Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Social Networks 72 (2023) 1–12

Contents lists available at ScienceDirect

Social Networks

journal homepage: www.elsevier.com/locate/socnet

Networks in lockdown: The consequences of COVID-19 for social relationships and feelings of loneliness☆

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ARTICLE INFO

Keywords:
Networks during covid-19
Weak ties and loneliness
Network changes in crises

ABSTRACT

This paper studies social network changes during the COVID-19 crisis in the Netherlands and their relation to perceived loneliness for the younger and the older cohorts. Arguments from opportunity theory and social capital theory are used to formulate hypotheses on network changes during the pandemic. Core discussion networks and networks with practical helpers from two representative cohorts (18–35 years of age and 65+ years of age, n = 1342 participants in both waves) during the lockdown in May 2020 are compared with networks of the same respondents in May 2019. We find that networks became smaller and more focused on stronger ties, while weaker ties more often decayed. Feelings of loneliness incsreased on average for all respondents and in particular for those who live alone or have a disadvantaged socioeconomic position. Importantly, the decrease in the number of the practical helper network, that is, decline in relatively weaker ties, affects experiences of loneliness in both groups.

Introduction

On March 11, 2020, the spread of COVID-19 was officially recognized as a pandemic. In the Netherlands, on March 16, 2020, the first lockdown started. To fight the spread of the virus meeting opportunities were closed by order of the government, including schools, universities, sport clubs, museums, cinemas, restaurants, and bars. Everyone not employed in an occupation considered crucial for societal processes (medical professions, municipality officers, the police, or fire companies) was advised to work from home as much as possible. By the beginning of 2022, after almost two years of living with the virus, and after periods of loosening and tightening the rules directed to control the spread of SARS-COV-2, the virus is still affecting the world's societies and the situation is not under control.

The governmental rules implemented to minimize the risk of infection affected all aspects of life and the way people maintained their relationships. Notably, consequences differed across social groups. For example, while older people faced the risk of serious illness and might have suffered from restricted contact with (grand-)children, younger people might have felt a pressure towards solidarity and missed the opportunities to go out. Furthermore, because the younger generation is in the stage of building their networks, they probably had more difficulties in coping with the lockdown than older people, whose networks are more established. Indeed, the literature indicates that mental problems are more severe for the younger generation, while the older generation faces more severe physical illness and higher mortality risks when getting infected (see Kim and Crimmins, 2020; Maffly-Kipp et al., 2021 and the mortality figures of the Netherlands 'National Institute for Public Health and the Environment, 2022).

This paper studies social networks during this crisis and examines their changes compared to the time before and whether this differs across generations. Furthermore, it studies the relation between network changes and changes in mental well-being, or more precisely, feelings of loneliness. In general, I argue that the COVID-19 crisis has forced people to focus exclusively on the social resources they had accumulated before the crisis. Opportunities for creating new ties and for maintaining or strengthening more distant ties were strongly limited. At the same time, the social distance rules that called for minimizing contacts may have forced people to make choices concerning with whom to stay in touch. Arguments from opportunity theory (Blau, 1977) and social capital

☆ The author is very grateful to the anonymous reviewers, Gerald Mollenhorst, Veronique Schutjens, and to the interdisciplinary project group at Utrecht University, whose comments very much improved the paper. Funding for that research was provided by the University research theme 'Dynamics of Youth' (2020/DoY IG 3/1).

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https://doi.org/10.1016/j.socnet.2022.08.001

Available online 9 August 2022

theory (e.g., Lin, 2001, Völker, 2021) result in different expectations about network changes during the lockdown. The former theory leads to the expectation that people basically maintain contact to those they can meet, because they have the opportunity; the latter predicts that people stay in touch with others who provide more resources. Henceforth, the research questions are straightforward:

- *How did people's personal networks change during the lockdown in the Netherlands? Are these changes explained by social capital theory and/or by restricted meeting opportunities?*
- *In what way do feelings of loneliness vary with changes in personal networks during the lockdown?*
- *Do the network changes and experiences of loneliness during the lockdown vary with age?*

Two-wave panel data collected among two social groups are employed: a younger group (age 18–35 years) and a group of older persons (age 65 years and older). The first wave was collected before the covid crisis, in May 2019, and the second in May 2020 during the first lockdown in the Netherlands. Among others, data contain information about people's network of core-discussion relationships and relationships important for practical support and people's well-being. During the second wave of measurement, changes and reasons for not mentioning a certain network member again were examined.

Before providing the theoretical arguments and describing the setup of our study, I first review what is known about personal network changes during crises and during the life course as well as how networks relate to feelings of loneliness. Additionally, the rapidly growing literature on networks during the COVID-19 pandemic is briefly reviewed.

Network changes in times of natural or personal disasters

The importance of our social relationships cannot become more visible than in times of crisis. These are the moments where the mutual dependencies that link people with each other become manifest. Due to the relative rareness of such events and the lack of data, the literature on whom to turn to in times of disasters is relatively small. Because crises are events with many particularities, it is difficult to compare results across studies (Suter et al., 2009). The seminal paper by Shavit et al. (1994) inquired into networks of Haifa citizens during the Gulf War in 1991. The authors examined to whom people turned for support during the missile attacks. During the first weeks of these attacks, which lasted for five weeks, schools and universities were closed, and people stayed at home. After the war, the survey was repeated and the results showed that during the war, networks were smaller and more kin-oriented than afterwards. Furthermore, network members helped in two important ways: providing mental support, such as talking and advising, as well as immediate help, such as 'checking in' (op cit:1209), that is, informing about the well-being of the network members.

Another important research in this regard is reported in the papers by Hurlbert et al. (2001); see also Hurlbert et al. (2000); on the allocation of network resources in 'nonroutine' situations). The authors studied networks and tie activation during hurricane Andrew, which struck the Gulf coast in 1992. Using a telephone survey, they found that support networks during the days of the hurricane were relatively dense, homogeneous, and consisted of many family members. Hurlbert and colleagues also argued that such dense and close networks might not provide the support that is needed. When a disaster occurs, people need information. Links to professional agencies can become crucial for obtaining help, but these resources are not provided by a dense, homogeneous network of core ties. Regarding the network consequences for different social groups, they showed that the urban poor suffer twice because they lack both economic and social resources. Maintaining network ties during a natural crisis is costly, e.g., it requires cell phones or transportation opportunities that not everyone can easily afford. In addition, in particular the urban poor lack ties to institutions and professionals, which can be important providers of information.

Hurricane Katrina, one of the greatest natural disasters in recent American history, has likewise been researched for understanding networks during natural disasters. Varda et al. (2009) reviewed the literature on networks during crises and during the Katrina hurricane in 2005 and discussed how crises cause networks to change. They state that disasters such as hurricanes "shake up the entire social infrastructure" (2009:13) and turn everything upside down about what we know regarding how people relate (see also Quarantelli and Dynes, 1977; Forgette et al., 2009; Elliot et al., 2010; Messias et al., 2012; Islam and Walkerden, 2014).

Although not a network study, Klinenberg's (2015) ethnographic study on the 1995 heatwave in Chicago - by then the most severe recorded heatwave in history - should also be mentioned here. Klinenberg describes that the odds of dying through heat vary across neighborhoods with different compositions and community life. When comparing two neighborhoods with a similar the percentage of elderly, mortality rate is lower in the neighborhood with a vital community.

Another study, likewise, not explicitly dedicated to social networks, but nevertheless rich in findings about relationships and community is on the Dutch flood disaster in 1953 (Lammers, 1955; Nauta and Van, 1955).[1] Back then, villages were swept away by the water. More than 70.000 people had to leave their homes and were hosted by family, friends, or volunteers in the safe part of the country. Lammers reported the relationships between evacuees and their hosts and found that most tensions occurred if both differed in religion (1955:49). Nauta and van Strien described how the former village communities were replaced by 'emergency' communities with very strong group boundaries and an almost hostile habitus towards the outgroup (1955:43).

Compared to the literature on natural and environmental crises, the literature on the network consequences of *personal crises* is abundant. There is a vast body of research on network changes after divorce, widowhood, depression, and illness. Guiaux et al. (2007) examined changes in personal networks after widowhood (Baarsen et al., 1999; Baarsen van and Broese van Groenou, 2001). They used data from the Longitudinal Aging Study from Amsterdam and found that contact and support, particularly contact with children and siblings, considerably increased after widowhood, but decreased again after 2.5 years. Previously, Morgan and March (1992) compared networks of recent widows with people who cared for a spouse with Alzheimer's. They found, among others, that widows mentioned considerably more network members than caregivers. While the social world for widows seems to grow, that of caregivers decreases and becomes centered around the sick partner. Further, Vassilev et al. (2011) reviewed the literature on social networks and social capital in situations of chronic illness. They point out the importance of more extended communities for people with long-term conditions. More broadly, Kalmijn (2012) studied life course changes in contacts with friends, family, neighbors, and acquaintances while inquiring into several critical life events (union formation, parenthood, separation, and widowhood) with large-scale representative panel data (Swiss household panel). He found that separation and widowhood intensify contacts with friends, particularly for women.

When overlooking this literature, it can be concluded that natural disasters bring people closer together with their existing network of confidants, while personal crises divide social networks and cause the individual to engage in new contacts.

