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How did COVID-19 Influence the Social Network of the Elderly?

: focusing on income-group difference

코로나-19가 노인의 사회적 관계망에 미친 영향

: 소득 집단 간 차이를 중심으로

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이 휘 영

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Abstract

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One pivotal element, which distinguishes the COVID-19 pandemic and other social shocks, is that the pandemic has directly hindered and reshaped the social life without leaving out a single person. Though many of the negative individual outcomes have been suspected to be associated with the significant decline of social networks, few studies have examined how social networks have been influenced by the shock. Considering that older adults are one of the most hard hit population, this void of knowledge can be especially alarming.

The study aims to address three research questions: (i) to what extent did the social networks, namely kin ties and non-kin ties, of Korean older adults changed after the outbreak of COVID-19? (ii) within the configuration of social network of the elderly, which type of network, among kin and non-kin network, will remain relatively robust and which type will weaken after the shock of COVID-19? (iii) is there any disparity in the changes of social networks between the lower income and the upper income groups?

In order to answer these questions, I take one of quasi-experimental approaches, namely difference-in-differences analysis, using National Survey of Older Koreans data. The statistical results show that the shock of COVID-19 decreased the probability to meet children or non-kin once or more a week by 12.2 percent point and 12.9 percent point respectively.

While the sizes of decrease in the two types of network were not significantly different, the probability to meet children once or more a week and the probability for non-kin were 16.6% and 71.0% respectively in 2020, which cast huge doubt on the saliency of kin network of the elderly. Regarding the inter-group divergence of the network configuration between upper income group and lower income group, results indicated that the loss of kin network was relatively greater for lower income group and the loss of non-kin network was relatively greater for upper income group.

keywords : Social network, older adults, COVID-19, kinship, inequality, difference in differences

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Ⅰ. Introduction

One pivotal element, which distinguishes the COVID-19 pandemic and other social shocks, is that the pandemic has directly hindered and reshaped the social life without leaving out a single person. Its economic impact was indeed considerable, as some of the index were compared to those during the Great Depression. In many countries, unemployment rate skyrocketed and wage income plummeted by the figures which looked "almost fantastical" (Susskind & Vines, 2020, p. S5). Yet, considering it was the first time to adopt various physical distancing measures from closures of school and non-essential business to total lockdown, how the pandemic reshaped social life is what actually deserves more attention. People were told, and mandated, by the government to "stay at home". Students met their classmates through computer screens, workers were told to work full-time at home, group gatherings were not allowed, and travels were not an option either. Social life, to an unprecedented extent to most of us, came to a virtual standstill during the pandemic.

Then our next question is: what should be a crucial element in understanding social life? There is a long tradition in science research of focusing the relationships between objects rather than highlighting the individual characters or behaviors themselves. The kind of research which attempts to investigate the links among the objects is called structural. This structural approach covers a large array of objects in science. They can

be planets in the solar system in astrophysics, atoms interacting with each other in molecular chemistry, and animal species of an ecosystem in biology.

In social science, the structural approach is based on the study of relations and interactions among social actors, which are social networks or social ties. As a Columbia University sociologist, Allen Barton (1968, p. 1), wrote, "If our aim is to understand people's behavior rather than simply to record it, we want to know about primary groups, neighborhoods, organizations, social circles, and communities." This view of prioritizing the connections in which an actor is embedded is not just a theoretic groundwork for structural researchers, but it is also grounded in the intuitive notion that how personal ties are distributed and patterned has significant consequences for people (see Freeman, 2004). One of the oldest examples is the list illustrated in the Bible, where there is a completely separate section dedicated to list the personal relationships which reach to its end.

The downturn of social life or social networks is expected to have great impacts on the well-being of people; in fact, there are few things which are not relevant to how one is connected to others. Like the notion of social networks appreciates interconnectedness of people, elements which constitute the well-being of people is intimately and deeply connected to the notion of social networks. Over decades, a wide array of research has confirmed how social networks can benefit physical and mental health (Cornwell & Laumann, 2015'

Kawachi & Berkman, 2001) and building social networks is known to enhance life satisfaction (Lim & Putnam, 2010). A more recent studies even demonstrates how network is associated with human brain functioning at later life period (Youm et al., 2021). Furthermore, during disasters, social networks have been documented to provide emotional and social support, mutually deliver material and financial assistance, and serve as a crucial buffer (Edin & Lein, 1997; Hendersen, 1977; Henly, Danziger, & Offer, 2005; Messias, Barrington, & Lacy, 2012). These findings clearly demonstrate that the significance of personal networks cannot be more emphasized in addressing both micro and macro social work problems.

Considering how social network is deeply interwound with individual's welfare, the shock of COVID-19 would have had detrimental impact not only through observable and direct manner, but also through submerged channel of deteriorating social network. It is already suggested that the decline of mental health and the sharp increase of depressive syndrome and substance use can be attributed to the sudden halt of social life (Litwin & Levinsky, 2022; Panchal et al;, 2020; Racine et al., 2021).

However, very few studies can be found which investigate how social networks were affected by COVID-19 pandemic in Korea. Such void of knowledge can be especially alarming, as it can lead to the double negligence of marginalized population at risk. For instance, using social contact data in Canada, Drolet and her colleagues (2022)

reported that Canadian older adults above the age of 65 had virtually no contact outside the house during the pandemic, while we scarcely know how social life of Korean adults were during the pandemic.

This study aims to fill this scholarly void by investigating how the social networks of older adults, one of the most hard hit population by the shock, have changed after the outbreak of COVID-19 in Korea. Most of existing studies which examined the change of social network in other countries conducted the analysis by stratifying the entire population by age (Backer et al., 2021; Drolet et al., 2022; Gimma et al., 2022). The novel feature of this research is that the inter-group changes of social network between upper and lower income groups are examined and compared. It has been consistently suggested that the resource of social network is stratified across different classes within a society (Lin, 1999). Moreover, people with lower socioeconomic status face considerably greater pressure during large-scale exogenous shocks and disasters, despite their heavier dependency on supports and resource derived from social network (Eisenman et al., 2007; Klinenberg, 1999; Messias, Barrington, & Lacy, 2012).

It is, therefore, imperative to investigate the change of social networks in general population, but also to further examine whether there had been disparate patterns in the change of social networks between those in the upper side of economic ladder and those in the lower under the wave of COVID-19. In addition, in estimating the change of social

network of the elderly, this study focuses on how different types ties - namely kin ties and non-kin ties - varied between periods. As studies are increasingly highlighting the relatively less visited role of non-kin ties of older adults recently, relations with people who are out of the familial boundary should be included and separately examined in the network study of the elderly population (Lapierre & Keating, 2012).

Specifically, this study has three purposes: 1) to examine how the social networks of the elderly people have been changed after the outbreak of COVID-19, 2) to examine the divergence in kin ties and non-kin ties within a social network of the elderly during the shock, 3) and to illuminate the differing impacts between the higher income and the lower income elderly groups.

In what follows, I first discuss the theoretical background of social network and review some of the classic works done by previous scholars. Although most of empirical studies on social network nowadays rarely discuss theoretical concepts (Small et al., 2021), it would be an useful starting point that we construe how different scholars contributed to the understanding of social networks and how their contributions influenced network studies of today. Next, the divergence in different types of ties(i.e. kin ties and non-kin ties) and the divergence in the features of social network across different income groups are discussed.

Then, using National Survey of Older Koreans data, I

estimate to what extent did the social networks of the Korea elderly change after the outbreak of COVID-19. I turn to quasi-experimental framework to estimate the change of social networks. Following previous research on the impact of COVID-19 (Chen, Qian, & Wen, 2021; Lee & Hong, 2021), in order to capture counterfactual change of patterns of social network, I use observations in 2011-2014 period as the benchmark group. The difference-in-differences(DID) regression will be conducted for the entire data sample, and the two income groups(upper and lower income groups) respectively. I also employ triple interaction term to statistically test whether the two groups had significantly different patterns of change. Additional tests are conducted to assess the robustness of the estimation. Finally, theoretical implications and suggestions for social policy is discussed.

The results from the statistical analysis can be briefly summarized as follows. First, the probability of older adults to meet chilrden once or more a week and the probability to meet non-kin once or more a week both significantly decreased after COVID-19. Second, non-kin ties showed saliency among Korean elderly regardless of their economic status. Third, divergence in kin and non-kin ties between the different income groups was statistically significant, with the lower income group showing smaller decrease of non-kin ties.

Ⅱ. Theoretical Background and Literature Review

2.1. Theoretical Foundation of Social Networks

Network is one of the most widely used concepts in all social sciences over decades. At a practical level, the notion of network was conceived to capture rapid changes in real world. The emergence of network society called for theoretical foundations of social network. At the same time, at a theoretical dimension, the flexibility of its concept captivated scholars with its broad applicability. As an extremely versatile notion, network was expected to dodge the rigidity of structuralism. Though both highlight patterns, relationship, fabric or ties among individuals and groups, network theory was considered not to show rigidity or ideological dogmas, compared to the traditional structural approach. Scholars who had different backgrounds and interests have put their respective efforts to depict how social lives and relations between people can achieve distinctive patterns and outcomes (Small et al., 2021). While some theorists were strongly appealed by the absence of strong ideological bias in network theory, other scholars who had their focus on research methods favored it as an analytical tool.

Portes (1998) points out three reasons in understanding why social networks, or social capital, have captured interests

from authors across different fields. First, the concept emphasizes the beneficial results of sociability while putting aside its less desirable characteristics. Second, it facilitates broader discussions on how such non-material and non-monetary form can bring crucial resource and influence. Third, its fungibility was able to minimize the distance between various perspectives and fields, as we can see how social capital is examined in the body of literature of social welfare, economics, and sociology.

Portes' view contributes to the understanding of rich development of network research as a whole. However, at the same time, the adaptability of the concept make the notion so diverse that it is hard to find a single generally accepted common vocabulary among different approaches (DiMaggio & Garip, 2012). Words such as social networks, social capital, personal ties, and egocentric network are used interchangeably in order to signify similar meaning with different emphasis, all under the same hood of network research, which is due to the multiple theoretic foundations of the area.

As it is not possible to trace its theoretical development through a single line of path, nor is it advisable to do so, here I introduce some major theoretical works which are thought to have made crucial theoretic contribution to network research of today (Portes, 1998; Small et al., 2021).

The first thinker who directly and systematically informed the network research as it is done today is German sociologist Georg Simmel. Focusing on the meaning of

modernity, in his *Web of Group Affiliations*, Simmel (1997) stated that the reason people associate with others had changed from "organic" criteria - such as kinship and village community - to "rational" interests - such as occupations and clubs. While ties and gatherings in the former era presented strong sense of self and, at the same time, fears towards outsiders and limited mobility and information, those in the latter era allowed belongings to multiple associations, which produced a web of affiliations. Simmel suggested that social relations in the premodern era can be described as a set of concentric circles, while the modern form of relations resemble a set of intersecting circles.

