Abstract

Objectives: Research among older adults reveals that the loss of core network members is a risk factor for loneliness. Still, it is not clear whether all such losses induce similar levels of loneliness, particularly as network members are distributed at varied geographic distances. Neither is it clear whether tie addition—the other ubiquitous aspect of network turnover in later life—offsets the loneliness that arises from different network loss scenarios.

Methods: This paper scrutinized core network losses across multiple relationship–distance scenarios. We used the fourth and sixth waves of data from the Survey of Health, Ageing, and Retirement in Europe and estimated fixed-effect models.

Results: The loss of a child from a core network increases feelings of loneliness across variant distances, especially when not complemented by additional connections. Losing relatives or nonkin core connections in proximity (within 1 km and 5 km radius, respectively) is also associated with increased loneliness, yet such effects are also largely mitigated by the addition of new core network members.

Discussion: The relationship between core network member losses and loneliness can significantly differ based on the nature of the lost connection and its geographic distance. Active rebalancing of one's core network following losses and proactive network expansion can serve as pivotal strategies to prevent loneliness for the aging population.

Keywords: Network loss, Network replenishment, Proximity

Loneliness has been long identified as a significant risk factor for physical health, mortality, mental health, and cognition, particularly among older adults (Hawkley & Cacioppo, 2010). Described as the perception that available companionship falls short of one's desires (Perlman and Peplau, 1981), loneliness is now believed to be as dangerous as smoking or excessive drinking (Holt-Lunsdadt, 2010). About 10%–20% of older adults in Northern and Western European countries report severe loneliness, but this figure reaches as high as 30%–55% for their peers in Central and Eastern Europe (Hansen & Slagsvold, 2016).

Spikes in loneliness often follow changes in one's core network, that set of intimate ties people depend on for advice, companionship, and other forms of support (Mcpherson et al., 2016). Of the ways that personal networks evolve, losing close connections—by death, conflict, or merely "growing apart"—appears uniquely inimical (Adams et al., 2004). Such losses are common at older ages, as life transitions including retirement, relocation, health decline, and widowhood often alter people's social environments, produce new time and financial pressures, and disrupt the activities in which they maintain relationships (Cornwell, 2011; Cornwell et al., 2014; Wrzus et al., 2013).

Loneliness-inducing as core network change can be, the impact may differ depending on the nature of the lost connections. According to the convoy model of social relations (Kahn & Antonucci, 1980), intimate ties in the core network, such as family relationships, are generally stable, providing a wealth of emotional support, small and large services, financial aid, and companionship, and parent–child bonds are usually the most supportive (Wellman et al., 2021). Alternatively, non-family relationships offer key sources of companionship and small-scale assistance and tend to be less bound by normative expectations. These relationships are often established out of convenience and exhibit fluidity across the peripheral layers of one's social convoy (Ikkink & van Tilburg, 1998; Small & Sukhu, 2016; Wrzus et al., 2013). Losing such a tie—even if once located in the core—may not pose as strong a risk for loneliness.

Network member loss also occurs at *different geographical distances*, which may carry different implications for changes in loneliness. Though nearby ties are often considered most beneficial, many older adults also have connections spanning outside of their immediate area (Hank, 2007; Rainie & Wellman, 2012; Viry, 2012). Older people, as well as their network members, could have relocated for education, career opportunities, and family formation (Carrasco et al., 2008; Finchum, 2005), creating distance from important kin and non-kin network members alike. Nevertheless, evolving digital technologies have provided more possibilities for older

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adults to sustain meaningful and supportive relationships over longer distances (Marin & Hampton, 2019). This creates the possibility that losing even faraway connections could exacerbate loneliness.

The diverse forms of late-life core networks—specifically at the intersection of relationship and distance—raises new questions about the effects of core network losses on loneliness. Existing research, typically relying on aggregate measures of core network changes (e.g., network size, turnover rate), often fails to detail the specific attributes of the lost connections and thus cannot adequately address what it means to lose a connection of a specific relationship at a certain distance. To address this question, we use the fourth and sixth waves of the Survey of Health, Aging, and Retirement in Europe (SHARE). These survey data trace not only older adults' loneliness but also provide information on their distance from, and relationships with, the connections that move in and out of their core discussion networks.

Background

The Proximity Factor in Core Network Loss

Although many of the foundational studies on late-life social connectedness have depicted how various characteristics of core networks differ across age and other demographic traits (Cornwell, 2011), scholars are increasingly pursuing the causes and consequences of network *change*, as many people undergo network loss of family or non-relative ties (Cornwell & Laumann, 2018; Rivera et al., 2010). Connection deterioration and loss often have a wide range of negative effects on the well-being of older adults, such as more loneliness, higher psychological distress, and adverse health outcomes (Adams et al., 2004; Cohen-Mansfield et al., 2016; Cornwell & Laumann, 2015, 2018).