Network changes across the life course

Obviously, networks also change through time and across an individual's life course, without any crisis event. In the last decade, more

[1] The studies belonged to a large project by the Committee on Disaster Studies of the National Academy of Sciences and the National Research Council Washington D.C.

and more network studies on such changes have been conducted. For example, Van de Bunt et al. (1999) studied friendships through time in a sample of university freshmen at seven points of measurement using actor-oriented statistical models and demonstrated the dominance of opportunity structures upon preferences for friendship engagement and maintenance. Furthermore, in a meta-analysis on social network changes across the lifespan, Wrzus et al. (2013) found that while controlling for all kinds of life events, general network sizes as well as friend networks increase up to young adulthood followed by a decrease, a finding that is in line with opportunity arguments. Also, relationships to colleagues and neighbors depend on specific stages in life, while relationships to family constitute the most stable networks. Mollenhorst et al. (2014) examined changes in the core discussion networks and in the networks of practical helpers in a representative sample in the Netherlands and found that after a period of 7–8 years, only 30 % of the helpers were still the same persons. Of the 70 % who were not mentioned twice, approximately two-thirds were no longer in the network, and the others were forgotten or had another relation function at the second point of measurement (op cit:70). The reasons for these changes were not clear, most people just mention that the other person got out of sight. The authors found, however, that people maintained their network size. Network functions and getting a specific type of help were retained, while the network members who fulfilled this function, changed. Hence, the network dynamics largely take place on the level of the alters. Using the same data in a study specifically dedicated to tie loss, Tulin et al. (2021) studied the decay of personal relationships and found that dissimilarity is a hurdle for tie maintenance, although the question of 'why' remained open.

In summary, networks show many dynamics during the life course. Changes mostly take place on the level of the alters, while networks and their composition are less affected. Important functions of networks are retained through time. Opportunity theory is important in the explanation of such changes, but the precise interplay between preferences and opportunities in network dynamics is not fully clar.

Is the COVID-19 pandemic different from other crises?

To some extent, the worldwide COVID-19 crisis mirrors the crises reviewed above. However, the pandemic also differs in important respects from crises already known. Unlike natural disasters, people are not displaced, do not lose their homes, or lack the supply of electricity, water, or food. Access to information is not a scarce good. In contrast, the internet, TV, and social media provide abundant news and interpretations of facts. Furthermore, finding others and getting in touch are not hampered by collapsed communication techniques.

Additionally, two other characteristics of the COVID-19 pandemic stand out. First, the threat of getting infected is not restricted to a specific place or geographical setting, such as usually in the cases of natural and political disasters. The contamination risk is posed by all persons one meets and is not restricted to a confined group or area. In particular, the people one does not know well pose an uncontrollable risk since these are the persons whose contacts and actions are unknown. Of course, household members and close friends are also a source of potential infection, but people know more about the activities of these close contacts than of more distant individuals.

Second, the governmental rules to control infections make it almost impossible to engage in new relationships and to strengthen relationships with people met shortly before the crisis. Consequently, how one manages the crisis depends on the network built before and the resources accumulated therein.

Networks during the COVID pandemic and mental well-being

Given that an imbalance between desired and achieved relationships is at the core of loneliness experiences (De Jong Gierveld et al., 2006; de Jong Gierveld and Kamphuis 1985; van Tilburg 1990), a restriction of meeting opportunities should have stark impacts. Differently put, if there is any relation between social networks and loneliness, the pandemic with its rules of restricted socializing should bring this to the surface. Indeed, Elmer et al. (2020), who studied student networks during the lockdown in Switzerland with two waves of longitudinal data (2018 and 2020) found that interaction and co-studying became scarce and, importantly, indicators of loneliness, stress, and anxiety increased. In line with this, Rumas et al. (2021) found that younger people and those with smaller networks were more at risk of feeling lonely. In a large-scale US survey, Philpot et al. (2021) found an increase in loneliness, particularly among people with vulnerable health and women. Regarding differential associations for different types of ties, Tibbetts et al. (2021) found that increased interaction with weaker ties showed more undesirable health effects than increased interaction with stronger ties. However, their study consists of a poll for just one week and long-run effects are not clear. Furthermore, Kovacs et al. (2021) found in a longitudinal survey a decrease in network density during the pandemic compared to the previous period. Additionally, people with less than five close confidants during the crisis were found to be more likely to report enhanced loneliness. However, Luchetti et al. (2020) found no increase in loneliness in a study employing a nationwide American sample interviewed in February, March, and April 2020. In contrast, in many cases, levels of support increased. Hoffart et al. (2021) reported only a small decrease in feelings of loneliness after discontinuation of social distance protocols in a large sample of adults. Finally, Bu et al. (2020) revealed in a large-scale study of the UK that levels of perceived loneliness under strict lockdown rules were relatively stable.

Overall, available results are not consistent across studies,[2] suggesting that the effects of the COVID-19 and the governmental rules are not straightforward and that countries are hard to compare. The consequences of COVID-19 for social networks and mental health, such as loneliness, might be complex and moderated by many factors. Furthermore, panel studies are relatively scarce, and studies differ significantly in terms of sample, measurements, and methods of analysis.

A note on social networks and loneliness

To date, it has been demonstrated that certain network patterns go hand in hand with experiences of loneliness, although the causal direction is still a matter of debate (Kawachi and Berkman, 2001). It is not clear whether people who feel lonely have a smaller network or whether feelings of loneliness cause people to disinvest in their network, which in turn becomes smaller. Furthermore, loneliness seems to be predicted best by a multitude of conditions, such as living alone, suffering from ill health, and having few contacts with network members (Yang, 2018). Interestingly, the loneliness effects of life events fade away, except for partnership dissolution, which seems to last even if persons remarry (Peters and Liefbroer, 1997; Ellwardt et al., 2015). It is also notable that feelings of loneliness differ across countries (Yang and Victor, 2011), and national variations in loneliness even seem to override the effects of a person's age. Finally, there are indications that specific kinds of diversity in personal networks protect people from loneliness. For example, it has been shown that people whose network consists predominantly of kin are more likely to feel alone (Silverstein and Chen, 1996). Related to this finding is also the argument by Sandstrom and Dunn (2014) on the importance of weaker ties, next to stronger ties for the explanation of loneliness. Relying on merely one type of relationship seems to narrow the range of accessible resources, and the resources available can be useless in unexpected situations.

[2] The number of studies on networks during the pandemic and their consequences is rapidly growing, and no complete overview can be provided here.

This study – arguments and setup

My point of departure for the arguments on how networks might change due to COVID-19 is that social networks do not emerge out of the blue but are created intentionally and with the view of expected beneficial resources, albeit they sometimes result from serendipitous encounters. People are restricted in their choices for interaction partners; they follow their preferences under constraints (see Fischer's, 1982, choice constraint approach). During the COVID-19 crisis, settings that constitute meeting opportunities were largely closed, implying that constraints were maximized and quite similar for everybody. Opportunities to meet, one of the major driving forces behind network changes, got screwed on tightly. It became hard to create new relationships and people had to fall back on their existing ties. Individual preferences, the other key explanation for network patterns remained, of course, which raises the question, whether the preferences for a certain tie were strong enough to overcome the restrictions in the opportunities to meet.

Furthermore, important parts of a network were probably affected in different ways. Most people have a set of intimate ties that is usually small (core discussion networks, see Marsden, 1987) and a larger set of more casual and weaker ties. Both parts of the network are important: strong relationships provide emotional support and confirm one's identity (Stets and Burke, 2003; Leonard and Onyx, 2003); weaker relationships are crucial for the diffusion of innovation and for inspiration (cf Granovetter, 1973), and they are more diverse in attitudes and behaviors (e.g., Sandstrom and Dunn, 2014; Wald, 2016). Additionally, instant practical support, such as helping with odd jobs, is often provided by weaker relationships (Völker and Flap, 2007; Bidart and Lavenu, 2005), which is related to the fact that such help is provided by neighbors. The peculiarity of the lockdown situation and the COVID-19 social distancing rules is that the settings where people meet their weaker relationships were rigorously restricted and people were 'locked in' with their household members. It is likely that people got more focused on their stronger relationships, the people they meet without any extra effort and who provide their 'social comfort zone' of conformation, support, and understanding. This also holds for the strong ties with friends or family outside of the household. The difficulty of maintaining contact with weaker ties is also related to the convention of meeting such network members in groups like the choir, the sport club, or the friends in a pub. Approaching such a network member on an individual base, and, e.g., suggest going for a walk does not belong to the relational repertoire within these contacts, which makes them even more costly to maintain. In addition, and as mentioned above, weaker ties are probably perceived as a greater risk of infection because people know less about who their weak contacts have met (Burt, 1999; Völker and Flap, 2001; Burt et al., 2013). In other words, weaker ties, indirect ties, and ties to strangers could be seen as a risk when compared to close friends or family, whose daily routines, contacts, and behaviors are better known.