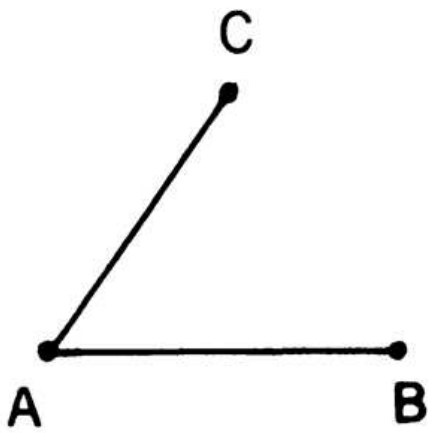
The idea served as an intellectual basis for what is now known as a two-mode network, where people are interconnected to one another by the means of their membership in common associations (Breiger, 1974). It also inspired future scholars to understand that people simultaneously engage in many overlapping social circles which are constructed through different contexts - such as family, work, and neighborhood - and common activities, such as social clubs and sports teams.

From this perspective of Simmel, because the focal person may be the only point of intersection in the personal social network structure, we can direct our interest to the person(or ego) who is located in the center of the complex network structure. This is why network studies of today are called egocentric analysis (Small et al., 2021).

A more contemporary source and arguably one of the most prominent and cited works within the body of empirical network research was done by Mark Granovetter. In his classical work *The Strength of Weak Ties*, Granovetter (1973) defined "the strength of a tie is a (probably linear) combinations of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (p. 1361), and argued that we can categorize a given tie as strong, weak, or absent. As a mathematical sociologist, he describes his idea with a simple picture of a triad. In the triad, nodes with alphabets are selected individuals and the lines signifies there exists strong or weak ties between different persons.

He illustrates the concept of "bridge", which is "a line in a network which provides the only path between two points". For instance, in figure 1, line A-B is a bridge, in that A or B cannot meet each other with other paths which involve C. Then, one theoretical assumption is made that, given the other two connections are strong ties(line A-C and line A-B), the triad shown in figure 1 never occurs, because eventually person B and C will be in contact through the already existing strong ties. Granovetter (1973, p. 1364) put it, "[E]xcept under unlikely conditions, no strong tie is a bridge. Consider the strong tie A-B: if A has another strong tie to C, then forbidding the triad of [the figure] implies that a tie exists between C and B, so that the path A-C-B exists between A and B; hence, A-B is not a bridge.

< Figure 1> Triad from Granovetter(1973, p. 1363)



A strong tie can be a bridge, therefore, only if neither party to it has any other strong ties, which is unlikely in a social networks of any size (though possible in a small group). Weak ties suffer no such restriction, though they are certainly not automatically bridges. What is important, rather, is that all bridges are weak ties" (Granovetter, 1973, p. 1364). Since bridges in a network can create paths to more heterogeneous people with shorter path, he emphasized that weak ties play a crucial role in accepting novel changes and innovative ideas. He wrote, "Intuitively speaking, this means that whatever is to be diffused can reach a larger number of people, and traverse greater social distance (i.e., path length), when passed through weak ties rather than strong." (Granovetter, 1973, p. 1366).

Granovetter's work has had great influence on research of diffusion studies and network effect (DiMaggio & Garip, 2012). It provided theoretical explanation to older studies which

examined that innovations often occured in marginal sectors (Becker, 1970), how information is spread via mass-media (Rogers, 1962), and why "people receive crucial information from individuals whose very existence they have forgotten" (Granovetter, 1973, p. 1372). Moreover, myriads of evidence after Granovetter's study corroborated how networks between people or entities can diffuse benefits, or even adverse effects.

Calvo-Armengol and Jackson (2004) provide elaborate observation on how exogenously provided job information is passed among members in a network and suggest that a person's probability of learning and potentially taking a job increase as the percentage of already employed friends - or *alters* in network research term - increases. Employing cross-national analysis of product diffusion, Van den Bulte and Stremersch (2004) report that network effect had greater influence on adoption of a product than exogenous events, such as external shocks or marketing campaigns. It also known that the winner among competing technologies(e.g. Mac versus Windows, Lotus versus Excel) is often not the one with technological superiority, but the one which is able to spread itself among user networks faster and more efficiently (Brynjolfsson & Kemerer 1996). On the other hand, a large number of studies on criminology and adolescent behavior also demonstrate how diffusional mechanisms among peers and friends can convey negative effects, such as criminal behavior, drug abuse, and incarceration (Duncan et al., 2005; Elliott & Menard, 1996).

What is ironically interesting in exploring the legacy of Granovetter's work is that though his emphasis was heavily put on the seemingly weak ties, his influence often has rather worked in an opposite direction, inspiring future researchers to focus on strong ties. While Granovetter highlighted the role of weak ties in the diffusion of information, later scholars noted on the benefits which are derived from strong ties, such as prevention of isolation and emotional support.

The contribution of Granovetter is considered to be instrumental. In addition to some of the related studies on network effect introduced here, his idea on the strength of tie served as theoretical foundation for most of the social survey items regarding social network (Burt, 1984).

Furthermore, his classification of ties, based on strength, remains as one of the most effective analytical instrument in social network studies and has been consistently revisited by later scholars. For example, Lin (1999, p. 472) furthered the idea and suggested that the strength of ties "be measured either with a perceived strength(e.g. intimacy of relationship) or a role category(e.g. kin, friends, and acquaintances)". In his well-designed study, Small (2013) shows that, in contrary to wide spread intuition and theoretical assumption in academic research which had not been tested empirically, people's core discussion group is composed with a large portion of weak ties. Some of the items in the survey study which this paper employs also ask respondents to answer about ties based on their strength, as it will be discussed in the later section.

Lastly, a French thinker who took an in-depth look into the role of social networks to function as one form of resource is Pierre Bourdieu. His understanding of the concept is instrumental, which separates his concentration on personal ties from those of the thinkers we discussed above. According to Bourdieu, individuals participate in groups and deliberately construct sociability due to the accruing benefits of social connections. He wrote, "the profits which accrue from membership in a group are the basis of the solidarity which makes them possible" (Bourdieu 1986, p. 249).

Therefore, it was inevitable for Bourdieu to apprehend social networks as capital, "a accumulated labor (in its materialized form or its 'incorporated,' embodied form) which, when appropriated on a private, i.e., exclusive, basis by agents or groups of agents, enables them to appropriate social energy in the form of reified or living labor" (Bourdieu, 1986, p. 241). Though the term *social capital* was already used by the authors dating back to early twentieth century, Bourdieu is thought to be the first to provide systematic contemporary analysis of the concept (Portes, 1998).

Bourdieu suggested that capital can present itself in three fundamental forms: as economic capital, which is able to be immediately and directly transformed into money and in the forms of property rights; cultural capital, which may be institutionalized in the form of educational qualifications; and social capital, which consists of social obligations and may be institutionalized in the form of a title of nobility. Since the first

form of capital is in material form and the latter two is in immaterial form, those forms can ensure *transubstantiation*, a conversion one form to another. Bourdieu defined social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition - or in other words, to membership in a group - which provides each of its members with the backing of the collectively-owned capital" (Bourdieu, 1986, p. 247). The volume of the social capital, thus, depends on the size of the network one can mobilize and the volume of capital possessed by each of the person one is connected to.

As we can infer from his view on personal ties, the existence of a network is not natural or social given. Rather, it is a result of strategies, which is aimed at establishing or reproducing social connections which are utilizable in the short or long term. The reproduction of social capital postulates an continuous effort of sociability, which demands expenditure of time, energy, and other forms of capital. Though such efforts can be seen as wastage from a narrowly economic standpoint, he states that it can be a solid investment in the terms of social exchanges. They entail uncertainty due to unspecified obligations and potential violation of reciprocity exchange, but this unclarity of exchange can help disguise such transactions (Bourdieu, 1984).

Because Bourdieu often dealt with connections of social elites, his theoretic lens has been often used in studies on

inequality and stratification, a point which will be also discussed in the paper. One of the studies which borrows Bourdieu's understanding of social capital is the work done by Anheier and colleagues (1995). Investigating the German city of Cologne, they mapped social ties among artists and intellectuals and showed that, while core members of the city's elite showed very firm networks, those in peripheral and commercial pursuits had more restricted access to them. Holzer (1987) noted that, between white and black youth, between 24% and 38% of the employment rates gap can be attributed to superior returns to the job referral networks. Using the random assignment data of MBA students at Harvard Business School, Shue (2013) reports that peer networks are crucial determinants of managerial decision-making. Graduates from the same section at the school showed significantly more executive compensation and similar acquisitions strategy than among students from disparate sections.

As the theoretic contributions of the authors above have differentiable features, it is often tricky to coherently classify them in network studies. While some of the concepts and understandings may share common points, others might have stemmed from completely different interests or perspectives on human behaviors. For instance, though they are all in the same umbrella of network studies, while we can relate Mark Granovetter's focus to diffusion mechanism in a given network, Pierre Bourdieu's focus on the capitalistic aspect of networks (Lin & Bian, 2021). On the other hand, such gap can be very

narrow and blurred at times. For example, James Coleman (1988), an author whose work is very well known for examining the role of social capital in the creation of human capital, curiously does not mention Bourdieu in his writings, though his uses of the concept of social capital is generally considered to closely parallel that pioneered by Bourdieu (see Portes, 1998).

The fact that there are a variety of theoretical grounds in network studies explains why terms such as networks, personal ties, social capital, or even network capital (Haythornthwaite et al., 2007) are interchangeably employed when referring the social connections and the benefits deriving from them, and why many of the today's practitioners of empirical network study spend very little time dealing with these theoretic concerns (Lin & Bian, 2021; Small et al., 2021). Yet, the methods, analytical traditions, and the concepts of network research can each find their origins and roots from the past. For example, Simmel's illustration of social network served as a foundation of egocentric analysis; there are few social survey studies which do not share theoretical grounds with Granovetter's understanding of strength of ties; and Bourdieu's idea of conversion of social relationships into other forms of resource inspired future scholars how network can aggravate social inequality. The study of social networks, thus, should better be viewed as "a perspective, or set of perspectives, on how to study social relations and their consequences for individuals and groups" (Small et al., 2021, p. 5). Although it is

not a single theory per se, it has provided numerous smaller instrumental perspectives.

Upon these theoretical foundations, in this paper I define social network as a set of actors connected by a set of relations in which actors mutually seek or give reciprocity and material and non-material support. This social support can also be understood as "social resource", which are "accessible through one's direct and indirect ties" (Lin, 1999, p. 468). In contexts where support which is provided from social network is to be emphasized rather than the structural composition of ties itself, social network would implicate accessed social resources. Social interaction, which is an element of social network, refers to dynamic process where the mobilization of relations occurs and seeking or giving of reciprocal support happens.

2.2. Kin and non-Kin Ties of the Elderly

There are a number of criteria for distinguishing types of network. One of the most widely used classification with which scholars make a clustering of social network of the elderly is a distinction between kin and non-kin ties. Analyzing the subjects of welfare for older adults in particular, Litwak and Szelenyi (1969) pointed out three types of support activists: kin and non-kin ties, and professionals. On one hand, informal support is assistance provided by kin ties and/or non-kin ties, where non-kin ties refer to ties that are neither biologically nor

legally associated, such as friends, neighbors, and acquaintances (Conkova, Fokkema & Dykstra, 2018). On the other hand, because support provided by professionals in most cases takes a form of paid caregiving, it is distinguished as a formal support. In this view, while the formal support indicates official and caregiving professionals who are playing in the field of public sector, kin and non-kin ties play a role in the social and personal realm as a kind of social networks.

Intuitively, kinship is a factor that forms a basic human relationship in society, and at the same time, it is a factor that enables the most stable and continuous relationship. For instance, Bras and Tilburg (2007, p. 296) investigated how different kinships influenced the size and composition of social networks and the relationships among elderly siblings. Koster (2018) also examined how individuals maintain social relationships both within and across households.