Although it is not yet clear whether the losses occurring in proximity are more detrimental than those happening over longer distances, there are reasons to presume this. Previous research has noted that being in proximity allows for more frequent contact and interaction, which helps in recognizing needs and facilitates the timely delivery of support (Hank, 2007; York Cornwell & Goldman, 2021). The convenience from proximity can even supersede relationship strength, especially in exchanges of small services (Wellman et al., 2021). Despite advances in communications technology, the most rewarding forms of relational support—such as companionship—still appear to largely depend on physical co-presence (Fischer, 1982; Frei & Axhausen, 2007; Ikkink & van Tilburg, 1999; Logan & Spitze, 1994; Mulder & van der Meer, 2009). Local connections are also often better equipped to provide locale-specific information, resources, and advice, and are more likely to be interconnected, allowing for coordinated support (Logan & Spitze, 1994; Small & Adler, 2019; York Cornwell & Goldman, 2021). As such, proximate connections could be a vital presence in one's core network, offering unique advantages over distant connections. Losing a connection nearby may therefore be most consequential for higher loneliness in later life.

Family Core Connection Losses and Proximity

The link between the proximity of a lost core connection and ensuing feelings of loneliness could become more complicated when considering one's relationship with the lost connection. The loss of a core family connection, even over longer distances, could nevertheless have a significant impact on loneliness. Older adults often have high expectations of family members to be responsive to their needs (Shor et al., 2013), and support provision over longer distances has become more feasible with the assistance of technologies (Quan-Haase et al., 2017). In particular, adult children are a major source, providing the widest range of support and characterized by high intimacy (Wellman et al., 2021). In this way, voluntary exclusion of a child—or perhaps another family connection—from one's core network could represent insufficient or unbalanced support, deterioration of relationships, or escalating conflict (Goldman & Cornwell, 2018). In the case of bereavement, the sense of grief can be deeply felt regardless of distance, and such a permanent loss could be unsettling even if that person was not regularly seen. Together, these reasons imply that losing a child or other family member from one's core network will induce loneliness, no matter the distance.

However, there are also reasons to argue that even for family connections, losses occurring over a distance are less likely to provoke loneliness in those lost in proximity. Older adults could have lower expectations and reliance on support from a faraway family connection (Mulder & van der Meer, 2009; Ward et al., 2014). Indeed, as older adults adjust their social convoy and pivot toward accessible and responsive local support sources that best meet their evolving needs, removing a family or even a child connection located at a distance from the core network can be a viable strategic choice (Fihel et al., 2021). In cases of a family death, the physical distance could also somewhat buffer the shock and grief, especially when life trajectories have drifted apart and daily lives become less entangled.

Non-Kin Connections Losses and Proximity

The role of proximity can also be more nuanced than initially perceived when it comes to non-kin tie loss and loneliness. Compared to family connections, non-kin relationships are typically more voluntary and reciprocal and less bound by obligatory norms (Neyer et al., 2011). Non-kin connections, especially the proximate ones, tend to be fluid and dynamic, making such losses potentially less impactful on loneliness. Some research suggests that individuals often build specialized relationships with convenient others and cycle between them depending on their specific needs and the situation at a particular time (Rainie & Wellman, 2012; Small et al., 2015). Moreover, when support needs are more general, accessibility and responsiveness are likely prioritized, allowing for more flexibility in choosing the provider (Iveniuk et al., 2020; Small & Sukhu, 2016). This implies that non-kin relationships developed earlier in life and sustained over longer distances often drift apart over time in favor of more accessible and supportive alternatives. For these reasons, losing a non-kin connection—close by or far-off—may not necessarily be associated with increased loneliness.

Still, some non-kin members of the core network may not be so easily replaceable. Non-kin members, especially proximate ones such as neighbors, acquaintances, and peer members in local organizations, significantly contribute to older adults' independence and access to non-familial resources (Cornwell, 2011; Cornwell & Laumann, 2018; Silverstein et al., 1996). Being a part of the core network signifies selectivity and significance, implying that a non-kin connection that has made it to this list likely holds a distinct place in the individual's life. Such a connection could play an essential role

in one's established daily routine, provide companionship, or provide specialized support when the need arises (Cornwell & Laumann, 2018; Ellwardt et al., 2017). Losing that nearby person could potentially induce loneliness. Likewise, friend connections that have survived longer distances to remain part of the core network, possibly developed from memorable shared life experiences, could have served crucial emotional or practical purposes. Their exit from the core network, possibly due to death or health decline, could be highly consequential for one's loneliness, even if they were far away.