In short, the opportunities to meet people with whom one is weakly related became diminished, and, in addition, weaker contacts might be framed as a potential source of infection. Therefore, weaker ties can be expected to decay, and the network tasks they fulfill will be organized in another way. In other words, *stronger ties are expected to be retained, at the cost of weaker ties, who move to the periphery in personal networks (H1)*. This development might affect, in particular, the older generation, since they are, compared to younger people, less used to maintaining contacts via modern techniques like social media or WhatsApp groups (Rosales and Fernández-Ardèvol, 2016; Rosenfeld et al., 2018; Statistics Netherlands, 2020a). *(H1.1)*.

In addition to the expectation that people's focus during the crisis will be on emotionally closer ties, geographically close ties may also become of particular importance: interestingly, the social setting that cannot be locked down during the crisis is the local neighborhood. Hence, given that meeting opportunities are important for engaging in contacts, during the lockdown, these opportunities are found within and around a person's house. Consequently, the role of contacts in the neighborhood can be expected to become more prominent. Although relationships with neighbors are usually relatively weak, they might become closer and more important in these times. While people cannot meet their colleagues and acquaintances in a pub, they can chat with their neighbors at a safe distance and even have barbeques at the same moment. Hence, *neighborhood relationships can be expected to be retained or even strengthened during the COVID-19 crisis* (H2). Once more, this development might hold in particular for the elderly, given that they use less often modern techniques for maintaining contacts that transcend neighborhood boundaries, and given that they are more settled into a neighborhood than the young. (H2.1).

Social capital theory (Lin, 2002; Son, 2020; Flap and Völker, 2013) provides another explanatory argument for network patterns that is not always in line with predictions based on opportunity theory. Because of the social distance rules and the call by the government to minimize contacts, people might choose with whom to stay in touch. Those who have a large network might become more selective and concentrate on just a few network members. A straightforward expectation from social capital theory is that network members who provide more resources are retained in the network at the cost of those who don't. In many studies, a person's education is considered as an indicator for social capital and the resources that can be mobilized (e.g., Song and Chang, 2012, Lin, 2001). Higher educated network members might have not only more resources themselves, but they also know more others and access information easily. Assuming that resources are closely associated with a person's education leads to the *expectation that network members who are similar or better educated than a focal actor are more likely to kept in the network than those with a lower level of education* (H3). In addition, these kinds of choices might not be the same across social groups. People who have ample resources might have more options for their choices of alters, because they are an attractive network member themselves. Hence, they can afford being, on average, more selective with whom to interact. The closure of social strata has been shown to be more severe at the top (Lin, 2001; Otero et al., 2021). Consequently, I expect that people in higher social strata, i.e., with higher education, are more selective when they choose interaction partners during the lockdown, implying that they might select more strongly on resourceful alters (H3.1).

In summary, due to the COVID-19 pandemic and the governmental rules that restricted contacts, networks are expected to change. These network changes become even more important if they affect people's mental state and well-being during the crisis (see the abovementioned discussion about increased loneliness due to the COVID-19 crisis). Previous research has already shown that small networks are not related one-by-one to increased feelings of loneliness (De Jong Gierveld et al., 2006). However, in the case of the lockdown, people are suddenly forced into a smaller circle of close contacts. This might cause feelings of disconnection and loneliness, in particular if they live alone. Further, it has been shown that people above all feel lonely if they lack important network resources (Dykstra, 1990). During the lockdown, people need others for emotional support and the provision of comfort when they are afraid of becoming infected, which might be found in the stronger circles of a network. As mentioned above, however, not only strong but also weak ties are important for the explanation of loneliness (Sandstrom and Dunn, 2014). Weaker relationships, which had to be kept at a distance during the pandemic, are important for the provision of information, and they can change one's view on the situation. During the lockdown, weaker ties, more than stronger ties, can help to put things in perspective and find creative ways to live with the isolation. Since both, weaker and stronger ties provide important support in these days, *feeling detached of either weak or strong ties can be expected to result in increased feelings of loneliness* (H4). As argued above, however, a decay in weaker ties is considered more likely than a decay in stronger ties.

In summary, I expect that during the lockdown, the focus of personal networks is more on emotionally and geographically close ties (H1 and H2) and that this holds more for the elderly than for the young (H1.1.

Table 1
demographics of samples in 2019 and in 2020.

Respondent characteristic		2019		2020		Composition of The Netherlands 2020
		n	%	n	%	%
Sample (n)		1924		1342		
Sample (age)	18–35	867	45.1	497	37.0	30.0
	65+	1057	54.9	845	63.0	19.5
Sex	female	1112	57.8	748	55.7	51.3
	male	812	42.2	594	44.3	49.7
Born in NL		1802	96.4	1289	96.3	76.0
Education	Primary school	77	4.0	55	4.1	6.0[a])
	Secondary school*	524	27.4	377	28.3	14.0
	Vocational Training**	343	17.9	238	17.8	39.0
	University of applied sciences ***	538	28.1	379	28.3	25.0
	University	432	22.6	293	21.9	16.0
Marital status	single	506	26.6	339	25.4	48.9****
	married/ cohabitating	1199	62.3	843	63.1	38.2
	divorced	59	3.1	47	3.5	7.8
	widowed	139	7.3	106	7.9	4.9
Living alone		569	31.7	417	31.7	18.0

*Mavo/Havo/VWO in the Dutch system, ** MBO in the Dutch system, *** HBO in the Dutch system. **** Statistics Netherlands counts percentage of unmarried.

and H2.1). If people make choices concerning with whom to maintain contact, they are expected to prefer others with more resources (H3), and this probably holds even more for highly educated people (H3.1). Finally, if networks decay due to the rules by the government to fight the pandemic, feelings of loneliness increase. (H4).

Data, measurements, and methods

These expectations are investigated with panel data of two representative samples in the Netherlands, a sample of people between 18 and 35 years of age and a sample of people aged 65 years. Both waves of measurement were conducted through online interviews organized by a national fieldwork agency. Internet coverage in households in the Netherlands is more than 97 % (Statistics Netherland, 2020b). The first wave conducted in May 2019 took place during a study on networks of different generations and intergenerational solidarity (Völker, 2019). After the start of the COVID-19 crisis in the Netherlands, in March 2020, the sample of 2019 was reinterviewed in May 2020 during the lockdown. By then, respondents had approximately 8 weeks of experience with the COVID rules to minimize the spread of the virus, while it was announced that the governmental rules would be loosened in June. The sample in 2019 consisted of 1925 respondents, of whom 868 were between 18 and 35 years of age and 1057 were older than 65. In the second wave, 1342 respondents participated again, 497 in the younger sample and 845 in the older sample. The response rate was 86 % in the first and 70 % in the second wave. Respondents are part of a national panel and participate in different surveys, depending on their individual characteristics. For participation, they earn points that can be converted into a coupon for a large department store.

Table 1 shows the composition of the sample at both waves and compares it with national statistics. The sample deviates from the population in the Netherlands in a couple of respects; most important, people with a migrant background are clearly underrepresented. Additionally, the sample consists of more married people; however, married and cohabitating were combined in one category in our measurement, while cohabitating is not counted in national statistics.

Table A1 in the Appendix A shows the occurrence of life course changes between 2019 and 2020 and the feelings of our respondents related to COVID-19. About 40 % of the respondents experienced changes in their living situation. Changes in a respondents' work situations occurred for 17 %. 14 % experienced death of a person in their closer circle.

Those who had to work from home continuously (15 %, not in table) reported that they had difficulties concentrating. Approximately 20 % reported that combining work with caring for households and children was troublesome. Income changes were minor, more than 90 % reported no change in their income between 2019 and 2020.

Measurements

Networks

Networks were measured by means of the exchange method (Fischer, 1982). In the first step, respondents are asked to nominate alters with whom they exchanged various types of resources. In the second step, information about the characteristics of these alters and the relationship with ego is collected. For this paper, the focus is on the network members who were mentioned in two types of resource exchange: first, the core discussion network, i.e. the reaction to the question, "With whom did you discuss important matters during the last two months?"[3]; and second, the network of practical helpers; these are the network members who were mentioned in response to the question, "Who do you ask for help with odd jobs in and around the house during the last two months? These might also be the people doing the shopping for you in these days". Up to five alters could be mentioned for each question. Alters delineated via the core discussion network question are usually at the stronger end of a closeness scale (Marsden, 1987), while alters who entered the network via the question about practical helpers are comparatively less closely related to the focal actor (Mollenhorst et al., 2009; Mollenhorst et al., 2014; Fischer, 1982).

The network parameters delineated in the second step consisted of emotional closeness (scale from 1 to 5) and contact frequency (on a scale from 1 to 6, where the higher category indicates lower frequencies). The measurement referred to face-to-face contacts as well as to contacts via the internet, SMS, etc. Geographical distance entailed categories ranging from 0 km for household members up to more than 150 km. In addition, it was measured how long the respondent and the network member have been knowing each other (in years and months), and respondents reported the network member's age, education, and work status. Also, role relationships, i.e., family, partner, friends, neighbors, work relations, or other relationships, were established.

Respondent characteristics

Respondent characteristics were measured straightforwardly. We measured a respondents' sex, age, highest education obtained (5 categories), income (11 categories) and work situation (employed, own business, housekeeper, retired, in education, no job and looking for a job). Additionally, information about a respondent's living situation (living alone, with partner, children other) has been collected. The number of members in the household and the number of alters mentioned in the two name-generators were included as control variables in the analyses. In models predicting loneliness, self-rated health was likewise controlled, which was measured on a 7-point scale (from very bad to very good).