The significance of kin tie has been highlighted, despite the rise of modern welfare state and the demise of traditional extended family structure. As more families were atomized and the support services were increasingly provided by bureaucratic organizations, the decline in supportive interaction between older adults and primary network groups was predicted. However, as Cantor (1979, p. 437) wrote, “evidence exists of a solid core of informal social support, particularly in time of crisis” and the centrality of kin tie is still largely accepted by many of the studies.

Along with the interests on kin ties, the role of non-kin

ties has also increasingly garnered scholarly attention. As non-kin network can have its relative strength in proximity and homogeneity, it can also be a rich source of social supports for the elderly population. For instance, Fast and colleagues (2003) reported that 15% of the elderly receiving support because of a long-term health problem have care networks which are solely comprised of non-kin. The assistance provided from friends is known to extend independence longer than assistance from family carers and was critical in keeping older adults from institutionalization (Nocon & Pearson, 2000; Wenger, 1993). Interestingly, Lapierre and Keating (2013) argued that the significance of non-kin over kin is much less visited in research, as many of the existing survey studies do not amply investigate non-kin network as much as kin network[1].

Several theoretical efforts have been made to verify the divergence in the functions and importance of kin and non-kin relationships of the elderly. Proposing task-specific model (Litwak, 1985; Litwak & Szelenyi, 1969), Litwak has made a major contribution to this field of inquiry. The model states that the match between task-specificity and type of relationship decides who will provide what type of support to older adults. Because types of relationships show different features in terms of proximity, duration, resources and degree of affection, certain types of relationships are expected to be more apt to perform certain tasks than others. For example, due to their

1) Their argument can be, to some degree, valid, as the survey questionnaire used in this study also does not investigate the exchange of resource with non-kin network.

geographical proximity, neighbors are expected to better assist short-term instrumental tasks like shopping or cooking meals, while kin, including spouse, children, and other immediate families, are likely to do better with long-term tasks. Empirical results endorse such theoretical framework. Using European data, Hank (2007) reports than even among older adults' kin network of children, proximity played a significant role in selecting whom to interact with. Psychological research also suggests that the meaning of reciprocity is contingent on actor's role relations and the content of their exchange (Rook, 1987).

Cantor (1979) is another important contributor to this conception, which had major influence to the research on the social network of elderly. Unlike Litwak, she proposed a hierarchical-compensatory model that older adults have a fixed set of ranked preference for a type of network. In other words, the model suggests that older adults have a hierarchy in preferred supporters, with spouse and children at the top, followed by relatives, friends and neighbors, and professional helpers. She wrote, "among the present generation of elderly, kin are clearly considered the primary source of help, regardless of the task. Only to the extent that family, particularly children, are not available and with respect to certain well-defined tasks do friends, neighbors, and formal organizations become important in the provision of informal social supports" (Cantor, 1979, p. 461)[2].

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2) It is interesting to note that such statement is made in the study which is

Cantor's explanation provided much more clear and intuitively appealing outline for the social network of the elderly. It shared common implications on the centrality of kin network with ethnographic studies in sociology, which highlighted the buffering role of kin ties of the urban poor, in the late twentieth century (Hogan, Hao, & Parish, 1990; Stack, 1975). Her work influenced a large body of research. Shanas (1979) examined national survey data on the non-institutionalized community aged and reported that immediate family, spouse, and children of old person are the major social support in time of illness. Chen and Feeley (2014) stated that higher support with kin ties was associated with lower level of loneliness and higher level of well-being for older adults. Ikkink and Van Tilburg (1999) also suggested that close kin relations were the most durable in terms of length.

Though how to classify the divergence of different types of ties of the elderly have achieved agreement by distinguishing kin ties and non-kin ties, how to measure the level of social network of each type of ties remain far from being conclusive, as different scholars choose different measures among a very wide array of options. For instance, reviewing 33 instruments used to measure social support or social network, O'Reilly (1988, p. 871) observed that "the most critical issue remains the lack of agreement on what are the conceptual and operational definitions of social support and social network". He also

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titled *Neighbors and friends: An overlooked resource in the informal support system.*

suggests that such lack of agreement could have resulted due to the fact that social network and social support represent each different aspect, as social network refers to structural side and social support refers to behavioral side.

This point is also clearly demonstrated in one of the most widely used scale in assessing social isolation, which is Lubben Social Network Scale(LSNS) (Lubben, 1988). The scale, which is constructed to assess "social networks and social supports" (Lubben et al., 2006, p. 503) specifically among older adults, ask questions, which include "How many relatives do you see or hear from at least once a month?", "How many relatives do you feel close to such that you could call on them for help?", "How many relatives do you feel at ease with that you can talk about private matters?", and repeat them for non-kin ties by replacing relatives with friends (Lubben et al., 2006, p. 504). The scale is grounded on the assumption that social network and social support can be identified to a single variable and that lack of such variable signifies social isolation.

Meanwhile, researchers who follow the analytical traditions of social network analysis(SNA) often measure size, density, and centrality of social network of a given person, where size signifies the number of people in a given network, density illuminates the proportion of observed direct ties to the number of total possible ties, and centrality quantifies the importance of a particular person within a network. Yet the methods of measuring these elements also vary and have been adjusted over time (see Killworth et al.[1990] and Zheng,

Salganik, & Gelman[2006] for how they are computed).

Scholars who particularly put prime weight on the count of social interactions in measuring social network try to capture social contacts, the number of social interactions between a respondent and members(or alters) in a network. Contacts, in this context, are often defined as either physical (handshake, hug, kiss) or nonphysical (two-way conversation in the physical presence of the person) (Drolet et al., 2022) and usually counted on a daily basis.

A similar approach to the contact-based measurement of social network is asking the frequency of interactions in a given period. This method defines interaction in a broader sense than the contact-based approach, because they allow a variety of modes of interaction, such as in-person interactions, telephone or video calls, and messages (Freedman, Hu, & Kasper, 2022). Furthermore, because the questionnaire often specifies a duration in which interaction has occurred(e.g. once a week, once a month), frequency-based approach can trace how the patterns of frequency have changed through time for different types of personal ties.

There still remains a myriad of differing approaches in measuring social network of empirical research. For instance, Kawachi and colleagues (1996) include marital status and church group membership in assessing individual's level of network in their classic work on how social network is associated with mortality. While Liu, King, and Bearman (2010) operationalize social network as spatial propinquity between

families, Youm, Baldina, and Baek (2021) utilize perceived loneliness and group-level segregation to proxy the level of social network of the elderly.

All these distinctive variations of the measurement of personal ties stems from the fact that social network is multifaceted concept (Lin, 1999; Portes, 1998). As it can be inferred from how the theoretical definition of social network is defined in this paper, when we say social network, it can be a set of people who are related or the web of such relations itself, or it can rather be various forms of advantages and disadvantages that are received from them. Therefore, the level of a social network can sometimes be measured by the degree by which an actor subjectively perceives it as important. On the other hand, in cases where the practical weight of a tie in reality deviates from its perceived significance, how often networks are mobilized can be a more accurate representation (Desmond, 2012). The relative weights and the suitability of features of social network can differ by the target population of interest and the context they are situated in. It should, therefore, be noted that it is upon a researcher to make a decision on which aspects of ties should be measured and also how they should be measured.

2.3. Social Networks of Different Income Groups

Researchers have consistently noted on the possibility that social network is stratified within a society, and properties

and benefits of social networks differ across socioeconomic groups (Letki & Mieriņa, 2015). To begin with, it is suggested that those with high socioeconomic status are likely to have wider range of social network. Social resources theory, which is developed in the classic work of Nan Lin (1982) in an effort to explain how social capital affects status attainment in a society, "argues that better initial positions (for example, parental socioeconomic resources or initially attained socioeconomic statuses) promote the likelihood of reaching and using better social resources" (Lai, Lin, & Leung, 1998, p. 160). In this vein, Campbell, Marsden, and Hurlbert (1986) stated that network composition and range are positively associated with income. Another research done by Pichler and Wallace (2009) also reports that formal and informal networks differed depending among groups with different income level. They demonstrate that those in the upper class are likely to be embedded in a broader range of networks through the engagements in formal associations. Furthermore, using data from 24 European countries, Lancee and van de Werfhorst (2012) observed that inequality in income was translated into imbalance in the frequency of socializing in associations.

These findings seem sensible, since, at the most basic level, seeing other people and socializing with them is an activity that demands expense in money or time. Hence, there can exist a evident causal association between low income and social networks, as having insufficient income can be a financial barrier to engaging in social activities. In their research on

long-term unemployed people in Glasgow, Lindsay (2010) found they were far less likely to socialize with people than those in work. Long-term unemployed had weak and small ties than a person who has only recently been unemployed. Low income New Zealand parents in Boon and Farnsworth's research (2011) similarly stopped social activities when they could not afford them.

With regard to time available to socialize, this has to be at discretion of the individual to be useful. If an individual has other necessary work, such as caring responsibilities, then they need a sufficient income to pay for this care if they go out to work, or choose to use this time for socializing. Analysis of the UK Time Use Survey from 2000 showed that a lone mother with two children has time of 0 to -2000 minutes a week because of the high cost of childcare. In other words, these people have a negative amount of discretionary free time and are unlikely to carry out a range of non-discretionary activities, including work. This compares to a high-income male with no children, who has discretionary free time of 1000-5000 minutes a week as they can pay for activities to give them more available time.

Yet, we should be cautious not to make an oversimplified conclusion that those with more economic means should always possess more social networks. Though the size, extensity, range of social network, or resource which are able to be potentially obtained may likely to be larger for those in the upper side of economic ladder, this does not necessarily

equate to the statement that they have more social network in reality. For instance, even if an individual has more extensive available *access* to larger social networks through various memberships in formal associations, the *frequency* in which social interaction actually occurs can still be greater for those with lower economic status, as they tend to more heavily depend on the supports from informal social network (Small & Gose, 2020).

As it is already pointed out by the work of Granovetter (1973), networks formed through formal associations such as workplace are ties that are occasionally visited, while, on the contrary, it is known that more frequent network of informal networks with friends and neighbors show significantly less variability across income ladder or even inverse association. This explains why while Campbell and associates (1986), cited above, found positive association between the size of social network and income, they also additionally noted that the density of social network was negatively associated with the size. Another cited literature of Pichler and Wallace (2009) also noted that lower classes had more intensive informal contacts.

Meanwhile, the forms of support and resources which are gained through by mobilizing personal ties are known to be stratified as well, as the effect of social network "on social resources accessed or mobilized may be contingent on the original status" (Lin, 1999, p. 482). With regard to those with higher socioeconomic status(SES), research often highlights how they take advantages of social network to create hurdles to

maintain the initial inequality and use homophily in their status to further magnify the cumulative advantages (DiMaggio & Garip, 2012). For example, Lin (1999) and Ioannides and Loury (2004) find that high socioeconomic status workers have a better chance to find a better quality job using their networks than low socioeconomic status workers. Similarly, it is known that network effects can contribute to the greater capacity of high-income people to exploit advances in medical science (Freese & Luftey, 2011).