Network Additions as Part of the Turnover Process

Though potentially consequential for loneliness, loss of ties is only one facet of network turnover in later life. Older adults also proactively and reactively enlist new connections to their network, a process which promotes health, cognition, and emotional well-being (Cornwell & Laumann, 2015; Cornwell et al., 2014; York Cornwell & Goldman, 2021). One explanation for tie acquisition centers on adaptive resilience to changing circumstances. For instance, when a core connection becomes dormant, lost, or dead, older people are often highly motivated to cultivate new relationships to fill its vacancy and restore support, effectively maintaining a relatively stable network size and structure (Cornwell et al., 2021). Another perspective emphasizes strategic, preemptive management of a social convoy that meets a broad range of needs that may change over time (Kahn & Antonucci, 1980). For instance, older adults may proactively replace existing connections, such as those located at longer distances, with family or non-kin relationships that are more emotionally rewarding and practically supportive (Carstensen et al., 1992; Fiehl, 2021; Iveniuk et al., 2020; Small et al., 2015). Both lines of thinking propose that listing an additional core connection should help to alleviate loneliness in case of connection losses. It remains uncertain, however, whether this alleviating effect differs from the relational-geographical scenarios of core network loss, especially considering some of these losses could be more impactful than others and potentially harder to compensate for.

Research Questions

First, how does the association between core network losses and increases in loneliness differ across different relationship-distance scenarios? In other words, which types of core network losses have the greatest impact on loneliness in the aging population?

Second, does having additional core connections help alleviate loneliness in various core network loss scenarios? Are network additions equally protective in all scenarios, or only beneficial in certain situations?

Method

Sample

We retrieve the analytical sample from the Survey of Health, Aging and Retirement in Europe (SHARE), a panel survey consisting of community-dwelling older adults aged 50 years and above and their spouses regardless of their age (Börsch-Supan, 2020; Börsch-Supan et al., 2013; Malter & Börsch-Supan, 2017). The survey employed probability sampling in each participating country. Our analysis uses Wave 4 (2011) and Wave 6 (2015). SHARE features a changing portfolio of research topics, and only these two waves offer a dedicated module for collecting information on respondents' ego-centric networks. Initial network composition was measured at Wave 4, although changes to participants' network were assessed four years later in Wave 6. The survey also offered rich information on their well-being, such as loneliness and social-demographic characteristics. Fourteen countries participated in both waves (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Poland, Portugal, Slovenia, Spain, Sweden, and Switzerland). However, Estonia did not participate in the drop-off questionnaire at Wave 4, lacking the necessary information on loneliness at Wave 4. In this way, we exclude Estonia from the present research and focus on the remaining 13 European countries.

In the present study, the analytical sample consisted of community-dwelling older adults aged 50 years and above at Wave 4, who mentioned at least one core network connection and participated again at Wave 6. The final analytical sample consisted of 18,055 respondents with complete data on variables of interest across both waves.

Variables

The dependent variable is loneliness, measured at both waves with the UCLA Loneliness Scale consisting of three questions on "How often do you feel … (1) left out, (2) isolated, (3) lack companionship?" Responses were coded as 1 (rarely ever or never), 2 (sometimes), or 3 (often) and summed up as a scale ranging from 3 to 9, where a higher score indicates a higher level of loneliness. The inter-item reliability of the loneliness scale was 0.75 at Wave 4 and 0.74 at Wave 6. Changes in this scale between the two waves capture changes in one's loneliness.

The SHARE used identical name generators to collect respondents' ego-centric network data at both waves. Each respondent's core discussion network consisted of up to six individuals with whom the respondents "discussed important things" and an additional position for individuals "important for any reason." At each wave, the respondents then provided further details for each connection, such as their relationship with the network member and their distance. Furthermore, Wave 6 featured follow-up questions to link the network data across the two waves and identify changes. Specifically, respondents were asked whether each Wave 4 connection was mentioned again at Wave 6 and, if not, the reason why. We categorized connections referred to "I forgot, [Name] should be included" as retained in the network at Wave 6 (Fischer & Offer, 2020). Reasons for network loss can be ascribed to various factors, including relocation, health issues, decreased closeness, and death. However, due to the low incidence of network loss resulting from death (2.9% of all connection losses), we are unable to isolate this factor in our study.