Loneliness

Loneliness was measured by a shortened version of a Rasch-type loneliness scale developed originally by De Jong Gierveld and

[3] Because we aimed at delineating the networks during the lockdown, we focused on the period in which the lockdown had existed, which was two months before the survey. Wording of the question was identical in both waves.

Table 2
Size of core discussion network and network of practical helpers, *younger sample (S1, n = 497)* vs *older sample (S2 = 845),* before and during covid-19.

	Core discussion network (%)				Practical helper network (%)			
	2019		2020		2019		2020	
	S1	S2	S1	S2	S1	S2	S1	S2
Network size								
0	9.7	20.2	12.5	25.1	10.3	15.0	22.3	30.8
1	7.8	11.3	8.9	10.1	18.2	26.0	20.9	22.8
2	11.9	13.8	14.7	11.8	17.8	20.4	18.5	21.2
3	15.7	17.3	21.1	16.8	21.3	18.3	19.7	14.3
4	18.5	13.3	15.5	14.6	13.7	9.6	9.7	5.4
5	36.4	24.0	27.4	21.7	18.7	9.7	8.9	5.4
Mean	3.35	2.64	3.00	2.50	2.66	2.00	2.10	1.57
SD	1.68	1.83	1.69	1.84	1.61	1.59	1.57	1.45
Network size for those with at least 1 network member								
Mean	3.70	3.31	3.43	3.35	2.96	2.47	2.59	2.21
SD	1.34	1.41	1.35	1.40	1.41	1.30	1.41	1.33

Note: paired t-test for core and practical helper network is significant at $p < .001$.

Kamphuis (1985), which is similar to the UCLA loneliness scale. The original scale consists of 11 items phrased in positive and negative statements about loneliness and is well established in the Netherlands (see Appendix A). In the second measurement, three items of the scale were left out, because they did not add to the scale's quality in 2019, and we had to save time. The scale had a Cronbach's alpha reliability of 0.87 in the first wave and a reliability of 0.84 in the second wave.

Analytic strategy

In the analyses presented hereafter, first results for aggregated networks are shown. The likelihood that a particular network member is retained is estimated by multilevel logistic regression models for longitudinal data (Rabe-Hesketh and Skrondal, 2012). To test the hypothesis about the consequences of network changes for loneliness, mixed and fixed effect models were estimated. In some analyses, networks of core discussion members and of practical helpers are presented separately, because these are different types of personal networks in terms of composition and strength.

A note on attrition

Table 1 shows that attrition is approximately 30 % in the total sample but is larger in the group of younger respondents. A logistic regression (Appendix A, Table A2) on attrition showed that, indeed, attrition is predicted by being younger (odds ratio 2.81) as well as by being less educated (odds ratio 1.62). Furthermore, the number of persons in the household predicts attrition, people from larger households are less likely to participate for the second time in the survey. No association was found for the interaction between age and education or for a person's gender (not shown). Additionally, the composition of the network in 2019 did not predict attrition.

In all multivariate analyses, it is controlled for education, next to other potential confounding conditions, such as the number of household members, health status, and critical life events. In the descriptive analyses, the groups under study consist of the respondents who participated twice in the survey: 497 respondents in the younger sample and 845 respondents in the older sample. The subsequent panel analysis employs all respondents.

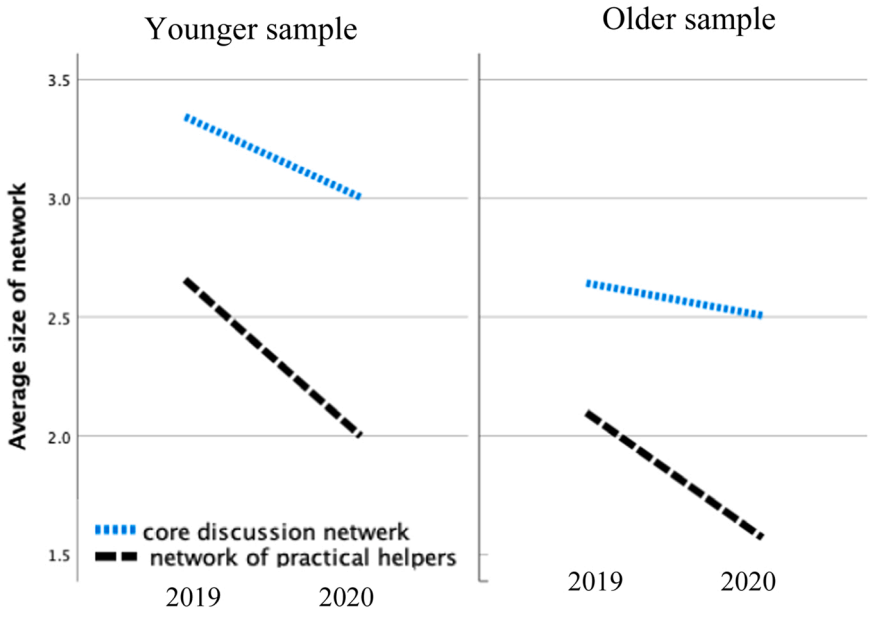

Fig. 1. changes in average sizes of core discussion network and network of practical helpers.

Table 3
Composition of core discussion network and network of practical helpers for the *younger sample (S1, n = 457, Panel A) and* for the *older sample* (S2, n = 845, Panel B) before and during Covid-19.

	Core discussion (%)		Practical helpers (%)	
Type of relationship	2019	2020	2019	2020
S1: Panel A, younger sample				
No network member	9.7	12.5**	10.3	22.3**
Spouse/Partner	12.7	24.3**	17.6	23.4**
Parents	28.2	28.2	27.4	33.6**
Child	1.7	0.5	0.8	3.6
Other kin	16.4	11.2**	25.2	19.6**
Friend	30.3	26.6*	17.3	12.6**
Neighbor	1.0	0.9	7.0	5.0
Other nonkin	11.3	8.2*	4.7	4.9
S2: Panel B, older sample				
No network member	20.2	25.1**	15.0	30.8**
Spouse/Partner	15.3	24.4**	23.7	14.5**
Parents	0.0	4.3*	0.1	0.2
Child	20.0	27.9**	19.2	31.2**
Other kin	18.0	15.4	18.9	17.1
Friend	28.8	19.4**	10.6	10.0
Neighbor	7.3	4.4**	22.5	20.0**
Other nonkin	10.6	8.0**	4.9	6.8

**p < .01, *p < .05 (two tailed tests).

Results

Because of the novel situation, an extended description of the networks in 2019 and 2020 is provided before the hypotheses are tested.

Changes in network size

In the first step, the network sizes of the core discussion networks and of the practical helper networks are compared for the two groups under study. Table 2 summarizes our findings for both groups and network parts. Table A3 in the appendix shows the figures for both groups together. When comparing core discussion networks of the younger and older generations before and during the lockdown, the table reveals that the average network size decreased but only slightly. The most remarkable change for the younger group is the drop in the number of people who mentioned 5 network members: in 2019, 36.4 % of the younger sample and 24.0 % of the older sample reported five network members in the core discussion network. In 2020, only approximately one-fourth of the young sample (27.4 %) mentioned such a relatively large number of core discussion network members, while the figure was 21.7 % for the older group. However, in the older group, the number of people who mentioned no core discussion network members increased from 20 % to 25 %. Interestingly, the difference between the networks of the older and the younger respondents decreased: the networks of the young became approximately 10 % smaller (from 3.35 to 3.00 on average) during the lockdown, while the size of the networks of the older respondents decreased by only approximately 5 % (from 2.64 to 2.50).

For the networks of practical helpers, the pattern is different. For both groups, network sizes clearly decreased. The number of people who mentioned no practical helper increased for both groups, particularly for the elderly group (from 15 % to 30.8 %). If at least one network member is mentioned, networks are on average more than 12 % smaller for the younger group and 10 % for the older group.

A fixed effect regression model (see Appendix A Table A4) on the changes in network sizes accounting for sample and measurement time (wave) confirms that both network parts declined and that especially the younger sample experienced network decay in the core discussion network. Fig. 1 illustrates these results.

Table 4
Contact frequency with core discussion network members and practical helpers in 2019 and 2020 (contacts through all possible modes, household members are excluded).

	Younger sample (%, n = 868/497)		Older sample (%, n = 1057/845)	
	2019	2020	2019	2020
Daily	14.9	11.3	13.6	2.4
A couple of times in the week	42.9	19.8	41.2	16.4
A couple of times in the month	27.1	54.8	23.9	58.6
Once in three months	9.3	11.9	7.8	17.7
A couple of times a year*	0.5	2.2	13.3	4.8

* This category was merged with the category 'less often than a couple of times a year.

Table 5
Reasons for dropping out during the lockdown (core discussion networks and practical helper networks of 1342 respondents.