In contrary to the upper class group that is likely to use networks to further elevate their initial advantage, it is suggested that the disadvantaged and the marginalized often depend on networks to manage urgent deficiencies and cope with their survival (Desmond, 2012; Stack, 1974). As reciprocity is the core attribute of social networks (Putnam, 2001), networks frequently serve as unpaid, yet trustworthy, and ultimate safety net to these vulnerable population. For instance, Raudenbush (2020) demonstrated that low-income African Americans who were dropped from health-care used their networks to gain medicines and insurance cards. Using interviews and thorough budgetary analyses on nearly 400 people in a deprived area, Edin and Lein (1997) estimated the financial contribution of social networks to household budgets and found that 17 percent of the total budget of welfare-reliant mothers and 21 percent of that of low-income wage-reliant mothers came from unreported gifts from network members.

In this vein, how and to what extent did social network

changed due to the shock of COVID-19 are also contingent to the socioeconomic backgrounds of individuals. As different socioeconomic groups have dissimilar pool of kin and non-kin networks available, different needs for support, and discriminated possession of resource, it is sensible and logical to expect that the impact of the shock would also be stratified across different classes.

How outcomes will turn out is inevitably an empirical question. However, based on the review above, we can conjecture some possible results. For instance, while the richness of available social network and resource of the higher socioeconomic status group can contribute to the less decrease in social network by the pandemic, their low dependency on personal ties during crisis can result in greater decrease in social network than the lower socioeconomic status group. In addition, regarding non-kin ties in particular, while the primary function of this type of network for the higher socioeconomic status group is to create the hurdle - or *distinction* (Bourdieu, 1984) - for further unequal gains of resource, its function for the lower group was heavily related with their survival strategy. As a result, during the time of crisis, such as the pandemic, the weight of non-kin ties for lower socioeconomic group can surpass that of the upper group.

2.4. The Impact of COVID-19 on Social Network

The huge and negative impact of the pandemic on social

network seems very straightforward, in that the governmental polices of physical distancing have been implemented rigorously in most countries affecting entire population without leaving any exceptions. The result is the general decline of social networks, including frequency and size (Drolet et al., 2021; Kovacs et al., 2021). However, research which systematically estimates to what extent and how networks decreased compared to the pre-COVID period remains surprisingly little (Drolet et al., 2022). Moreover, there are few researches which estimates the change of social networks in Korea, while some preliminary studies exist in Canada, England, the US, China, Belgium, Luxembourg and Netherlands (Backer et al., 2021; Coletti et al., 2020; Drolet et al., 2021; Gimma et al., 2022; Kovacs et al., 2021; Latsuzbaia et al., 2020; Zhang et al., 2020). Here I briefly review some of them.

Using a population-based survey study of social contacts with responses made before and after the outbreak of COVID-19, Drolet and her associates (2022) conducted well-designed study that demonstrates how social contacts have changed in Canada during the period which involved physical distancing order. Contacts decreased from the mean of 8 contacts per day to 3 contacts per day during the lockdown, and they closely followed the intensity of public health measure which the government has carried out. The results also implicated that seasonality was a key force in explaining the fluctuation of social contacts, as holidays and school and work vacations showed the lowest contacts.

The research done by Gimma and colleagues (2022) used an extensive set of data in England, which recorded 101,350 observations from 19,914 participants, to compute the change of age-stratified contact matrices of weekly contacts between March 2020 and March 2021. Their analysis show that the mean of reported contacts of adults over the age of 17 decreased about 75% compared to the pre-pandemic measures. However, the baseline figures of the study which represented the prepandemic situation were measured in 2005 to 2006, which makes them hard to serve for the accurate comparison group. The estimated change, notwithstanding, was large enough to suggest that there was a significant decline of social contacts.

China, the country where the first positive case of COVID-19 infection was reported, showed dramatic fall of social contacts as well. The research which analyzed how the contacts of people in Wuhan and Shanghai changed from 1 February 2020 to 10 February 2020, when stringent government interventions were put in place, also indicates a huge drop. Using baseline period of December 2019 for Wuhan and 2017-2018 for Shanghai, the study indicates that the average number of daily contacts reduced from 14.6 to 2.0 in Wuhan and from 18.8 to 2.3 in Shanghai (Zhang et al., 2020).

These studies examine a single aspect of social network, which is the frequency of contacts. Moreover, nearly all of them end up providing the average change of total social contacts, without associating with individual characteristics or classifying the type of social network. Hence, although they

provide useful preliminary results of how social contacts in general changed by the COVID-19 shock, they have very limited implications as they scarcely provide information on the divergence of the configuration of social network.

The research done by Balázs Kovács at Yale and his colleagues (2021) is one of very few studies which decomposed networks of an individual to kin and non-kin ties. Moreover, multiple aspects of social network, such as strength, frequency and the mode of interaction, were considered in the analysis. The data were from two waves of survey studies done in mid-June 2019 and min-June 2020. In order to collect responses from the same individuals in the two periods, the size of the sample was limited to 189. The results were: first, in average, the counts(size) of very close non-kin ties decreased during the pandemic; second, for very close ties, the only mode of communication(i.e. in-person, audio, video, text, email) that showed statistically significant change was in-person communication; and third, distant communication with weak ties was inversely associated with increase in self-reported loneliness.

Carlsen and his colleagues (2021) conducted a research on the role of social networks under COVID-19 pandemic, by analyzing how informal networks quickly mobilized citizen-to-citizen support when government and non-government organizations locked down during the COVID-19 pandemic. They found that the much of support was distributed through social networks and, therefore, was not available to those lacking social ties.

Lower income level groups had relatively weak social network and, in turn, this gave them difficulties in getting benefits during the crisis.

Freedman, Hu, and Kasper (2022) is another notable study which investigated the impact of the pandemic on social network. Their research particularly focused on the frequency of contacts of the elderly in the US, and examined interactions by the modes of communication with non-resident kins and non-kins after COVID-19 outbreak. Social network was measured with regard to how often communications have been made. Whether interaction occurred on a weekly basis or not served as a cutoff between categories. The results demonstrated that weekly in-person contact dropped from 61% to 39%, while remote interactions, such as phone and electronic contacts, stayed relatively unchanged in average. Moreover, the study suggested that older adults with higher pre-pandemic kin and non-kin networks were less likely to decrease their interactions during the pandemic.

Ⅲ. Hypotheses and Research Design

3.1. Research Questions and Hypotheses

[Research Question 1] To what extent did the social networks, namely kin ties and non-kin ties, of Korean older adults changed after the outbreak of COVID-19?

< Hypothesis 1 > The social networks of kin ties and non-kin ties would have weakened after the outbreak of COVID-19.

[Research Question 2] Within the configuration of social network of the elderly, which type of network, among kin and non-kin network, will remain relatively robust and which type will weaken after the shock of COVID-19?

< Hypothesis 2 > The kin ties of the elderly population would have remained stronger than the non-kin ties for both income groups under COVID-19 situation.

[Research Question 3] Is there any disparity in the changes of social networks between the lower income and the upper income groups? COVID-19 can have disproportionate impact on the kin and non-kin ties between the lower and the upper income groups.

< Hypothesis 3-1> The decrease of kin ties in the upper income group would be greater than the lower income group.

< Hypothesis 3-2> The decrease of non-kin ties in the upper income group would be greater than the lower income group.

3.2. Data

National Survey of Older Koreans(NSOK hereafter) is used to address the questions above. From 2008, NSOK has collected responses from about 10,000 Korean older adults who are aged 65 or over every 3 years. Though 2008 study and 2011 study were longitudinal data, studies after 2011 were done as cross-sectional study. Nearly 200 items on household information, health status, functional status, social activities, kin and non-kin relationships, living conditions, and economic status are investigated. A nation-wide stratified samples are selected and then visited by pre-trained investigators.

Using the Korean census data as sampling framework, NSOK undergoes 2 stages of sampling stratification. It first stratifies the entire population by 17 regions and then, except the 7 metropolitan areas, stratifies the remaining regions to smaller units. It was designed to include least 400 older adults in every district units. The responses were weighted by design weight, non-response adjustment weight, and post-stratification weight.

2011, 2014, 2017, and 2020 NSOK are used in the statistical analysis. Though the pandemic prevailed in 2020, the data collection of 2020 NSOK was conducted in a same manner

as with the previous studies with investigators visiting elderly respondents. Since some of the investigations were done during the period of stricter social distancing policy, preliminary investigation was practiced in order to prevent issues, such as respondents' reluctance to the investigation because of the virus. In addition, though the principal contents of the survey remained unchanged, the order of the survey items and specific vocabularies of questionnaire were adjusted from the 2017 NSOK. In terms of the number of household, that of the 2019 was investigated in order to estimate more accurate equivalized household income.

Because social distancing officially initiated on March 22 2020 in Korea and the investigation of 2020 NSOK was done during September 14 to November 20, the responses from the 2020 data reflect the impact of the COVID-19 pandemic, which serves as instrumental context to statistically capture the changes of social networks of the elderly.

3.3. Research Method

In order to estimate the impact of COVID-19 on the social networks of the elderly, I use regression framework. More specifically, the econometric approaches of linear probability model(LPM) and difference-in-differences(DID) will be employed. To begin with, LPM - which is a type of binary regression model - is used, due to the binary nature of the dependent variable. While non-linear models, such as logit and

probit models, can be applied to binary responses, their lack of interpretability of coefficients make it hard to explain the statistical results. In contrary, LPM provides results that can be intuitively understood, which can especially be useful in estimating the effect of social shock and deriving related policy implications, without losing much of methodological rigorousness. Moreover, because non-linear models can be ineffective in cases where interaction terms of variables exist in the estimating model like the present study, we can expect that LPM provides more reliable estimations.

LPM assumes the following:

$$E[Y|X] = \Pr(Y = 1|X) = x'\beta$$

As a result, the vector of parameters of β can be estimated by ordinary least squares, and it provides best linear approximation.

Some critics of LPM point that the model can predict values which deviate from the interval from 0 to 1. Yet, as Wooldridge (2002, p. 455) wrote, "[i]f the main purpose is to estimate the partial effect of the [independent variable] on the response probability, averaged across the distribution of [the independent variable], then the fact that some predicted values are outside the unit interval may not be very important." Furthermore, the predicted values of the empirical model in this paper are within the range of 0 to 1. It is also known that "LPM residuals are necessarily heteroskedastic unless the only

regressor is a constant" (Angrist & Pischke, 2009, p. 47). For this reason, all of the estimations in this paper use heteroskedasticity-consistent robust standard error.

DID is an effective estimation strategy to control the group-level omitted variables (Angrist & Pischke, 2009, p. 227). In most of the applied research settings, the existence of unobserved confounders poses a huge uncertainty to the validity of the result. Moreover, with the current case of the pandemic, the massive shock would have triggered a number of time-varying confounders to change in a given period. In this respect, DID has its strength that it restrict the way in which unobserved confounders influence the target outcome.