We construct our independent variable based on whether an individual experienced the loss of children, other relatives, or non-kin connections within specific geographical distances. We differentiate between children and other relatives due to their distinct roles in providing support, but limitations in sample size prevent further categorization of familial relationships.

SHARE documented one's geographic proximity with a network connection in seven categories, namely: (a) in the same household; (b) in the same building; (c) less than 1 km away; (d) between 1 and 5 km away; (e) between 5 and 25 km away; (f) between 25 and 100 km away; (g) between 100 and 500 km away, and (h) more than 500 km away. We regrouped

these responses into four categories to ensure that each of them has sufficient cases for analysis: 0–1 km; 1–5 km; 5–25 km, and above 25 km. The area within 1 km generally represents one's neighborhood and is often considered within walking distance. We consider within 5 km as a convenient distance for frequent face-to-face interactions, and a radius of 25 km around one's residence to be transit-accessible and suitable for casual interactions (Fischer, 1982). Although these categorizations are to some extent arbitrary and perceptions of proximity likely vary across European countries and regions, this approach allows a more nuanced examination of network changes than a singular threshold. As such, we identified 12 relationship-distance categories (3 relationships × 4 distances).

We tracked whether any connection loss occurred within these categories between the two data collection waves. Everyone began at 0 at Wave 4, with a loss in each relationship-distance category at Wave 6 being captured as 1; otherwise, it remained at 0. As such, we have 12 dichotomous variables to depict connection losses. Note that we have omitted a respondent's partner from our tracing of network changes because the partner typically cohabitates with the respondent. Such loss offers little to the understanding of how network loss at varying distances differentially affects loneliness. Nevertheless, we include one's partnership status as a separate covariate in the analysis.

We considered a series of other covariates, such as network additions and life transitions. As we are employing fixed-effect models that already account for time-stable factors over, we pay particular attention to factors that are likely to change and that play a part in the association between network loss and perceived loneliness. Older adults often acquire additional core network members after losing one (Cornwell & Laumann, 2018), which may help alleviate loneliness. As such, we identified if one mentioned any other network members at Wave 6 (Yes = 1) and set their initial value at Wave 4 as 0 across the sample. We also measure one's average emotional closeness to core network members at both time points, which may affect one's loneliness.

The study also considers a range of life transitions common at older ages that may exacerbate loneliness. Individuals' partnership status (having a partner in household = 1), working status (being employed or self-employed = 1), living arrangement (solo living in a one-person household = 1), self-rated health (fair/poor health = 1), ADL (any limitations in activities of daily living = 1), activity participation (any organized activity = 1) and residence relocation (moved = 1) were recorded as dichotomous variables at both waves, where changes between 0 and 1 represented the possible transitions across the two waves. We presented respondents' age, gender (male/female), and level of education (low/moderate/high regrouped from ISCED-97) in the descriptive statistics. However, these variables are not present in the multivariable fixed-effect models because they do not change between waves 4 and 6.

Analytic Plan

We started by presenting the descriptive statistics for key characteristics of our sample and the change between waves. Then, using the sample of respondents with at least one core network connection at Wave 4 (N = 18,055), we assessed the association between different network loss scenarios and older adults' loneliness over time with fixed-effects linear regression models adjusted for household clustering. We used the Hausman test (Hausman, 1978) to determine whether individual-specific effects were correlated with independent variables; the results of the test favored a fixed-effects specification over its random-effects counterpart. The fixed-effect approach has a unique strength in accounting for stable individual and contextual factors, including those not explicitly observable in the data set, such as the community environment, diverse sociocultural contexts between and within countries, network formation preferences, and network support expectations. We further verified results from these models with subgroups of individuals who initially mentioned at least one child (N = 11, 495), relative (N = 7,403), or non-kin (N = 8,818) core connection in their network at the initial wave that are "at-risk" of losing a specific type of connection. Next, we investigated the extent to which the addition of new connections in the core network can mitigate the impact of losses on loneliness. Similar to the strategy above, these models focus on three specific groups: those who lost one or more child connections (n = 1,704), relative connections (n = 2,635), and non-kin connections (n = 4,391).

We conducted listwise deletion as missing values for all covariates <1%, a common practice in analysis using the SHARE data, although confirming the results with multiple imputations. We also employed an inverse probability weight to counter the possible attrition effect and applied it to our models (see notes 1 in Supplementary Materials for more details).