Reason reported	Not mentioned anymore in core discussion network in 2020 (%, n = 1524 ties)		Not mentioned anymore in the network of practical helpers in 2020 (%, n = 1343 ties)	
	Younger sample	Older sample	Younger sample	Older sample
Forgot to mention, person is still in network	29.9	34.2	34.9	36.4
Don't speak to this person since about 2 months	35.6	31.3	19.6	18.4
Don't speak to this person for quite some time (longer than 2 months)	19.6	13.5	12.3	11.2
We had an argument	2.2	0.6	1.6	0.5
Other reason/don't know	12.7	20.3	31.6	33.5

Changes in network composition

Table 3 summarizes the composition of the networks before and during the lockdown for the two samples. For the core discussion networks of the young, reliance on partners increased significantly. All other types of relationships became significantly less important or remained unchanged. In the network of practical helpers, the reliance on parents and partners increased, but the numbers for other kin and friends declined.

The older group (Panel B) of respondents shows a similar pattern with respect to the core discussion networks. Here, also reliance on partners increased remarkably. However, and not in line with our intuition, partners became less important during the lockdown. Interestingly, children became more important, in both the network of practical helpers, as well as in the core discussion networks of the older group.

Changes in contact frequency and closeness

During certain periods of the lockdown, it was forbidden to invite more than two people into one's home during the day. Additionally, walking outside with others from different households was restricted to two individuals. Table 4 shows how the contact frequency of the network members evolved between 2019 and 2020. Note that the contact frequency in 2020 includes contact via the internet or sms/whatsapp. The table shows that the average contact frequency dropped. While in 2019, more than 40 % of the network members are seen weekly, in 2020 these are only approximately 20 % (younger sample) and 16 % (older sample, respectively. In addition, while the younger group showed little change in their daily contact frequencies, the elderly retained only a few daily contacts.

Closeness in core discussion networks is higher than in the network

Table 6
Likelihood for a network tie to be retained during the lockdown (logistic multilevel model).

Alter retained?	M1 OR (sd) p-value	M2 OR (sd) p-value	M3 OR (sd) p-value
Sample (younger)	0.970 (0.323) 0.928	0.923 (0.313) 0.814	0.899 (0.305) 0.756
Ego characteristics			
Sex (male)	0.832 (0.097) 0.117	0.822 (0.097) 0.101	0.817 (0.097) 0.090+
Income	1.026 (0.032) 0.413	1.030 (0.032) 0.347	1.025 (0.073) 0.450
Living alone	1.317 (0.151) 0.016*	1.496 (0.176) 0.001***	1.509 (0.178) 0.000***
Work situation (ref=paid job)			
In education	1.039 (0.258) 0.877	1.089 (0.276) 0.763	1.082 (0.274) 0.756
Retired	0.860 (0.285) 0.649	0.806 (0.271) 0.524	.806 (0.272) 0.524
Homemaker	1.806 (0.662) 0.107	1.648 (0.614) 0.180	1.616 (0.602) 0.197
No job	1.212 (0.380) 0.538	1.170 (0.372) 0.621	1.147 (0.365) 0.666
Education	0.975 (0.034) 0.484	0.981 (0.035) 0.610	0.876 (0.051) 0.025*
Alter and relational characteristics:			
Similarity in education (ref= same level)			
alter higher than ego			.0866 (0.352) 0.724
alter lower than ego			0.282 (0.124) 0.004***
Interaction Similarity*education Ego			
alter higher than ego			1.053 (0.073) 0.450
alter lower than ego			1.257 (0.092) 0.002**
Age	1.002 (0.002) 0.314	1.000 (0.002) 0.774	1.000 (0.002) 0.768
Sex (male)	1.212 (0.110) 0.036*	1.191 (0.110) 0.060+	1.193 (0.111) 0.057+
Closeness	1.804 (0.139) 0.000***	1.611 (0.131) 0.000***	1.621 (0.131) 0.000***
Frequency of contact	.687 (0.028) 0.000***	0.723 (0.034) 0.000***	0.723 (0.034) 0.000***
Core discussion network	1.459 (0.179) 0.002**	1.395 (0.176) 0.009**	1.410 (0.179) 0.007**
Practical helper network	1.055 (0.124) 0.064	0.899 (0.109) 0.385	0.905 (0.110) 0.420
Role relations (ref=family)			
Partner		1.617 (0.257) 0.003**	1.650 (0.263) 0.002**
Friends		0.574 (0.055) 0.000***	0.575 (0.055).000***
Work relations		0.386 (0.093) 0.000***	0.393 (0.095) 0.000***
Neighbors		0.716 (0.108) 0.028*	0.718 (0.109) 0.030*
Var (cons) Ego	1.128 (0.156)	1.178 (0.163)	1.172 (0.162)
Log likelihood	-2459.816	-2422.846	-2416.590

Note: *p < .05, **p < .01, ***p < .001. Loglikelihood empty model=−4062.877. N = 1925/1342 respondents with 7113/4113 network members in 2019 and 2020, respectively.

of practical helpers. On a scale from 1 to 5, the average closeness of the core discussion ties is very high with 4.75 (sd 0.39) and of practical helper ties somewhat lower with 4.3 (sd 0.54). The difference in closeness between both network parts is significant in both bivariate and multivariate tests.

New network members and network members who dropped out

Of all the alters mentioned in 2020, only 8 (0.4 %) were known for less than 2 months, implying that there were almost no new members who entered the network during the lockdown. This figure confirms the idea that people rely on network members they have already known. The data allow assessing the reasons why a specific alter has not been mentioned again after the relatively short period of approximately 12 months. Table 5 illustrates that many changes in personal networks occurred during the period of the COVID-19 rules (the two months before the interview). Although many alters who are not mentioned for a second time are 'just' forgotten, it holds in particular for the core discussion networks that many of the alters were not mentioned again because they were not met in the last two months; exactly the lockdown period preceding the data collection. For practical helpers, the role of 'forgetting' alters is even larger, but for this part of the network, the lockdown seems to play not such an important role. This could however still indicate that the persons met less often and therefore are forgotten. An analysis of the open answers to this question reveals that people often simply do not know why they no longer meet. Relationships seem just to fade away (cf. Tulin et al., 2021). In line with this, tie dissolution due to quarrels is very rare.

Of the 3968 core discussion ties mentioned in 2019, approximately 60 % were mentioned again. If it is accounted for the fact that many ties were initially forgotten to be mentioned but are still in the network with the same relational function, more than 70 % of the relationships are retained. The ties mentioned as 'forgotten' have been added to the networks in the analyses. For the network of practical helpers, figures are similar: initially, of the 3155 practical helper ties in 2019, 55 % were mentioned again; but accounting for the ties that were forgotten but still in the network, almost 70 % of the ties are stable. Importantly, however, a substantial number of ties (more than 30 % for the core discussion networks and 20 % of the practical helpers) were lost quite recently, at the time of the lockdown, which started on March 16, 2020. In addition, more than 50 % of the 'other reasons' mentioned, when inquiring into the reasons for not mentioning a contact again, are related to COVID.

Testing the hypotheses

Four hypotheses were formulated based on arguments from opportunity and resource theory and included specific expectations for the two age groups in the study. Table 6 examines the first three hypotheses, on the increased focus on stronger ties at the cost of weaker ties (H1), on local ties (H2), on the maintenance of resourceful ties (H3), and on the differences between the younger and the older generation (H1.1 and H2.1). Multilevel logistic regression models are estimated for the likelihood of alters to be mentioned again in the second wave.

Model 1 in Table 6 indicates that alters who are more closely connected to ego are significantly more likely to be mentioned in the second wave of measurement (OR=1.804). In line with this is the finding that network members who belong to the core network also have a higher chance of being retained (OR = 1.459). In addition, frequency of contact also matters in the sense that more frequent contacts are likely to be maintained. This confirms H1. However, H1.1 is refuted: there is no difference between our two samples. Model 2 in Table 6 tests the hypotheses that ties to neighbors became more important during the lockdown (H2) by including the types of role relationships in the model. Given that there are hardly any new network members included in the networks at the second measurement, H2 implies that neighbors have a

Table 7
Mixed-effect multilevel regression on loneliness (n = 1925/1342 respondents with 7113/4113 network members in 2019 and 2020, respectively).

	M1			M2		
Loneliness	Coefficient	(se)	P value	Coefficient	(se)	P value
Sample (younger)	0.387	0.778	0.618	0.752	0.829	0.360
Wave	0.989	0.147	0.000***	0.756	0.172	0.000***
Ego characteristics						
Sex (male)	1.617	0.371	0.000***	1.319	0.380	0.001**
Income	-0.802	0.211	0.000***	-0.798	0.214	0.000***
Living alone	1.322	0.376	0.000***	1.333	0.382	0.000***
Work situation (ref=paid job)						
In education	1.049	0.644	0.103	0.979	0.674	0.147
Retired	0.324	0.731	0.657	0.433	0.791	0.584
Homemaker	0.518	0.954	0.587	0.629	1.017	0.536
No job	2.051	0.653	0.002**	2.183	0.681	0.001**
Education	0.086	0.105	0.415	0.169	0.102	0.120
Live event between waves*	0.194	0.209	0.353	0.360	0.210	0.087
Reported health	-0.897	0.127	0.000***	-0.982	0.136	0.000***
Network characteristics						
Core discussion network				-0.334	0.091	0.000***
Practical helper network				-0.322	0.081	0.000***
constant	28.540	1.245	.000***	30.506	1.342	0.000***
Random effects						
Sd (cons)	5.330	0.136		5.176	0.144	
Sd (residual)	3.527	0.074		3.572	0.085	
Log Likelihood			-7308.224			-6363.538

Note: *p < .05, **p < .01, ***p < .001. Log Likelihood empty model = −10037.025.