DID has been documented to be effective in capturing the causal effect of the shock, which is induced by exogenous events (Abadie & Cattaneo, 2018). However, it requires some assumptions in order to produce accurate estimation. First, DID framework permits only two treatment histories: never treated(the control or benchmark group) and treated in the post-shock period(the treated group). The two groups will be, therefore, represented by W = 0 and W = 1 respectively. Every unit of the observation has two potential outcomes, while we can only observe one of them in reality. The assumption, namely the consistency assumption, links the potential outcomes at time t with treatment w to the observed outcomes as below:

$$Y(t) = (1 - W)\,Y^{0}(t) + WY^{1}(t)$$

The other assumption is counterfactual assumption, also known as parallel trends assumption. It states that the variation in outcomes from before-shock period(t = 0) to after-shock period(t = 1) of the control group is a good proxy for the counterfactual change in untreated potential outcomes of the treated group. The fact that the this involves counterfactual outcomes which cannot be observed in reality, as illustrated below, explains why it is an *assumption*. The assumption can be expressed as:

$$E[Y^0(1) - Y^0(0) | W = 1] = E[Y^0(1) - Y^0(0) | W = 0]$$

Following previous studies which use observations from past periods as the benchmark group to capture the counterfactual change pattern during COVID-19 (Chen, Qian, & Wen, 2021; Lee & Hong, 2021), this study use the change of social network from 2011 to 2014 as the benchmark group. In their well-designed econometric research, Chen, Qian, and Wen(2021) use consumption data in China, which are gathered before the outbreak of the pandemic, in order to represent the untreated(or un-shocked) potential outcomes of the treated(or shocked). In this analysis, it is assumed that the trend of the variation in social network will not significantly differ between the two periods of 2011-2014 and 2017-2020. The DID regression is identified as below:

$$y_i = \alpha + \beta_1 POST + \beta_2 TREAT + \beta_3 POST \times TREAT + \delta X_i + \epsilon_i$$

... equation (1)

In order to test the hypotheses, regression analysis based on equation (1) will be each performed for 3 types of samples: entire sample, upper income group sample, and lower income group sample. First, DID analysis with the entire sample will estimate how social network of the entire older adults was affected by COVID-19 in general(*hypothesis 1*, *hypothesis 2*). Then, to examine how the changes diverged across different socioeconomic groups within the elderly population, equation (1) is performed with upper income group sample and lower income group sample respectively(*hypothesis* 3).

While the upper income group denotes individuals in the highest quintile(i.e. those who are above 80th percentile) in the income spectrum, the lower income group denotes individuals in the lowest quintile(i.e. those who are below 20th percentile). Here, the income of a respondent is defined and measured as equivalised income. Equivalised income is a measure which takes account of the differences in a household's size and there are a number of equivalence scale, such as per-capita, "Oxford" scale, "OECD-modified" scale, and square root scale. Because official statistics in Korea use the square root scale, this study also divides total household income by square rooted household size in calculating individual income.

The inter-group variation between different income groups can be simply shown by comparing the sizes of

coefficients from the two regression analysis results of DID on upper income group and DID on lower income group. However, in order to test statistical the significance of this inter-group disparity, the following augmented specification will be used to identify the heterogeneity between different income groups:

$$y_i = \alpha + \beta_1 POST + \beta_2 TREAT + \beta_3 INCOME + \beta_4 POST \times TREAT + \beta_5 POST \times INCOME + \beta_6 TREAT \times INCOME + \beta_7 TREAT \times POST \times INCOME + \delta X_i + \epsilon_i$$

... equation (2)

The coefficient of β_7 in equation (2) "captures the extra average impact of the COVID-19 outbreak for the group defined by the interactive term, relative to the benchmark group" (Chen, Qian, & Wen, 2021)[3]. In other words, equation (2) can be used to test *hypothesis 3* with more statistical rigor.

3.4. Variables

The variables used in the analysis are as follows. The

3) The triple interaction term is widely used under two different purposes. On one hand, it can be used as a triple-difference-in-differences(DDD) estimator which offers more robust estimate of the causal effect of a shock. On the other hand, like how it is employed in this paper, it can be used to test if the variation of the shock statistically differs between the two heterogeneous groups. The study of Muralidharan and Prakash (2017), published in *American Economic Journal*, demonstrates the former case well. For the latter case, see Caselli and Falco (2021) and Chen, Qian, and Wen (2021).

dependent variable of y_i is social network outcomes of the Korean elderly people. Considering the distinct features of the personal ties of the elderly population, the network measure of Freedman, Hu, and Kasper (2022) is employed. In order to estimate the change of social network of older adults after the outbreak of the pandemic, the joint research team of Michigan and Johns Hopkins scholars measured how the frequency of contacts in a given period with kin and non-kin changed("Less than weekly", "Weekly or more"). Because the negative impact on social networks primarily affected on physical contacts, measuring the frequency aspect of social network, rather than size or density, can better reflect the actual consequence of the shock. The questionnaire of NSOK asked respondents "How often did you meet [children / relative / friend • neighbor • acquaintance] in the past 1 year?"[4]. While Freedman, Hu, and Kasper (2022) collapsed the responses of "at least daily", "a few times a week", "about once a week", "less than once a week", and "never" into binary categories of "weekly or more" and "less than weekly", I collapsed the responses of "almost everyday(4 or more times a week)", "2~3 times a week", "once a week", "1~2 times a month", "1~2 times in 3 months", "1~2 times a year", and "almost no contact" into binary categories("Less than weekly" = 0, "Weekly or more" = 1). As a result, contacts with children and relatives represent kin network, and contacts with friend • neighbors • acquaintances

4) Here, children and relatives indicates those who are nonresident with a respondent.

represent non-kin network, and the mean of the dependent variable represents the probability to meet kin or non-kin once or more a week, which can be examined with LPM.

The independent variable of interest is the interaction terms of *POST* and *TREAT* dummy variables. Following previous studies which utilized observations in past periods as the comparison group in their DID setting (Chen, Qian, & Wen, 2021; Lee & Hong, 2021), the dummy variable *TREAT* is defined as 1 for 2017 and 2020 sample, and 0 otherwise. *POST* is defined as 1 for post periods in treated sample and untreated sample, which are 2014 and 2020. The coefficient of β_3 in equation (1), therefore, captures the impact which the shock COVID-19. In equation (2), the *INCOME* dummy variable is 0 for lower income group, and 1 for upper income group.

X_i denotes for the vector of control variables. To control the effect of individual-level confounders on the social network of the elderly, sex, age, marital status, and education are included as control variables (Park & Park, 2013).

For *sex* dummy variable, male older adults are coded 0. It is reported that those who are female often show richer level of social networks in general (Campbell, Connidis, & Davies, 1999; Cornwell, 2009). In contrast, according to the recent study which investigated the change of social network during the pandemic, female people were shown more likely to face the decline of social interactions (Freedman, Hu, & Kasper, 2022).

Age is coded as continuous variable. Age has been

demonstrated to have double-faced attributes when it comes to network studies. While age can potentially decrease network size as physical mobility and social activities ebb in the later life period, it can also show positive association with social network of the elderly, in that its demand increases in later life period. Hence, though age shows a negative correlation with social networks in some research, results remain to be inconsistent in others (Choi, 2018; Cornwell & Laumann, 2015; Min & Han, 2007; Phillips, Bernard, Phillipson, & Ogg, 2000).

Marital status is coded into 5 categories: Unmarried(0), married(1), married(bereaved)(2), married(living separately)(3), and divorced(4). It is known that marriage can contribute to strengthening social network, since a spouse becomes one of the most crucial personal tie of an individual and marriage expands the number of kin by adding relatives by marriage (Hill & Dunbar, 2003). Such kin ties are also known to enhance health status of an individual by "marriage protection effects" (Waldron, Hughes, & Brooks, 1996). Moreover, using 1.3 million observations from social network service users, Aral and Walker (2012) demonstrated that marital status is also associated with the extent to which people are affected by their non-kin ties, which implies that the degree of mobilizing non-kin ties can be influenced by one's marital status.

Finally, *education* is coded into six categories by final educational attainment: no education(0), elementary school(1), middle school(2), high school(3), college(less than 4 years)(4), and university or above(5). While it is generally known that

people with higher education are likely to have greater network size, some studies report that education has no significant effect on the mobilization of social network (Granovetter, 1973; McPherson et al., 2006; Small, 2013). Furthermore, in terms of the mobilization of social network during crisis and disasters, studies also reported that education was not a significant factor to explain the variance of social network (Bryant et al., 2017; Chu, Liu, & Yang, 2021).

Ⅳ. Empirical Results

4.1. Descriptive Statistics

<Table 1> presents the descriptive statistics of the variables. While the first column shows the results of the entire sample, the second and third column each represents lower 20% income group and upper 20% income group. In addition, mean values of the dependent variable of social network is also shown in the bottom.

First, there were more female respondents(59.8%) than male respondents(40.2%) in the total sample. The ratio of sex was similar to that presented from other studies on older adults (Cantor, 1979). While this disproportionate ratio was more pronounced for the lower income group with 69.6% of female and 30.4% of male, female(50.9%) and male(49.1%) respondents in the upper income group had more balanced sex ratio. The average age of older adults was 74.2.

For subjective health, 5.1% of the respondents replied that they are very unhealthy, 33.0% replied that they are unhealthy, 34.6% replied that they are healthy, and 2.3% replied that they are very healthy. The two income groups showed health disparities, as 46.3% of the lower income older adults replied that they are (very) unhealthy, while 26.3% of the upper income older adults replied that they are (very) unhealthy.

More than half of the respondents were married and living with their spouse. Very small number of respondents

reported that they were never married before. When the two income groups were compared, 43.3% of the lower group were married, while 72.6% of the upper group were married. The ratio of those who bereaved their spouse was more than double for the lower income group.

Regarding education, about 27.4% of the elderly respondents had no schooling and more than half did not receive education equivalent to or above the middle school level. Inter-group disparity was also noticeable between the income groups. While 41.2% had no schooling and 2.2% had higher education in the lower income group, the figures were 12.7% and 15.8% respectively in the upper group.

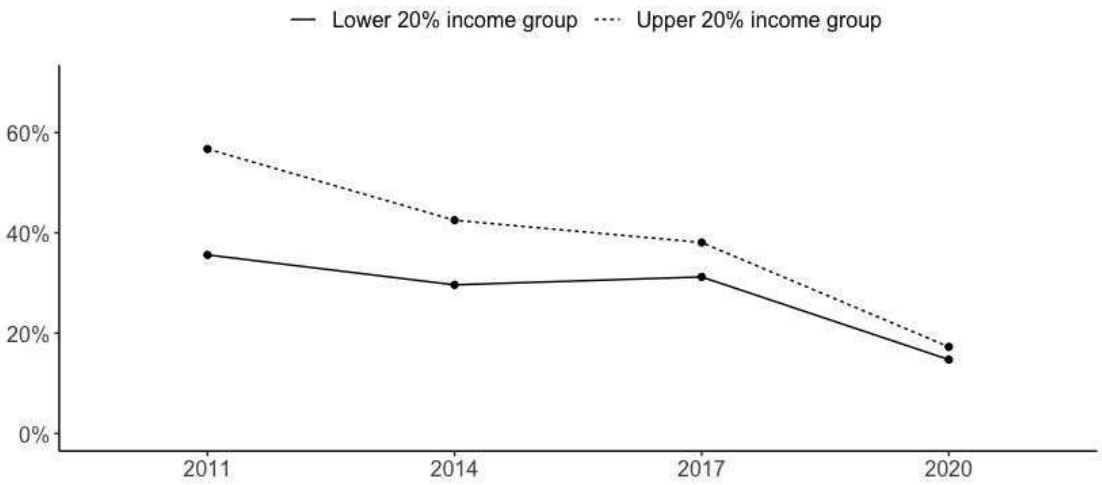
The configuration of the dependent variable of social network suggests surprising results, considering many of the studies which examine the social network of the elderly presume the dominance of kin ties, following the theoretical framework by Cantor. The results indicate that non-kin network, rather than kin network, has saliency with regard to the network of Korean older adults, regardless of their income status. The probability of older adults to meet their children once or more a week in the past 1 year was 34.5% and the probability for family was only 6.5%. On the contrary, the probability for non-kin was 78.3%. Lower income group showed lower level of kin network compared to the statistics of entire sample and the upper group sample, while the non-kin network was higher.