Results

Descriptive Statistics

Table 1 shows shifts in perceived loneliness, changes in core networks, the prevalence of life changes across the two SHARE waves, and the basic demographic of the respondents. In Wave 4 collected in 2011, the average age of the respondents was about 65 years old, and 60% of the sample were women. Across the two waves, the average level of loneliness increased slightly. Among individuals starting with at least one connection in the core network, each respondent listed 2.5 ties on average. The most prevalent core network connections were children within 1 km (mean = 0.4 connections, standard deviation (SD) = .7), followed by children located more than 25 km away (mean = 0.3 connections, SD = .6) and non-kin ties within 1 km (mean = 0.3 connections, SD = .6). Note that the averages are at the ego/respondent level, which can fall below 1 because not all respondents had such a connection. Over the 4-year period between the two waves, there was a slight increase in the proportion of people living alone, reporting fair or poor health, and developing one or more limitations in activities of daily living. On the other hand, there was a decrease in the number of people reporting having a partner in the household, working for payment, and participating in organized activities.

Table 1 also reveals changes in the core networks over time, where only a modest proportion of all respondents, between 2% and 9%, underwent a loss in their core networks, depending on the type of connections and their distances. At the same time, approximately 66% mentioned an additional tie in their core network connections between the two waves, with an average of 1.3 new connections. Table 2 elaborates on relationship and distance of lost ties among those who lost one or more connections. Although the distribution of losses

Table 1. Descriptive Statistics of the Sample (*N* = 18,055, Unweighted)

	Wave 4		Wave 6	
	Mean/%	**SD**	**Mean/%**	**SD**
Loneliness scale (3–9)	3.68	1.16	3.83	1.30
Core network compositions				
Children 0–0.99 km	0.37	0.65	0.35	0.63
Children 1–4.99 km	0.18	0.46	0.18	0.47
Children 5–24.99 km	0.22	0.51	0.23	0.51
Children 25+ km	0.28	0.59	0.29	0.61
Relatives 0–0.99 km	0.15	0.45	0.14	0.42
Relatives 1–4.99 km	0.11	0.38	0.10	0.37
Relatives 5–24.99 km	0.14	0.42	0.13	0.42
Relatives 25+ km	0.19	0.50	0.18	0.50
Non-kins 0–0.99 km	0.27	0.60	0.24	0.57
Non-kins 1–4.99 km	0.20	0.52	0.18	0.49
Non-kins 5–24.99 km	0.22	0.57	0.19	0.54
Non-kins 25+ km	0.15	0.48	0.14	0.45
New members	/	/	1.31	1.34
Average closeness with connections	3.21	0.61	3.29	0.59
Key individual characteristics				
Living alone	23.5%		27.0%	
Having a partner in the household	69.8%		65.8%	
Working for payment	27.7%		18.4%	
Self-rated fair or poor health	33.0%		36.1%	
One or more ADL	8.5%		10.7%	
Participating organized activities	40.4%		38.9%	
Core network changes				
Lost any children within 0–0.99 km			3.3%	
Lost any children within 1–4.99 km			1.8%	
Lost any children within 5–24.99 km			2.4%	
Lost any children at 25+ km distance			3.2%	
Lost any relatives within 0–0.99 km			3.9%	
Lost any relatives within 1–4.99 km			3.0%	
Lost any relatives within 5–24.99 km			3.5%	
Lost any relatives at 25+ km distance			5.3%	
Lost any non-kins within 0-0.99 km			8.9%	
Lost any non-kins within 1–4.99 km			6.9%	
Lost any non-kins within 5–24.99 km			7.4%	
Lost any non-kins at 25+ km distance			5.5%	
Brought in additional connections			66.2%	
Experienced other changes between waves				
Started solo living			5.3%	
No longer have a partner in HH			5.1%	
No longer working			10.4%	
Declined self-rated health			13.2%	
Onset of ADL			6.6%	
Quit all organized activities			12.7%	
Moved			18.6%	
Other demographics				
Age	65.22	8.98	69.22	8.98
Male	38.5%			
Education: low	40.4%			
Education: middle	37.7%			
Education: high	21.9%			

Table 2. Prevalence of Network Losses at Variant Distances

	0–0.9 km (%)	1–4.9 km (%)	5–24.9 km (%)	25 + km (%)
Lost one or more child from the core network (n = 1,704)	35.2	18.7	25.5	34.2
Lost one or more relative from the core network (n = 2,635)	26.4	20.5	24.3	36.1
Lost one or more non-kin from the core network (n = 4,391)	36.4	28.2	30.3	22.4

Notes: The percentages in each row may not sum up to 100% because an individual may lose more than one connection with a particular relationship.

appears to be relatively balanced, there is a trend of increasing losses in connections with children and other family members as the distance increases. Additionally, losses within a 1 km radius are also quite common. Losses concerning non-kin connections predominantly occur within a 1 km radius. It is important to note that the percentages in Table 2 do not sum to 100% in each row due to the possibility of respondents experiencing multiple losses concurrently.