Table 8
Changes in network size and loneliness (fixed effects estimation, n = 1925/1342 respondents with 7113/4113 network members in 2019 and 2020, respectively).

Loneliness	Coefficient	SE (robust)	t	p
Change in N core discussion network	-0.089	0.102	-0.87	0.383
Change in N practical helper network	-0.266	0.089	-2.98	0.003**
Wave (2019/2020)	1.04	0.274	3.79	0.000***
Older group#wave	-0.269	0.384	-0.70	0.483
constant	25.43	0.341	74.40	0.000
sigma_u	6.55			
sigma_e	3.46			
R2 (within)	0.052			

relatively high chance of being retained in the networks. However, the odds that neighbors are mentioned twice are low (OR = 0.716). This finding confirms the bivariate results presented in Table 3; neighbor relationships did not evolve during the lockdown. In fact, compared to family, all types of relationships are less likely to be mentioned twice, except for partner relationships. Once more, there are no differences between the older and the younger sample. Hence, H2 and H2.1 are not confirmed.

The third model in Table 6 tests our hypothesis (H3) on the importance of social resources. Ties to higher educated alters are expected to have a greater chance of being retained than ties that do not stand out in this regard. The model shows that alters who are less educated than the ego have a lower chance of being mentioned again (OR.282), compared to those who have the same educational level. This association is even stronger for more highly educated respondents (OR=1.257).

As to the characteristics of the respondents, it is remarkable, that those who loved are more likely to mention network members twice. Probably, people who lived alone were most careful in retaining their personal network.

Finally, we examine our fourth hypothesis on the relationship between social networks and loneliness: if networks decay, loneliness is expected to grow (H4). Table 7 summarizes our analyses in this regard. It presents a mixed effect model considering the two waves of measurement nested in individuals. The first model includes only respondent characteristics, and the second adds the two types of networks: the core discussion network and the practical helper network. Both models show that over time, loneliness has increased, indicated by the significance of the 'wave' coefficient. There is, once more, no difference between the samples. Furthermore, Model 1 shows that loneliness significantly increased for men, lower-income groups and for those without a paid job. People whose health is on average decreasing also feel lonelier. In the second model, the networks are included, and it shows that a decline in both types of networks is associated with greater loneliness. Model 2 adds networks to the analysis and reveals that decline in both core discussion networks, and the practical helpers' network is associated with increase in feelings of loneliness. In this model, however, within- and between-subject effects are entangled, and we cannot draw conclusions about network changes 'within' individuals. Therefore, a fixed effect model was estimated, as summarized in Table 8. The table shows that a within-subject decrease in the network of practical helpers is associated with increased feelings of loneliness, but the change in core discussion networks is not. Hence, Hypothesis 4 (H4) is confirmed, but we add that, in particular, the decrease in practical helper networks causes feelings of loneliness.

Conclusion and discussion

In 2020, COVID-19 became a pandemic, and in the Netherlands, like in many other countries, people lived for months in a lockdown situation, where practically all meeting places were closed. We collected network data in this period from two representative samples, a younger sample and an older sample, and compared these data to the networks of the same respondents in 2019, approximately one year before the crisis. More specifically, we examined changes in their networks of confidants with whom they discussed important matters and of people whom they would ask for help with a small practical job in or around the house. In addition, we examined whether people experienced greater loneliness during the lockdown and whether social networks played a role in explaining this loneliness. We explicitly formulated and tested four hypotheses on network changes due to the COVID-19 crisis. First, we expected that networks become more focused on stronger ties at the cost of weaker ties. Second, we expected that geographical closeness of a tie enhances the likelihood of being retained. Third, we argued that relations to alters with more resources were more likely to be retained and

that people of higher social strata were even more selective in this regard, and fourth, we expected that people whose networks decreased felt lonelier in 2020 than in 2019. In general, we also explored whether the lockdown had more extreme consequences for the younger generation.

Our findings support three of the four expectations. It is striking that even for those already relatively close networks, emotional closeness still predicted whether a person was mentioned again during the crisis. Persons seem to lean on those they were already close with, while weaker ties faded away (confirming H1). No differences between the two age groups, were found, though (H1.1. was not confirmed). In this sense, however, the internet and social media did not mitigate the effects of the pandemic. The younger generation, who is most capable of using modern communication techniques, did not keep their networks more intact by using these techniques. Of course, more in-depth research is needed to assess the effects of such modern communications.

We also expected that the meeting places that remained open such as the local neighborhoods would become a prominent place for interaction, but neighbor relationships were not more often retained and neither were new neighbor relations established, which refutes H2. Additionally, the resources of both the respondents and the network members themselves matter for retaining the network, which confirmed H3 and H3.1. The closing down of all kinds of meeting places made it difficult to establish new social contacts and resources. People were basically thrown back to their existing relations. However, network members with similar education than the respondent had a better chance to remain in the network when compared to network members with a lower educational level. This might be a sign that they are seen as more attractive for being retained in the network, hence ties to better educated alters are perceived as more beneficial.

Finally, it was hypothesized that network decay would enhance feelings of loneliness, which was confirmed by our analyses. The association between networks and loneliness holds for both groups of respondents. However, in particular the changes in the practical helper network, a network that consists of weaker ties than the core discussion network (Mollenhorst et al., 2009), are related to increased feelings of loneliness. Additionally, it was found that loneliness increased for groups who were already at the periphery of society. Those without a paid job, with poor health or with lower income were hit even more by the pandemic in their mental well-being.

The study has several limitations. First, the method of delineating networks via an online survey is not the optimal procedure and is less reliable than a face-to-face method of network delineation. Additionally, the method forced us to keep the questionnaire as short as possible, which restricted our opportunities to measure change. Furthermore, panel attrition in the study was approximately 30 %, and the number was higher for the respondents of the younger sample than for the older group. It would have been desirable to have larger groups of young and less educated people, as well as migrants. Additionally, related to the method is that we missed respondents who have no internet available in their homes. Although these are less than 3 % of all households, it would be important to know more about this group, since the consequences of the pandemic might be even more severe for these persons. Indeed, it has already been argued that social inequalities have been magnified by the pandemic (see Gauthier et al., 2021).

Second, we cannot prove that the changes we have found are caused by the COVID-19 crisis. We have no control group - there is no study measuring the same type of networks in the same period but in a situation without COVID-19, although there are important studies on network changes and tie dormancy, see, for example Fischer and Offer (2020), Marin and Hampton (2019). Several arguments make it plausible that the network changes found are related to the pandemic. First, the predicted changes are based on arguments on how people's networks would change in a lockdown situation, and most of the expectations were confirmed. Second, the findings are more in line with studies on social or natural crises than with studies on network evolution during the life course. Importantly, studies on network changes throughout one's life largely show that people retain the size and composition of their networks, while the network members change. Here, however, I found that network sizes and composition changed while almost no new network members joined the network.

Overall, the paper showed that the focus of people's attention during the crisis is on the closest network members. When the situation normalizes and meeting places open again, this pattern of 'network lockdown' might have long-term consequences. People might feel unused to engage with strangers or more weaker ties in general. They also might keep the distance for a while since weaker ties might stay associated with a higher risk of getting infected with a disease.

It is striking that experiences of loneliness are deepened by the loss of practical helpers. These are the persons who are usually available immediately and who enter the home, which has become difficult during COVID-19. Networks of practical helpers usually consist of neighbors and are generally weaker than members of core discussion networks (Fischer, 1982; Mollenhorst et al., 2014). Future research must shed light on the question of whether feelings of loneliness are caused by the nature of a tie of being weak or by the function of providing practical help.

Finally, what do our findings imply for the theoretical arguments about opportunity structures and individual preferences? Of course, one cannot escape from opportunity structures, or, as coined in the one-liner by Peter Blau (1977), 'you cannot marry an Eskimo if no Eskimo is around'. On the one hand, our results show that if the opportunities for meeting weaker ties were minimized people stick to their stronger ties. However, people from meeting places that were still open, such as in local neighborhoods, did not gain importance. Additionally, people made choices due to their preferences, which we assumed to be preferences for more resourceful others. Notably, making use of the opportunities for meeting others that were still available might mitigate the increase in loneliness, but people did not act in this way. Hence, the results can be interpreted as an indication that opportunities do not always override preferences.

To conclude, the lockdown rules forced people into their small circles of strong ties, which are important for providing comfort and understanding but are not appropriate for developing new horizons. This happened at the cost of weaker ties, though, and the increase in feelings of loneliness is experienced before all if these weaker ties got out of sight during the crisis. It is likely that even when COVID-19 is under control, weak ties might still be kept at a distance since their past activities are not exactly known. For the same reason, people will probably remain wary of making new contacts, since the alleged risk through contacts with strangers might take time to vanish.