<Table 1 > Descriptive statistics of the sample

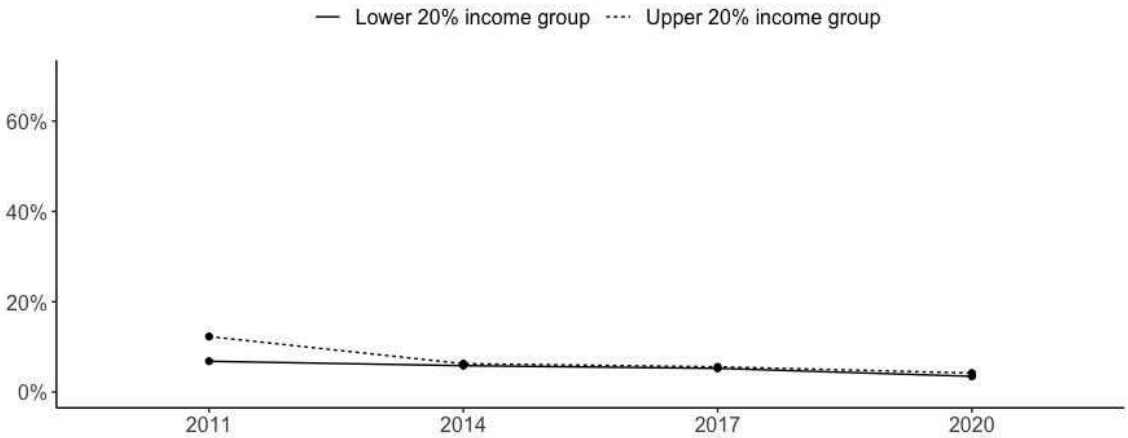
		Total (N = 41,841)	Lower income (N = 8,348)	Upper income (N = 8,363)
Sex				
	Male	40.2%	30.4%	49.1%
	Female	59.8%	69.6%	50.9%
Age		74.2	76.3	72.1
Subjective health				
	Very unhealthy	5.1%	7.0%	3.0%
	Unhealthy	33.0%	39.3%	23.3%
	Average	24.9%	25.4%	22.6%
	Healthy	34.6%	27.0%	46.6%
	Very healthy	2.3%	1.3%	4.5%
Marital status				
	Unmarried	0.4%	0.9%	0.2%
	Married	61.0%	43.3%	72.6%
	Married (bereaved)	35.4%	51.0%)	24.6%
	Married (living separately)	0.7%	0.9%	0.6%
	Divorced	2.6%	3.9%	1.9%
Income		1,686.2	456.2	4,487.0
Education				
	No schooling	27.4%	41.2%	12.7%
	Elementary school	34.4%	35.3%	26.1%
	Middle school	15.8%	11.9%	17.8%
	High school	16.7%	9.5%	27.6%
	College (less than 4 years)	1.2%	0.6%	3.0%
	University or above	4.5%	1.6%	12.8%
Social network	Children	34.5%	28.0%	39.0%
	Family	6.5%	5.4%	7.2%
	Friend / neighbor / acquaintance	78.3%	79.6%	74.5%

The three figures below allow us to make preliminary conjectures on the three hypotheses of this paper. First, though the means presented in the figures are rough statistics, which has not been controlled for any of the possible confounders, they imply that, except family network, children and friend network would have significantly abated due to the shock of the pandemic, as it is speculated in *hypothesis* 1. Second, the figures indicate that the saliency of non-kin network over kin network is not a temporary phenomenon induced by the shock of COVID-19, but is a trend which has been consistent over a recent decade. Unless the effect of COVID-19 is estimated to have far more outweighing negative effect to non-kin network than kin network in the regression analysis, because the baseline level of each network is so different, *hypothesis* 2 will not be supported. Third, as the drops in social network across different income groups seem to vary and the negative slope of the lower income group's trend line seems to be more flat, the impact of COVID-19 could have had stratified divergence in its impact, as it is speculated in *hypothesis* 3-1 and *hypothesis* 3-2.

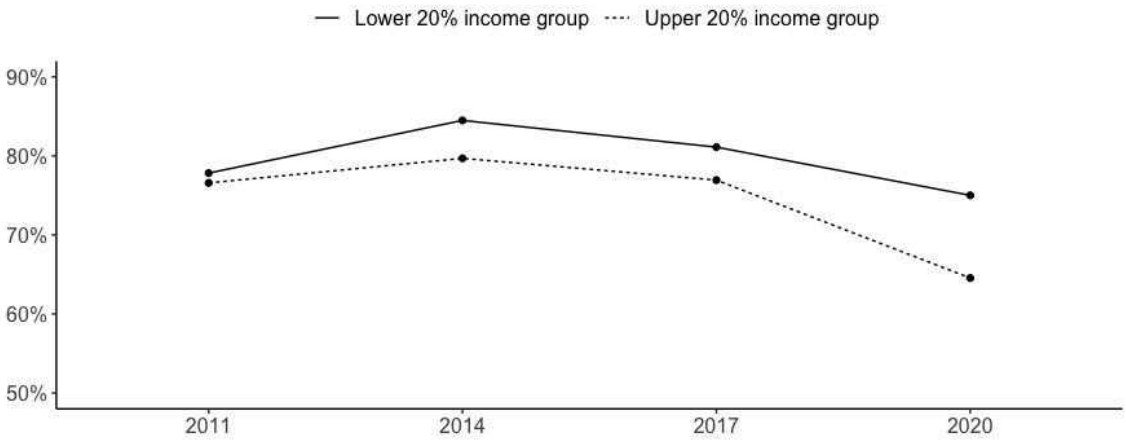
<Figure 2> The probability to meet once or more a week : Children



<Figure 3> The probability to meet once or more a week : Family



<Figure 4> The probability to meet once or more a week : Non-kin



4.2. Influence of COVID-19 on the Social Networks of the Elderly

Table 2 to table 4 present the results of DID regression done with the entire sample set. It should specifically highlighted that the estimated target coefficients (*POST* TREAT*) in the three tables show little variation across models. Adding the full set of control variables only changed the coefficient by 0.011 for children, 0.002 for family, and and 0.019 for friend, compared to the baseline model. This strongly indicates that the empirical approach of DID was successful in controlling the effects of possible confounders and the estimated effects are robust (see Angrist & Pischke, 2009, p. 241).

It is estimated that the shock of COVID-19 has decreased the likelihood to meet children once or more a week by 12.2 percent point and the likelihood to meet friend once or more a week by 12.9 percent point. On the contrary, the likelihood to meet nonresident family is estimated to have increased by 2.4 percent point due to the shock, but the change was considerably small. All of the results were statistically significant under the significance level of 0.01. Except for the the case of family network, it can inferred that these results support the *hypothesis* 1.

< Table 2 > The effect of COVID-19 on social network of the elderly : Children

	(1)	(2)	(3)	(4)
Constant	0.464***	0.427***	0.064*	−0.015
	(0.005)	(0.028)	(0.034)	(0.037)
POST	−0.088***	−0.088***	−0.088***	−0.089***
	(0.007)	(0.007)	(0.007)	(0.007)
TREAT	−0.099***	−0.099***	−0.096***	−0.100***
	(0.007)	(0.007)	(0.007)	(0.007)
*POST * TREAT*	−0.111***	−0.111***	−0.118***	−0.122***
	(0.009)	(0.009)	(0.009)	(0.009)
Age		0.001	0.001***	0.002***
		(0.0004)	(0.0004)	(0.0004)
Female		−0.001	0.020***	0.028***
		(0.005)	(0.005)	(0.005)
Marital status				
Married			0.323***	0.322***
			(0.017)	(0.017)
Married (bereaved)			0.278***	0.283***
			(0.017)	(0.017)
Married (living separately)			0.211***	0.211***
			(0.031)	(0.031)
Divorced			0.137***	0.136***
			(0.020)	(0.020)
Subjective health				
Unhealthy			0.051***	0.046***
			(0.012)	(0.012)
Average			−0.005	−0.004
			(0.010)	(0.010)
Healthy			0.012*	0.013*
			(0.007)	(0.007)
Very Healthy			0.0003	−0.0001
			(0.005)	(0.005)
Education				
Elementary school				0.037***
				(0.006)
Middle school				0.040***
				(0.008)
High school				0.043***
				(0.008)
College (less than 4 years)				0.047**
				(0.021)
University or above				0.045***
				(0.013)

Notes : * p<0.1, ** p<0.05, *** p<0.01. Estimation done with entire elderly sample.

< Table 3 > The effect of COVID-19 on social network of the elderly : Family

	(1)	(2)	(3)	(4)
Constant	0.102***	0.172***	0.216***	0.243***
	(0.003)	(0.014)	(0.030)	(0.031)
POST	−0.042***	−0.042***	−0.042***	−0.041***
	(0.004)	(0.004)	(0.004)	(0.004)
TREAT	−0.046***	−0.046***	−0.046***	−0.045***
	(0.004)	(0.004)	(0.004)	(0.004)
*POST * TREAT*	0.026***	0.025***	0.024***	0.024***
	(0.005)	(0.005)	(0.005)	(0.005)
Age		−0.001***	−0.001***	−0.001***
		(0.0002)	(0.0002)	(0.0002)
Female		0.002	0.002	−0.003
		(0.002)	(0.003)	(0.003)
Marital status				
Married			−0.054**	−0.054**
			(0.026)	(0.026)
Married (bereaved)			−0.050*	−0.052**
			(0.026)	(0.026)
Married (living separately)			−0.049	−0.047
			(0.030)	(0.030)
Divorced			−0.059**	−0.058**
			(0.027)	(0.027)
Subjective health				
Unhealthy			0.013**	0.016**
			(0.006)	(0.006)
Average			0.0002	0.001
			(0.005)	(0.005)
Healthy			0.001	0.0005
			(0.004)	(0.004)
Very Healthy			−0.002	−0.002
			(0.003)	(0.003)
Education				
Elementary school				−0.006*
				(0.003)
Middle school				−0.008*
				(0.004)
High school				−0.020***
				(0.004)
College (less than 4 years)				−0.010
				(0.011)
University or above				−0.032***
				(0.006)

Notes : * p<0.1, ** p<0.05, *** p<0.01. Estimation done with entire elderly sample.