Connection Losses at Varied Distances and Loneliness

Table 3 displays the fixed-effects models examining the association between core network losses in different relationship-distance scenarios and loneliness. Model 1 shows the analysis based on the full sample, although Models 2, 3, and 4 focus on individuals who initially had at least one connection in a specific relationship, indicating they were "at risk" of losing such a connection. In Model 1, the results indicate that losing child core connections previously located at a medium range (5–24.9 km), as well as losing relative and non-kin connections in close proximity (0–0.9 km), is significantly associated with increased loneliness. These findings are largely consistent with the subsequent analysis focusing on specific subgroups. Moreover, Model 4 suggests that losing a non-kin connection at a medium range (5–24.9 km) is also significantly associated with higher levels of loneliness, a finding that was marginally significant in Model 1.

Table 4 shows how the association between different forms of ties loss and loneliness are conditional on the addition of a new tie. Values in the table are differences in the predicted level of loneliness, or average marginal effects, from fixed effect models that include interactions with mention of any new core network member (see Supplementary Materials for the original regression outputs). Overall, results suggest that mentioning an additional core network member is crucial for mitigating loneliness in the event of core network losses. In particular, losing a child connection from the core network, both in close range (1–4.9 km) and at a longer distance (over 25 km), is associated with significantly higher loneliness when one listed no additional member in the core network (0.5 point/0.4 *SD* increase of loneliness in both cases). Moreover, losing relative connections in direct proximity (<1 km), as well as non-kin connections nearby (anywhere in a 5 km radius), are both also associated with higher loneliness when no additional connection is mentioned (all with about 0.5 point/0.4 *SD* increase).

As most respondents in the sample reported relatively low levels of loneliness on the 3-item scale, the somewhat small magnitudes observed in the effects might raise questions about their substantial significance; therefore, we developed an alternative dichotomous variable, identifying the top 25% in the loneliness distribution as severely lonely. To determine if any of these losses significantly escalate the odds of transitioning into severe loneliness, we performed logistic regressions with fixed effects. The results indicate that the higher odds ratios associated with losing a child connection are not significant across the distances. However, losing a relative core connection in immediate proximity, and losing a non-kin core connection within a 5 km radius, are significantly associated with higher odds of transitioning into severe loneliness (OR = 1.7 for relatives and OR = 1.3 for non-kins). Upon validating sufficient cell sizes, subsequent interaction analysis further reveals that the transitions into severe loneliness in the above cases are only significant among individuals who did not report additional core network members. Given that stratifying the level of loneliness is not a common practice in the existing literature, we present this additional analysis in the Supplementary Materials rather than as part of the formal results.

Overall, it appears that losing a child as a core network member could potentially amplify loneliness, even over longer distances, particularly in the absence of additional connections. At the same time, it does not necessarily result in severe loneliness. In contrast, losing relatives as core connections could be particularly significant in close geographic proximity, although the introduction of another connection largely offsets the consequence of loneliness. Regarding non-kin core connection losses, the impact could be noticeable up to mid-range distances (about 25 km) although more pronounced at closer proximities (to about a 5km radius). Again, additions to the core network could counterbalance such losses.

Discussion

The current study extends the literature on social network dynamics and loneliness in aging populations. Instead of relying on broad, aggregated measures such as network size or the proportion of geographically proximate ties, we have taken a more fine-grained approach, examining how the impact of core network losses on loneliness may vary by the nature and geographic distance of the losses. Our findings highlight that the losses of proximate core connections, family and non-kin alike, can significantly exacerbate loneliness, potentially to severe levels. Conversely, losses that occur over greater distances appear to have less of an impact. This differentiation can likely be attributed to the fact that relative and non-kin connections in proximity are often better positioned to offer companionship and frequent interaction, emotional support, and quick practical assistance, factors that could prevail against loneliness (Hank, 2007; York Cornwell & Goldman, 2021). Turbulence in these localized support systems can potentially widen the gap between available and expected levels of support and social connectedness.