It is an early lesson from the literature on social networks that weaker ties are particularly related to novelty, diversity, and innovation (cf. Granovetter, 1973) and, importantly, also to social cohesion and solidarity. Losing others who are more distant and out of sight decreases understanding of their social worlds and might enhance polarization. The heated debate in many societies about vaccination, covid rules or other issues, fits with these thoughts. Given the possible relationship between the decay of weaker ties with closed mindedness, decreasing tolerance, and diminishing social solidarity, one can only hope that the pandemic quickly comes to an end and the world, our networks, and minds will open again.

Appendix A

Loneliness scale items.

1) There is always a person I can turn to with my daily niggles.
2) I miss a good friend.
3) I feel emptiness around me.
4) There are enough people who stand by me in case of trouble.
5) I miss sociability and coziness.
6) I find my social circle too limited.

Table A1
Life events between 2019 and 2020 and emotions related to the covid crisis.

Life events between 2019 and 2020	n	%
No changes	798	60.3
Changes:	526	39.7
of which:		
Moving in together	81	15.3
Married/new partner	9	1.7
Birth of (grand)child	70	13.3
Child leaving home	3	0.6
Person joined /child moved in with parents	12	2.3
Death in circle of close contacts	74	14.0
Illness (self or network member)	44	8.4
Divorce (self or in close circle)	9	1.7
Change of work	92	17.4
Retirement	29	4.9
Moving	77	14.6
Other	26	4.9
Emotions relation to Covid-19		
Much/very much:		
Afraid of infection	373	27.8
Afraid that loved ones could be infected	715	53.4
Feeling more connected with society because of corona	432	32.4
Feeling more cohesion in neighborhood	467	35.1
Being convinced that crisis will be mastered	1087	81.9
Actively maintaining social contacts (despite measures of social distancing)	957	71.6

Table A2
Regression of respondent characteristics and network size in 2019 on panel attrition.

	B (SE)	OR	P value
Sample (Young)	1.035 (0.117)	2.810	0.001***
Sex (men)	-0.196 (0.115)	0.088	0.822
Number of persons in household	0.149 (0.047)	1.161	0.001***
Education (University or higher)			
Primary	0.613 (0.298)	1.824	0.040*
Lower vocational	-0.107 (0.229)	0.898	0.639
Vocational	0.486 (0.218)	1.625	0.026*
Higher vocational	0.120 (0.223)	1.127	0.591
Secondary (pre-university)	0.059 (0.171)	1.061	0.730
University of applied sciences	0.083 (0.152)	1.086	0.591
Core network size	-0.066 (0.035)	0.937	0.062
Network size of practical helpers	-0.057 (0.038)	0.944	0.109
Constant	-1.370 (0.204)	0.254	0.001
R2 (adjusted)	0.11		

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

Table A3
Size of core discussion network and network of practical helpers before (May 2019, n = 1925) and during covid-19 (May 2020, n = 1342).

	Core discussion network		Practical helper network	
	2019 (%)	2020 (%)	2019 (%)	2020 (%)
Network size				
0	15.5	20.4	12.9	27.6
1	9.7	9.6	23.0	22.1
2	12.9	12.9	19.2	20.2
3	16.6	18.4	19.6	16.3
4	15.6	14.9	11.5	7.0
5	29.6	23.8	13.8	6.7
Mean	2.96	2.69	2.35	1.73
SD	1.80	1.80	1.59	1.51

7) I have many people who I can trust completely.
8) There are enough people to who I feel really close.
9) I miss others around me.
10) I often feel that others are letting me down.
11) If I am in need, I have friends to turn to.

Table A4
fixed effect model on changes in core discussion network and network of practical helpers (n = 1924 in 2019 and 1342 in 2020).

	Core discussion network		Network of practical helpers	
	Coeff (sd)	z value	Coeff. (sd)	z value
Younger sample	0.699 (0.081)	8.54***	0.559 (0.070)	7.94***
Wave	-0.164 (0.062)	-2.61**	-0.542 (0.060)	-9.00***
Sample (younger) *wave	-0.234 (0.101)	-2.32*	-0.141 (0.096)	-1.47
constant	2.640 (0.055)	48.03***	2.090 (0.047)	44.34***
Log likelihood	-6386.386		-5979.230	
Sd (constant)	1.19 (0.037)		0.845 (0.038)	
Sd (residual)	1.32 (0.025)		1.28 (0.024)	

See Tables A1-A4.

The items nr. 6, 9 and 10 were omitted from the questionnaire in 2020.

References

Baarsen van, B., Broese van Groenou, M., 2001. Partner loss in later life: gender differences in coping shortly after bereavement. J. Loss Trauma 6 (3), 243–262.

Baarsen van, B., Smit, J.H., Snijders, T., Knipscheer, K., 1999. Do personal conditions and circumstances surrounding partner loss explain loneliness in newly bereaved older adults? Ageing Soc. 19 (4), 441–469.

Bidart, C., Lavenu, D., 2005. Evolutions of personal networks and life events. Soc. Netw. 4 (27), 359–376.

Blau, P., 1977. Inequality and heterogeneity: a primitive Theory of Social Structure. Free Press, New York.

Bu, F., Steptoe, A., Fancourt, D., 2020. Loneliness during a strict lockdown: Trajectories and predictors during the COVID-19 pandemic in 38,217 United Kingdom adults. Soc. Sci. Med. 265, 113521 https://doi.org/10.1016/j.socscimed.2020.113521.

Burt, R.S., 1999. Entrepreneurs, distrust, and third parties: a strategic look at the dark side of dense networks. Shared cognition in organizations. Psychology Press,, pp. 213–244.

Burt, R.S., M. Kilduff, M., Tasselli, S., 2013. Social network analysis: foundations and frontiers on advantage. Annu. Rev. Psychol. 64, 527–547.

De Jong Gierveld, J., Kamphuis, F.H., 1985. The development of a Rasch-type loneliness scale. Appl. Psychol. Meas. Q 289–299.

De Jong Gierveld, J., Van Tilburg, T., Dykstra, P.A., 2006. Loneliness and social isolation. Cambridge Handbook of Personal Relationships. Cambridge University Press, pp. 485–500.

Dykstra, P.A., 1990. Next of (non) kin: the importance of primary relationships for older adults' well-being. Swets & Zeitlinger Publishers.

Elliott, J.R., Haney, T.J., Sams-Abiodun, P., 2010. Limits to social capital: Comparing network assistance in two New Orleans neighborhoods devastated by Hurricane Katrina. Sociol. Q. 51 (4), 624–648.

Ellwardt, L., van Tilburg, T., Aartsen, M., Wittek, R., Steverink, N., 2015. Personal networks and mortality risk in older adults: a twenty-year longitudinal study. PloS One 10 (3), e0116731.

Elmer, T., Mepham, K., Stadtfeld, C., 2020. Students under lockdown: assessing change in students' social networks and mental health during the COVID-19 crisis. Plos One 15 (7), e0236337.

Fischer, C., 1982. To Dwell Among Friends: Personal Networks in Town and City. University of Chicago Press, Chicago.

Fischer, C.S., Offer, S., 2020. Who is dropped and why? Methodological and substantive accounts for network loss. Soc. Netw. 61, 78–86.

Flap, H., Völker, B., 2013. Social Capital. Pp 220-251. In: Wittek, R., Snijders, T., Nee, V. (Eds.), The Handbook of Rational Choice Social Research. Stanford University Press, Stanford.

Forgette, R., Dettrey, B., Van Boening, M., Swanson, D.A., 2009. Before, now, and after: assessing Hurricane Katrina relief. Popul. Res. Policy Rev. 28 1, 31–44.

Gauthier, G.R., Smith, J.A., Garcia, C., Garcia, M.A., Thomas, P.A., 2021. Exacerbating Inequalities: social networks, racial/ethnic disparities, and the covid-19 pandemic in the Unites States. J. Gerontol. 76 (3), e88–e92.

Granovetter, M., 1973. The strength of weak ties. Am. J. Sociol. 6 (87), 1360–1380.

Guiaux, M., Van Tilburg, T., Broese van Groenou, M., 2007. Changes in contact and support exchange in personal networks after widowhood. Pers. Relatsh. 14 (3), 457–473.

Hoffart, A., Johnson, S.U., Ebrahimi, O.V., 2021. Loneliness during the COVID-19 pandemic: change and predictors of change from strict to discontinued social distancing protocols. Anxiety, Stress, Coping. https://doi.org/10.1080/10615806.2021.1958790.

Hurlbert, J.S., Haines, V., Beggs, J.J., 2000. Core networks and tie activation: What kinds of routine networks allocate resources in nonroutine situations? Am. Sociol. Rev. 65, 598–618.