< Table 4 > The effect of COVID-19 on social network of the elderly : Non-kin

	(1)	(2)	(3)	(4)
Constant	0.799***	0.687***	0.485***	0.631***
	(0.004)	(0.025)	(0.046)	(0.047)
POST	0.026***	0.028***	0.032***	0.036***
	(0.005)	(0.005)	(0.005)	(0.005)
TREAT	−0.005	−0.005	−0.001	0.007
	(0.006)	(0.005)	(0.005)	(0.005)
*POST * TREAT*	−0.110***	−0.111***	−0.134***	−0.129***
	(0.008)	(0.008)	(0.008)	(0.008)
Age		0.001**	0.002***	0.001**
		(0.0003)	(0.0004)	(0.0004)
Female		0.091***	0.086***	0.062***
		(0.004)	(0.005)	(0.005)
Marital status				
Married			0.075**	0.080**
			(0.037)	(0.037)
Married (bereaved)			0.105***	0.099***
			(0.037)	(0.037)
Married (living separately)			0.045	0.053
			(0.046)	(0.046)
Divorced			0.032	0.037
			(0.039)	(0.039)
Subjective health				
Unhealthy			0.112***	0.134***
			(0.011)	(0.011)
Average			−0.088***	−0.079***
			(0.010)	(0.010)
Healthy			0.021***	0.022***
			(0.006)	(0.006)
Very Healthy			−0.007*	−0.007
			(0.004)	(0.004)
Education				
Elementary school				−0.031***
				(0.005)
Middle school				−0.054***
				(0.007)
High school				−0.100***
				(0.007)
College (less than 4 years)				−0.165***
				(0.021)
University or above				−0.143***
				(0.012)

Notes : * p<0.1, ** p<0.05, *** p<0.01. Estimation done with entire elderly sample.

The interpretation of the increase in family network should be cautiously done, in that the baseline level was considerably smaller than those of children network and friend network. In 2017, while the probability of meeting children once or more a week was 0.365 and probability of meeting friend once or more a week was 0.794, the probability for family was 0.056[5]. Because the baseline level of family network during pre-pandemic period massively differed from others and was close to zero, the change in trend could have shown differing results. This is particularly true considering that the empirical strategy is based on DID approach (see Muralidharan & Prakash, 2017). Though it can also be suggested that the increase of family network was an effort to compensate the huge decline of other types of ties, such explanation seems invalid since the variation is too small to be understood as an complementary behavior.

If we leave out the family network due to that fact it differs vastly in its baseline level and its little weight in network configuration of older adults and focus on children network and non-kin network, COVID-19 had similar level of negative effect on both types of ties. However, because their initial baseline were significantly dissimilar, their outcomes in 2020 also varied hugely, with the probability to meet children

5) The probability of meeting family once or more a week was 0.040 in 2020, which is 0.016 less than in 2017. However, because the DID model was able to control individual characteristics and time-varying confounders, the coefficients in table 4 showed 0.024, suggesting that family network increased because of the shock.

once or more a week dropping to 0.169 and the probability for non-kin dropping to 0.710. *Hypothesis* 2 is, therefore, rejected, as non-kin network showed clear magnitude over kin network even after the outbreak of COVID-19.

In terms of the effects of remaining control variables, for children network, marriage played a huge role in increasing the probability. While it can, in theory, be expected that loss of or separation with spouse of previously married older adults can demand more frequent children network to fill the absence of the partner during the shock, children network also declined in these cases. Female respondents were more likely to meet children than male respondents. Subjective health did not show strong association with children network. Those who responded to be unhealthy had 0.046 greater probability than those who reported to be very unhealthy. Education level showed strong statistically significance in the relation with children network, but the effects were generally similar in size across different levels. It suggested that while the lack of education significantly decreases children network, the variation across different levels of education is minute.

Next, for family network, all of the coefficients of the martial status variable showed negative value, in contrary to children network. Older adults who are unmarried had significantly higher family network level, which potentially suggests that those are never married relied more on family, as they do not have their spouse and, likely, children over the pandemic period. While subjective health was not closely

associated with family network, higher education was observed to have negative effect on family network.

Regarding non-kin network, which is less visited network in previous literature, sex showed bigger effect size, when compared to children and family network. Female respondents showed higher probability of meeting non-kin once or more a week than male respondents. In terms of marital status, while those who are married and married(bereaved) showed higher probability. Subjective health did not show a consistent effect to non-kin network. Unhealthy respondents had 0.134 higher probability than those who are very unhealthy, but the direction of effect fluctuated as health status got higher. Education had negative effects on the friend network, as opposed to the children network. In other words, while older adults with higher education were less likely to meet non-kin after COVID-19, they were more likely to meet children after COVID-19.

4.3. Inter-group variation across different income groups

To test whether there were disparity in the negative effects of COVID-19 between the two income groups, DID is performed with the subsamples divided by income criteria. Table 5 presents result for the upper income older adults group and table 6 presents results for the lower income older adults group. All of the estimations are done with the full set of

control variables.

When we do the simple comparison of the coefficients in table 5 and table 6, results suggest that COVID-19 had greater negative effect on kin network for the lower income group. Due to the shock, the upper income elderly's probability to meet children decreased by 8.2 percent point, while the probability to meet family increased by 4.7 percent point; for the lower income group, both figures decreased by 11.3 percent point and 1.1 percent point respectively. On the other hand, the negative effect on non-kin network was greater for the upper income group. While the upper income group's probability declined by 16.9 percent point, that of the lower fell by 15.0 percent point.

The triple interaction terms in table 7 confirm the disparity in the changes of social network between the income groups is statistically significant for both kin and non-kin network[6]. The upper group have experienced significantly milder adverse shock with kin network, but their non-kin network abated more significantly than the lower group. As a result, while the empirical evidence rejects *hypothesis* 3-1, it supports *hypothesis* 3-2.

6) The result for children network was marginally significant under the significance level of 0.1.

< Table 5 > The effect of COVID-19 on social network of the upper income elderly

	Children	*Family*	*Friend / neighbor / acquaintance*
Constant	0.142	0.260***	0.997***
	(0.137)	(0.082)	(0.120)
POST	−0.132***	−0.059***	0.030**
	(0.016)	(0.009)	(0.013)
TREAT	−0.176***	−0.064***	0.009
	(0.015)	(0.009)	(0.013)
*POST * TREAT*	−0.082***	0.047***	−0.169***
	(0.021)	(0.011)	(0.019)
Individual characteristics controls	Yes	Yes	Yes

Notes : * p<0.1, ** p<0.05, *** p<0.01. The upper income group is defined as older adults with income above the 80% income quantile.

< Table 6 > The effect of COVID-19 on social networks of the lower income elderly

	Children	*Family*	*Friend / neighbor / acquaintance*
Constant	−0.104	0.137***	0.590***
	(0.070)	(0.050)	(0.083)
POST	−0.055***	−0.010	0.079***
	(0.015)	(0.008)	(0.012)
TREAT	−0.034**	−0.017**	0.052***
	(0.015)	(0.007)	(0.012)
*POST * TREAT*	−0.113***	−0.011	−0.150***
	(0.020)	(0.010)	(0.018)
Individual characteristics controls	Yes	Yes	Yes

Notes : *p**p***p<0.01. The lower income group is defined as older adults who are below the 20% income quantile.

< Table 7 > Inter-group variation of social network in exposure to COVID-19

	Children	*Family*	*Friend / neighbor / acquaintance*
*POST * TREAT*	−0.113***	−0.006	−0.148***
	(0.020)	(0.010)	(0.010)
*POST * Upper*	−0.076***	−0.050***	−0.048***
	(0.021)	(0.012)	(0.012)
*TREAT * Upper*	−0.135***	−0.051***	−0.041***
	(0.021)	(0.011)	(0.011)
*POST * TREAT * Upper*	0.044*	0.050***	−0.026**
	(0.027)	(0.015)	(0.013)
Individual characteristics controls	Yes	Yes	Yes

Notes : * p<0.1, ** p<0.05, *** p<0.01. The Upper dummy is coded as 1 for the upper income group, and 0 for the lower income group.

These outcomes suggest that kin network and non-kin network indeed have distinct functions for different classes. Because kin network often shares "considerable similarities in residence, social class, and other characteristics" (McPherson, Smith-Lovin, & Cook, 2001, p. 422), it might be that kin network of the disadvantaged group was incapable to provide - or be expected to provide - social support or resource, as they themselves were also in need of urgent assistance.

However, it is also sensible to expect that such homogeneity in socioeconomic status among network members exist for non-kin members as well. As a large body of ethnographic research documents that non-kin network of the lower income population is largely composed of people with similar socioeconomic status (Raudenbush, 2016), the

socioeconomic features of friends, neighbors, acquaintances of the disadvantaged are not likely to deviate far from them. However, such homogeneity is known to play the opposite functions for kin and non-kin networks especially for the low socioeconomic status group. In other words, while the common condition of being resource-deprived is likely to erode kin network, non-kin network is likely to be facilitated as they tend to share common needs and high propinquity. For instance, with his ethnographic work in one of the most impoverished region in the US, Desmond (2012) highlights that while kin network of the poor was prone to break, their non-kin network showed high levels of exchanging in resource and information. Qualitative research done in deprived regions in Korea also endorses such point (Lee & Lee, 2013; Tak, 2020). Therefore, while it is shown above that non-kin network of the Korean elderly had saliency over kin network in general, the magnitude of non-kin tie can be understood as particularly pivotal of the lower socioeconomic status group.

4.4. Robustness tests

In this section, I document a couple of further tests that aim to check the robustness of the estimations above.

< Table 8 > The effect of COVID-19 on social networks of the elderly living in major cities

	Children	*Family*	*Friend / neighbor / acquaintance*
Constant	0.007	0.216***	0.667***
	(0.062)	(0.045)	(0.071)
POST	−0.076***	−0.017***	0.052***
	(0.011)	(0.005)	(0.010)
TREAT	−0.116***	−0.010**	0.004
	(0.011)	(0.005)	(0.010)
*POST * TREAT*	−0.118***	−0.014	−0.143***
	(0.015)	(0.009)	(0.014)
Individual characteristics controls	Yes	Yes	Yes

Notes : * p<0.1, ** p<0.05, *** p<0.01.

< Table 9 > The effect of COVID-19 on social networks of the elderly not living in major cities

	Children	*Family*	*Friend / neighbor / acquaintance*
Constant	−0.032	0.257***	0.615***
	(0.045)	(0.042)	(0.064)
POST	−0.094***	−0.057***	0.024***
	(0.008)	(0.005)	(0.006)
TREAT	−0.090***	−0.065***	0.007
	(0.009)	(0.005)	(0.006)
*POST * TREAT*	−0.129***	0.042***	−0.116***
	(0.012)	(0.007)	(0.010)
Individual characteristics controls	Yes	Yes	Yes

Notes : * p<0.1, ** p<0.05, *** p<0.01.

Apart from socioeconomic status, it has been widely documented that whether an older adult is living in urban or rural area is pivotal in explaining the variance of personal ties. Levasseur and colleagues (2015) suggested that factors such as proximity to neighborhood, resource accessibility(e.g. health services, banking, social and sports activities), mobility, and the quality of social network explain such divergence in urban and rural areas. Empirical studies also demonstrate such regional discrepancy. For example, Evans (2009, p. 425) showed that while the size of network was greater for rural older adults, the frequency of interaction was greater for urban older adults. He stated that despite socioeconomic disadvantages of the rural elderly, "rural older adults have the advantage of being more highly integrated into social networks that provide informal social support when compared to their urban counterparts" in general. Lee and Cassidy (1985) also reported that the rural elderly interacted with kin ties more frequently than the urban elderly.

Since social networks and individual and environmental contexts of older adults in urban and rural regions deviate systematically in all aspects, this heterogeneity can significantly undermine the robustness of the estimation done by equation (1) (Jee & Goo, 2007; Lee & Lee, 2016; Son, 2010). In order to test whether this is an issue, additional tests are done with two subsample groups: those who are living in major urban areas in Korea(i.e. Seoul, Gyeonggi, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan) and those who are not.