Meanwhile, losing a relative or non-kin core connection at longer distances is not necessarily associated with significantly more loneliness, even without the presence of

Table 3. Results From Fixed-Effect Models for Older Adults' Loneliness Across Wave 4 (2011) and Wave 6 (2015)

	Full sample			Had at least one child			Had at least one relative			Had at least on non-kin		
	N = 18,055			*N* = 11,495			*N* = 7,403			*N* = 8,818		
Lost any children within 0–0.9 km	0.12		(0.10)	0.13		(0.20)						
Lost any children within 1–4.9 km	0.00		(0.15)	0.02		(0.87)						
Lost any children within 5–24.9 km	0.38	*	(0.15)	0.42	**	(0.01)						
Lost any children at 25 + km distance	−0.02		(0.11)	0.00		(0.97)						
Lost any relatives within 0–0.9 km	0.30	***	(0.08)				0.35	***	(0.00)			
Lost any relatives within 1–4.9 km	−0.02		(0.10)				0.02		(0.87)			
Lost any relatives within 5–24.9 km	−0.08		(0.10)				−0.02		(0.87)			
Lost any relatives at 25+km distance	0.08		(0.11)				0.12		(0.31)			
Lost any non-kins within 0–0.9 km	0.15	*	(0.07)							0.16	*	(0.03)
Lost any non-kins within 1–4.9 km	0.04		(0.08)							0.06		(0.49)
Lost any non-kins within 5–24.9 km	0.19		(0.10)							0.19	*	(0.04)
Lost any non-kins at 25+ km distance	−0.16		(0.11)							−0.17		(0.12)

Notes: Models are weighted and adjusted for the clustering in households and losses between the two waves.

The model also controls partner's presence in the household, living alone, working for payment, self-rated fair/poor health, having one or more ADL, participating in organized activities, and relocation. In the subgroup analysis, all core network losses in other relationships and distances are also controlled for, although they are not presented for clarity.
The fixed-effect model also accounts for observable and unobservable variables, such as age, gender, education, and country of residence, that do not change over time.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$ (two-tailed tests).

Table 4. Changes in Predicted Level of Loneliness (Averaged Marginal Effect), Conditional on the Presence of an Additional Core Network Member

	No network addition		With addition	No network addition		With addition
	Loneliness change: in scale		Loneliness change: in scale	Loneliness change: in *SD*		Loneliness change: in *SD*
Lost a child (N = 1,705)						
Any loss within 0–0.9 km	0.13		−0.03	0.10		−0.02
Any loss within 1–4.9 km	0.46	*	−0.38	0.35	*	−0.29
Any loss within 5–24.9 km	0.37		0.28	0.28		0.22
Any loss at 25+ km distance	0.46	**	−0.30	0.35	**	−0.23
Lost a relative (N = 2,635)						
Any loss within 0–0.9 km	0.48	***	0.31	0.37	**	0.24
Any loss within 1–4.9 km	0.19		−0.04	0.14		−0.03
Any loss within 5–24.9 km	0.03		−0.03	0.02		−0.02
Any loss at 25+ km distance	0.17		0.12	0.13		0.09
Lost a non-kin (*N* = 4,391)						
Any loss within 0–0.9 km	0.49	***	−0.01	0.38	***	0.00
Any loss within 1–4.9 km	0.49	**	−0.10	0.37	**	−0.07
Any loss within 5–24.9 km	0.25		0.14	0.20		0.10
Any loss at 25+ km distance	−0.13		−0.20	−0.10		−0.16

Notes: The model is weighted and adjusted for the clustering in households and losses between the two waves.
This model highlights the interaction between connection loss scenarios and having an additional connection in the core network.
The model also controls partner's presence in the household, living alone, working for payment, self-rated fair/poor health, having one or more ADL, participating in organized activities, and relocation.
The fixed-effect model also accounts for observable and unobservable variables, such as age, gender, education, and country of residence, that do not change over time.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$ (two-tailed tests for the difference between individuals who experienced a loss and who did not).

additional ties in the core network. Drifting apart over long distances could lead people to expect less frequent contact (Sun & Schafer, 2022). Indeed, a plausible underlying process is that older adults consciously manage their core network, eschewing distant familial relationships in favor of more accessible alternatives that better suit their needs (Fihel et al., 2021; Small & Sukhu, 2016; York Cornwell & Goldman, 2021). The fast development of communication technologies and social media in this period (i.e., consider the development from the iPhone 4/4S in 2011 to the iPhone 6S in 2015) also

allows for more possibilities for individuals to stay in touch over longer distances (Quan-Haase, Mo, & Wellman, 2017), which also changes individuals' perceptions of proximity.