Hurlbert, J.S., Beggs, J.J., Haines, V.A., 2001. Social networks and social capital in extreme environments. In: Lin, N., Cook, K., Burt, R. (Eds.), Social Capital: Theory and Research. Routledge, Londen, pp. 209–231.
Islam, R., Walkerden, G., 2014. How bonding and bridging networks contribute to disaster resilience and recovery on the Bangladeshi coast. Int. J. Disaster Risk Reduct. 10, 281–291.
Kalmijn, M., 2012. Longitudinal analyses of the effects of age, marriage, and parenthood on social contacts and support. Adv. Life Course Res. 17 (4), 177–190.
Kawachi, I., Berkman, L.F., 2001. Social ties and mental health. J. Urban Health 78 (3), 458–467.
Kim, J.K., Crimmins, E.M., 2020. How does age affect personal and social reactions to COVID-19: Results from the national Understanding America Study. PLoS One 15 (11), e0241950.
Klinenberg, E., 2015. [2002]. Heatwave. A social autopsy of disaster. In: Chicago. The University of Chicago Press, Chicago and London.
Kovacs, B., Caplan, N., Grob, S., King, M., 2021. Social networks and loneliness during the COVID-19 pandemic. Socius. https://doi.org/10.1177/2378023120985254.
Lammers, C.J., 1955. *Survey of Evacuation Problems and Disaster Experiences*. In: Studies in Holland Flood Disaster, Vol.II. Institute for Social Research, Amsterdam.
Leonard, R., Onyx, J., 2003. Networking through loose and strong ties: an Australian qualitative study. Volunt.: Int. J. Volunt. Nonprofit Organ. 14 (2), 189–203.
Lin, N., 2001. Building a network theory of social capitral. Pp2–28. In: Lin, N., Cook, K., Burt, R. (Eds.), Social capital. Theory and Research. Aldine de Gruyter, New York.
Lin, N., 2002. Social Capital: A Theory of Social Structure and Action. Cambridge University Press.
Luchetti, M., Lee, J.H., Aschwanden, D., Sesker, A., Strickhouser, J.E., Terracciano, A., Sutin, A.R., 2020. The trajectory of loneliness in response to COVID-19. Am. Psychol. 75 (7), 897–908.
Maffly-Kipp, J., Eisenbeck, N., Carreno, D.F., Hicks, J., 2021. Mental health inequalities increase as a function of COVID-19 pandemic severity levels. Soc. Sci. Med. 285, 114275.
Marin, A., Hampton, K.N., 2019. Network instability in times of stability. Sociol. Forum 34 (2), 313–336.
Marsden, P., 1987. Core discussion networks of Americans. Am. Sociol. Rev. 1, 122–131.
Messias, D., Barrington, C., Lacy, E., 2012. Latino social network dynamics and the Hurricane Katrina disaster. Disasters 36 (1), 101–121.
Mollenhorst, G., Völker, B., Schutjens, V., 2009. Neighbour relations in the Netherlands – a decade of evidence. Tijdschr. voor Econ. En. Soc. Geogr. 4 (100), 549–558.
Mollenhorst, G., Völker, B., Flap, H., 2014. Changes in personal relationships: How social contexts affect the emergence and discontinuation of relationships. Soc. Netw. 37, 65–80.
Morgan, D.L., March, S.J., 1992. The impact of life events on networks of personal relationships: a comparison of widowhood and caring for a spouse with Alzheimer's disease. J. Soc. Pers. Relatsh. 9 (4), 563–584.
National Institute for Public Health and the Environment (RIVM, 2022) Mortality dashboard. Retrieved from ⟨https://coronadashboard.government.nl/landelijk/sterfte⟩ on April 8, 2022.
Nauta, L.W., Van, Strien.P.J., 1955. A Study of Community Re-Integration. In: Studies in Holland Flood Disaster, Vol. III,. Institute for Social Research, Amsterdam.
Otero, G., Völker, B., Rözer, J., 2021. Open but segregated? Class divisions and the network structure of social capital in Chile. Soc. Forces 100 (2), 649–679.
Peters, A., Liefbroer, A.C., 1997. Beyond marital status: Partner history and well-being in old age. J. Marriage Fam. 59 (3), 687–699.
Philpot, L., Ramar, P., Roellinger, D.L., Barry, B.A., Sharma, P., Ebbert, J.O., 2021. Changes in social relationships during an initial "stay-at-home" phase of the COVID-19 pandemic: a longitudinal survey study in the U.S. Soc. Sci. Med. 274, 113779 https://doi.org/10.1016/j.socscimed.2021.113779.
Quarantelli, E.L., Dynes, R.R., 1977. Response to social crisis and disaster. Annu. Rev. Sociol. 3, 23–49.
Rabe-Hesketh, S., Skrondal, A., 2012. Multilevel and Longitudinal Modeling Using Stata. Stata Press Publication, Texas.
Rosales, A., Fernández-Ardèvol, M., 2016. Beyond WhatsApp: older people and smartphones. Rom. J. Commun. Public Relat. 18 (*1*), 27–47.
Rosenfeld, A., Sina, S., Sarne, D., Avidov, O., Kraus, S., 2018. WhatsApp usage patterns and prediction of demographic characteristics without access to message content. Demogr. Res. 39, 647–670.
Rumas, R., Shamblaw, A.L., Jagtap, S., Best, M.W., 2021. Predictors and consequences of loneliness during the COVID-19 pandemic. Psychiatry Res. 300, 113934 https://doi.org/10.1016/j.psychres.2021.113934.
Sandstrom, G.M., Dunn, E.W., 2014. Social interactions and well-being: the surprising power of weak ties. Personal. Soc. Psychol. Bull. 40 (7), 910–922.
Shavit, Y., Fischer, C.S., Koresh, Y., 1994. Kin and nonkin under collective threat: Israeli networks during the gulf war. Soc. Forces 72 (4), 1197–1215.
Silverstein, M., Chen, X., 1996. Too much of a good thing? Intergenerational social support and the psychological well-being of older persons. J. Marriage Fam. 58, 970–982.
Son, J., 2020. Social Capital. Wiley. Series 'Key Concepts'. Polity Press, New York.
Song, L., Chang, T.Y., 2012. Do resources of network members help in help seeking? Social capital and health information search. Soc. Netw. 34 (4), 658–669.
Statistics Netherland (CBS, 2020b) Internet: toegang, gebruik en faciliteiten, 2012–2019. [Internet: access, use and facilities, 2012–2019], retrieved from ⟨https://www.cbs.nl/nl-nl/cijfers/detail/83429NED?dl=27A20⟩ on April 8, 2022.
Statistics Netherlands (CBS 2020a) More elderly active on social media. Retrieved from ⟨https://www.cbs.nl/en-gb/news/2020/04/more-elderly-active-on-social-media⟩. On April 8, 2022.
Stets, J.E., Burke, P.J., 2003. A sociological approach to self and identity. Pp128-135, in M. Leary and J. Tangney, Handbook of self and identity. Guilford Press,, New York.
Suter, L., Birkland, T., Larter, R., 2009. Disaster research and social network analysis: examples of the scientific understanding of human dynamics at the National Science Foundation. Popul. Res. Policy Rev. 28 (1), 1–10.
Tibbetts, M., Epstein-Shuman, A., Leitao, M., Kushlev, K., 2021. A week during COVID-19: online social interactions are associated with greater connection and more stress. Comput. Hum. Behav. Rep. 4, 100133 https://doi.org/10.1016/j.chbr.2021.100133.
Tulin, M., Mollenhorst, G., Völker, B., 2021. Whom do we lose? The case of dissimilarity in personal networks. Soc. Netw. 65, 51–62.
Van de Bunt, G., van Duijn, M., Snijders, T., 1999. Friendship networks through time: an actor-oriented dynamic statistical network model. Comput. Math. Organ. Theory 5 (2), 167–192.
Van Tilburg, T.G., 1990. The size of the supportive network in association with the degree of loneliness. In: Knipscheer, K., Anonucci, C. (Eds.), Social Network Research: Substantive Issues and Methodological Questions. Lisse, Swets & Zeitlinger, pp. 137–150.
Varda, D.M., Forgette, R., Banks, D., Contractor, N., 2009. Social network methodology in the study of disasters: issues and insights prompted by post-Katrina research. Popul. Res. Policy Rev. 28 (1), 11–29.
Vassilev, I., Rogers, A., Sanders, C., Kennedy, A., Blickem, C., Protheroe, J., Bower, P., Kirk, S., Chew-Graham, C., Morris, R., 2011. Social networks, social capital and chronic illness self-management: a realist review. Chronic Illn. 7 (1), 60–86.
Völker, B., 2019. Pass it on? The age divide in personal networks. Presentation at the XXXIX Sunbelt Social Network Conference, June 18–23, Montreal, Canada.
Völker, B., 2021. Three decades of research into social capital. Achievements,blind spots and future directions. Pp 296-322. In: Small, M., Perry, B., Pescosolido, B., Smith, E. (Eds.), Personal Networks. Classic Readings and New Directions in Egocentric Analysis. Cambridge University Press, Cambridge, UK.
Völker, B., Flap, H., 2001. Weak ties as a liability: the case of East Germany. Ration. Soc. 13 (4), 397–428.
Völker, B., Flap, H., 2007. Sixteen million neighbors: a multilevel study of the role of neighbors in the personal networks of the Dutch. Urban Aff. Rev. 43 (2), 256–284.
Wald, C., 2016. Better together. Nature 531 (7592), S14–S15.
Wrzus, C., Hänel, M., Wagner, J., Neyer, F.J., 2013. Social network changes and life events across the life span: a meta-analysis. Psychol. Bull. 139 (1), 53–80.
Yang, K., 2018. Causal conditions for loneliness: a set-theoretic analysis on an adult sample in the UK. Qual. Quant. 52 (2), 685–701.
Yang, K., Victor, C., 2011. Age and loneliness in 25 European nations. Ageing Soc. 31, 1368–1388.