Table 8 shows the regression result with urban samples and table 9 shows the result with non-urban sample. When compared to the results from table 2 to table 4, the interaction terms remain stable, as the variations in coefficients were all less than 0.02. These evidence corroborate that the main estimation results are not significantly biased by the regional heterogeneity.

Next, regarding the estimations which tested inter-group disparity of social networks, it is methodologically assumed that older adults' income does not significantly deviate over the 4 periods of observation. Put more simply, it is assumed that older adults who was in the lower 20% income group in 2011 would not be in upper 20% income group in 2020. Though it is widely acknowledged that the variance of income during later life period is one of the smallest when compared to other stages in life (Elder, Johnson, & Crosnoe, 2003; McGonagle et al., 2012; Narayan et al., 2018), if there had been high level of economic mobility across income quintile groups, the estimation results can be biased.

In order to test this issue, additional test is done as shown in table 10. Here, the upper and lower income groups are defined as upper and lower 30% income groups. If the empirical assumption is violated, the results in table 10 would significantly deviate from the results in table 5 and table 6, since the effect of COVID-19 on social network of the each income group would have been wrongly estimated.

< Table 10 > The effect of COVID-19 on social networks of the different income groups(30%)

		Children	*Family*	*Friend / neighbor / acquaintance*
Upper income group	Constant	0.082	0.231***	0.855***
		(0.114)	(0.068)	(0.124)
	POST	−0.135***	−0.059***	0.031***
		(0.013)	(0.007)	(0.010)
	TREAT	−0.166***	−0.064***	0.006
		(0.013)	(0.007)	(0.010)
	*POST * TREAT*	−0.081***	0.050***	−0.167***
		(0.018)	(0.010)	(0.017)
Lower income group	Constant	−0.113*	0.188***	0.630***
		(0.062)	(0.046)	(0.071)
	POST	−0.045***	−0.028***	0.057***
		(0.012)	(0.007)	(0.009)
	TREAT	−0.017	−0.034***	0.031***
		(0.012)	(0.006)	(0.010)
	*POST * TREAT*	−0.142***	0.009	−0.141***
		(0.017)	(0.009)	(0.015)
Individual characteristics controls		Yes	Yes	Yes

Notes : * p<0.1, ** p<0.05, *** p<0.01. The upper income group is defined as older adults who are above the 70% income quantile. The lower income group is defined as older adults who are below the 30% income quantile.

However, results in table 10 indicate that the empirical assumption is not significantly violated. For upper income group, even though the boundary line was largely loosened to 70th income quantile, their result was remarkably similar to that in table 5. The outcomes of the lower income group

remained stable also. The effect size differed by 0.029, 0.002, and 0.009, respectively for children, family, and non-kin network.

Ⅴ. Conclusion

5.1. Summary of the Study

Social network was adversely impacted in an unprecedented scale due to the shock of COVID-19. From the closure of daily routine organizations to total lockdown, social life of people came to virtual standstill without exception. While many of previous studies suspected the decline of social network to be associated with various negative individual outcomes, such as deterioration of physical and mental health, few studies actually examined the change of social network caused by the shock. Furthermore, most of the existing research on the change of social network focused on the population-level mean without considering socioeconomic context of individuals. This paper aimed investigate how social network, namely kin and non-kin network, of the Korean elderly changed due to COVID-19, and whether distinct patterns appeared across different income groups.

Using National Survey of Older Koreans data that have responses collected in 2011, 2014, 2017, and 2020, quasi-experimental approach to estimate the causal impact of COVID-19 on the social networks of the elderly is implemented. Becasue COVID-19 was a shock which hit the entire population thereby leaving no comparison group, observations from 2011 to 2014 were set as the benchmark group to serve as a counterfactual pattern in social network (Chen, Qian, & Wen,

2021; Lee & Hong, 2021). Further tests to check the robustness of the estimations were also performed.

Statistical results regarding the research hypotheses are as follows. First, in order to test *hypothesis* 1("The social networks of kin ties and non-kin ties would have weakened after the outbreak of COVID-19."), DID analysis performed with each type of social network. Children and family network were analyzed as kin network, and friend · neighbor · acquaintance network was analyzed as non-kin network. It is estimated that COVID-19 has decreased the probability to meet children once or more a week by 12.2 percent point and probability to meet non-kin once or more a week by 12.9 percent point. While the average probability to meet family network decreased from 5.5% in 2017 to 4.0% in 2020, the causal effect of COVID-19 was estimated to increase the probability by 2.4 percent point. Except for the family network, which had very low baseline level to be compared with other network types (Muralidharan & Prakash, 2017) and little weight in the configuration of social network of the Korea elderly, the results indicated the negative effect of COVID-19 on social network of the elderly and supported *hypothesis* 1, as suggested by previous results (Backer et al., 2021; Drolet et al., 2022; Freedma, Hu, Kasper, 2022; Gimma et al., 2022; Kovacs et al., 2021).

Second, regarding the *hypothesis* 2("The kin ties of the elderly population would have remained stronger than the non-kin ties for both income groups under COVID-19 situation."), such conjecture was grounded upon previous

literature on social network of the elderly, which emphasized the saliency of kin ties, such as the hirerarchical-compensatory model of Cantor (1979). Although the adverse effect of COVID-19 was greater in non-kin network(-0.129) than kin network(-0.122 for children and 0.024 for family), the gap between non-kin and children network was minute. More importantly, the baseline level of the types of network significantly differed as the probability to meet non-kin once or more a week in 2017 was 0.794 and the probability to meet children was 0.365. The figures in 2020 were 0.710 and 0.166 respectively. Thus, *hypothesis* 2 which expected the saliency of kin ties was rejected.

Lastly, in order to test *hypothesis* 3-1("The decrease of kin ties in the upper income group would be greater than the lower income group.") and *hypothesis* 3-2("The decrease of non-kin ties in the upper income group would be greater than the lower income group."), DID analysis was performed respectively for the upper income group and the lower income group. Furthermore, to further elaborate the inter-group heterogeneity in negative impacts of the shock, additional empirical model in equation (2), which employed triple interaction term, was used (Caselli & Falco, 2021; Chen, Qian, & Wen, 2021). Statistical results showed that the upper group experienced less decrease in kin ties and great decrease in non-kin ties, compared to the lower group. Therefore, *hypothesis* 3-1 was rejected and *hypothesis* 3-2 was supported.

DID coefficients remained stable regardless of how many

individual-level control factors were added to the empirical models, which implied that the empirical strategy was successful in controlling the unobserved possible confounders. But to assure robustness of the estimation, a couple of additional tests were performed. The tests showed that the estimations in this paper did not have problems of bias and the violation of the empirical assumption.

5.2. Implications of the Study

The results of this study on how social networks of the Korean elderly were affected by COVID-19 and how the impact diverged between different economic groups have following theoretical and policy implications.

To begin with, evidence in this study heavily questions the centrality of kin ties of older adults, in contrary to how a vast majority of research on older adults theoretically assumes. As we have discussed how Cantor's hierarchical-compensatory model can provide clear picture on the configuration of older adults' social network as it presumes fixed rank of preference, a large number of related studies have followed such assumption that kin ties will have priority to older adults in any situation (Chen & Feeley, 2014; Shanas, 1979). However, evidence in this study clearly shows that the weight of kin network has been less significant even before COVID-19. Moreover, considering that this results are derived from Korean context, where filial piety in family dynamics is thought to be

much more strong than other developed countries (Chow, 1991; Kim, 1999; Park, 2015), such theoretical implication of this study can be applied to wider range of societies and cultures.

This incongruence between theoretical expectation from hierarchical-compensatory model of Cantor and empirical evidence may have derived from the fact that the model is overly generalized across elderly population with different backgrounds and socioeconomic contexts. In this sense, task-specific model of Litwak, which is arguably less popular than that of Cantor's, can have advantages, in that it considers such omitted factors. As Messeri and associates (1993) suggested, it may be more desirable that we view hierarchical-compensatory model as a special case of task-specific model. While task-specific model has theoretical richness as it accounts the feature of a specific type of tie as well as individual's context, hierarchical-compensatory model reduces the dimension by assuming that older adults have fixed preference of demand.

Second, the novel contribution of this study is that it quantitatively examined how variation of social network diverged across different socioeconomic groups. Although the notion of stratification was associated with social network from the beginning, efforts to examine them with empirical data remained very insufficient (DiMaggio & Garip, 2012). As we have also seen in discussing the validity of theoretical framework on the social network of the elderly, many of the theoretical assumptions in network studies are seldom

empirically tested (Small, 2013).

Furthermore, evidence in this study invokes the need of creating more systematic theoretic explanation on the divergence of social network in different socioeconomic groups. Existing theoretical frameworks tend to focus on single socioeconomic group rather than explaining their divergence in a whole picture (Bourdieu, 1984; Desmond, 2012; Granovetter, 1973; Lin, 1999;). While the task-specific model can be a useful starting point, where socioeconomic factor can be added to the decision making process, future empirical studies which are done in different contexts and settings can provide preliminary insights on how socioeconomic factor affects the network dynamics.

Fourth, this study suggests that social policy and social welfare research needs to broaden its scope into the concept of relational welfare. While the study on social welfare is grounded on person-in-environment perspective, this perspective should better be labeled as *persons*-in-environment. As Kathleen Ell (1984, p. 141) wrote, "[f]uture research can begin to answer questions such as in what ways role shifts are associated with network change ... among middle-aged and older adults. ... Whether one confidant or numerous less close relationships are most helpful in specific problem situations can also be explored." Because network is ubiquitous for all people, it should have more its deserved significance in discussing micro and macro social work intervention.

And finally, though it was promised in the recent

presidential campaign that the family support obligation rules for the elderly will be abolished, the fact is that the rules still remain with a few adjustments made with the income criterion and requires those with kin relations to be responsible for the living of the elderly. While the policy was infamous in the field of social welfare, criticisms often ended up with normative arguments. The evidence in this study, however, shows that the centrality of kin ties in the fabric of social network of the Korean elderly is not valid anymore, and that this was especially true for the disadvantaged elderly. If the frequency of social network can be a good proxy for the level of exchange of resource between network members, the family support obligation rules is definitely based on obsolete assumption on the network dynamics. Future network research that specifically aims to measure the degree by which kin members exchange financial resource can further corroborate such point.

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국문초록

본 연구는 코로나-19가 노인들의 사회적 관계망에 미친 영향을 분석한다. 노인의 관계망은 크게 친족 관계망과 비친족 관계망으로 분류되었고, 코로나로 인한 충격이 서로 다른 경제적 집단에 상이한 영향을 미쳤는지 확인하기 위해 균등화가구소득을 기준으로 상위집단과 하위집단으로 표본을 나누어 분석을 진행하였다. 분석 결과 비친족 관계망이 소득에 상관없이 노인의 관계망의 주를 이루고 있었고, 두 집단 모두 코로나-19로 인해 친족 관계망과 비친족 관계망의 감소를 경험하였다. 소득 상위집단은 비친족 관계망의 감소를 상대적으로 더 크게 보인 반면, 하위집단은 친족 관계망의 감소를 상대적으로 더 크게 보여 집단 간 차이를 확인할 수 있었다. 이 같은 결과들은 노인들의 사회적 지지와 관계망이 대부분 가족으로 구성되어 있을 것이라는 기존의 이론 및 정책적 가정들에 대해 비판적 함의를 제공한다.

주요어 : 사회적 관계망, 노인, 코로나-19, 친족, 불평등, 이중차분법
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