Our findings emphasize the importance of having ample replacements in the event of network losses, or even proactively expanding one's core network as preventive measures against loneliness. Although the loss of a child from the core network can induce heightened feelings of loneliness across short and long distances, such increases are considerably mitigated by the presence of an additional connection. It is conceivable that some exclusions may be voluntary, initiated by older parents who do not wish to burden their children or cause unnecessary concern if they are unable to provide immediate support (Wellman et al., 2021). Given that parent–child connections and support exchanges are often multidimensional and adaptable (Wellman et al., 2021), parents may also see such transitions as temporary and anticipate the reestablishment of the bond if future needs arise, which partly assuages the increase in loneliness.

Moreover, the impact of losing relatives or non-kin in proximity on loneliness is also largely mitigated among individuals who have mentioned additional core network connections. Such a pattern of resilience also applies to protecting individuals from severe loneliness. Previous research suggests that network turnover often reflects people's cycling between multiple specialized relationships to meet their evolving needs (Rainie & Wellman, 2012; Small et al., 2015). As older adults incorporate additional connections, effectively maintaining the size and structural characteristics of their core networks (Cornwell & Laumann, 2015, 2018; Cornwell et al., 2021), they are more likely to fortify themselves against loneliness. Yet there is some variation in how these rebalancing processes unfold. An additional analysis (available upon request) indicates that when a proximate core familial connection (i.e., within 1 km) is lost, only the addition of a relationally and geographically similar connection (i.e., a nearby family member) effectively mitigates feelings of loneliness. In contrast, the loneliness of losing a proximal non-kin connection appears to be offset by adding *any* type of new network member, irrespective of distance or relationship category. Future research may delve into exploring how different combinations of connections lost and added to the network lead to different experiences of support efficiency and accessibility, as well as the role of technology in rebalancing people's core networks.

One suggestion from previous research is that people often recruit "unimportant" non-kin core network members with limited emotional attachments simply because they are ideal for a particular topic or simply the most accessible (Small & Adler, 2019; Small & Sukhu, 2016). It is natural to expect that losing such a seemingly trivial relationship would have a minimal impact on loneliness. Yet, our findings contradict this presumption, instead corroborating earlier studies that underscore the significance of nearby non-relative connections among older adults (Cohen-Mansfield et al., 2016; Cornwell, 2011; Cornwell & Laumann, 2018; Silverstein et al., 1996). The loss of a proximate non-kin core network member, possibly engaged based on convenience, can still lead to significant increases in loneliness if a new connection is not readily available to step in.

The present study has several limitations to consider. First, the meaning of distance categories available in the SHARE survey likely differs by individual variation in distance perception, population density, and other contextual factors we were unable to consider. Although we have implemented fixed-effect models to account for the unobservable factors that are stable within individuals, future research should further scrutinize these dimensions. Second, our data included only information about core networks and offers no insight into more peripheral ties. Having a broader set of connections—even if relying on them less often for emotional needs—may provide more resilience against loneliness in case of core network turnovers. Third, we utilized a fixed-effect model to account for potential unobserved covariates such as local history and socio-cultural background that may influence both network transitions and loneliness. This assumes that these factors remain relatively stable within individuals over a four-year period. Meanwhile, this approach does not precisely identify how contextual factors shape the meaning of network losses and additions, and their implications for changes in loneliness Finally, though we attempted to rule out unobserved heterogeneity with fixed effect models, the results do not allow causal conclusions and we recognize the possibility of reverse causality. For instance, older adults who become less lonely may decide to dismiss some connections, such as those far away, from their core network because they are no longer as crucial as they were in times past.

In summary, this research provides valuable context to the relationship between network change and loneliness by addressing the "who" and "where" questions related to network tie loss. Our findings underscore the crucial role of close-proximity core network connections, including both relatives and non-kin, as their losses can significantly contribute to feelings of loneliness. Conversely, the loss of connections at a distance, even familial ones, often does not pose a significant risk for increased loneliness. Actively rebalancing one's network in the face of losses and proactively expanding one's network seems to be critical for averting loneliness and promoting well-being throughout the aging process.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None.

Data Availability

This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6, 7 and 8 (DOIs: 10.6103/SHARE.w1.710, 10.6103/SHARE.w2.710, 10.6103/SHARE.w3.710, 10.6103/SHARE.w4.710, 10.6103/SHARE.w5.710, 10.6103/SHARE.w6.710, 10.6103/SHARE.w7.711, 10.6103/SHARE.w8cabeta.001), see Börsch-Supan et al. (2013) for methodological details.

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Author Contributions

H. Sun initiated the idea, conducted the literature review and data analysis, and assembled the manuscript. M. Schafer collaborated with conceptualization, refined the study framing, helped structure the literature review, supervised the data analysis, and assisted with writing.

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