Are intergenerational relationships responsible for more {COVID}-19 cases? A cautionary tale of available empirical evidence

Are intergenerational relationships responsible for more COVID-19 cases? A cautionary tale of available empirical evidence

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Abstract

The SARS-CoV-2 virus, originated in Wuhan (China) at the end of 2019, rapidly spread in more than 100 countries. Researchers in different fields have been working on finding explanations for the unequal impact of the virus, and deaths from the associated disease (COVID-19), in different geographical areas. Demographers and other social scientists, have hinted at the importance of demographic factors, such as age structure and intergenerational relationships. The goal of this article is to reflect on the possible link between intergenerational relationships and COVID-19 cases in a critical way. We show that with available aggregate data it is not possible to draw robust evidence to support such a link. In fact, at the country-level higher prevalence of intergenerational co-residence and contacts is broadly positively associated with number of COVID-19 cases (per 100,000 persons), but the opposite is generally true at the sub-national level. While this inconsistent evidence neither demonstrates the existence nor the inexistence of a causal link between intergenerational relationships and the prevalence of COVID-19 cases, we warn against simplistic interpretations of the available data which suffer from many shortcomings. Only retrospective individual level data will provide robust evidence on the role of intergenerational ties. We conclude arguing that intergenerational relationships are not only about physical contacts between family members. From a theoretical point of view, different forms of intergenerational relationships may have causal effects of opposite sign on the diffusion of COVID-19. Policies devoted at fighting the spread of COVID-19 should also take into account that intergenerational ties are a source of instrumental and emotional support, which may favor compliance to the

lockdown and "phase-2" restrictions and may buffer their negative consequences on mental health.

Introduction

The rapid spread of the SARS-CoV-2 made urgent the need to understand which factors contribute to the diffusion of the virus. The disease associated with the virus, Coronavirus Disease 2019 (COVID-19), is particularly deadly for older people (Wu and McGoogan, 2020) and it has been argued that the high prevalence of infected older people is crucial to understand the high Case Fatality Rate (CFR) observed in some countries, such as Italy (Dowd et al. 2020; Dudel et al 2020). Researchers have also hinted at intergenerational relationships (IR) as a driver of COVID-19 cases, especially among older people (Bayer and Kuhn 2020). In particular, it was argued that "intergenerational interactions, co-residence, and commuting may have accelerated the outbreak in Italy through social networks that increased the proximity of elderly to initial cases" (Dowd et al, 2020).

The goal of this paper is to reflect on the link between IR and the prevalence of COVID-19 cases. We show that with available aggregate data it is not possible to draw robust evidence to support such a link. While we cannot demonstrate whether there is or there is not a (causal) link between IR and COVID-19 cases, our analyses at the sub-national level warn against simplistic interpretations of country level associations. We also discuss possible theoretical links between IR and the spread of COVID-19 that may work in opposite directions.

Physical intergenerational relationships and the spread of COVID-19

In line with simulation models of the spread of infectious diseases (Germann et al, 2006; Mossong et al., 2008), physical contact is the main transmission mode of COVID-19 (Huang et al, 2020; Peeri et al, 2020), implying a positive link between physical contacts and infection rates. With physical contact we refer to face-to-face meetings between at least two persons, being these relatives, friends, colleagues or other people.

Contact frequency between family members is stable over the life course and constitute a large part of individuals' overall contacts (Sander et al, 2017; Wrzus et al, 2013), especially in some countries where contacts between grandparents and their grandchildren and between parents and their children are considerably more frequent than in others (Dykstra, 2018; Reher, 1998). Italy and Spain, two of the European countries most seriously hit by the COVID-19 pandemic, are also among the countries who display higher prevalence of intergenerational co-residence (Albertini and Kohli, 2013; Tomassini et al 2004; Glaser et al, 2018; Grundy and Murphy, 2018) and of frequent intergenerational contacts between older parents and their adult children (e.g., Bordone, 2009; Hank, 2007; Yahirun and Hamplová, 2014) and their grandchildren, also due to intensive grandparental childcare (Bordone et al, 2017; Price et al, 2018). This may suggest a sort of "intergenerational contacts hypothesis", assuming that in countries where intergenerational face-to-face contacts between family members are more frequent, higher infection rates are observed.

This hypothesis has been recently put forward in the public and academic debate. For example, Balbo et al (2020) and Dowd et al (2020) argue that the comparatively higher prevalence of intergenerational co-residence and contacts in Southern Europe, and in particular in Italy, imply a higher vulnerability to epidemics that disproportionately affect older adults in these countries. A similar argument has been made by Esteve et al (2020) with respect to Spanish provinces. The only direct evidence in support to the "intergenerational contacts hypothesis" has been, however, provided at the country level by Bayer and Kuhn (2020). Using data from 24 countries (Australia plus some European and East-Asia countries), the authors found a positive correlation at the country level between the percentage of adults aged 30-49 living with their parents and CFR. The authors argue that this finding highlights the role of IR in spreading COVID-19 to older people. The article by Bayer and Kuhn (2020) has been criticized by Belloc et al (2020) that in their commentary noted that if when comparing Italian regions an opposite result would be obtained. We extend the analyses in these contributions by considering a larger set of IR indicators at both country and subnational level and from two different datasets. We also add a brief theoretical discussion on non-physical intergenerational relationships.

Methods

Data

Cumulative number of COVID-19 cases were drawn from a public repository, which daily collects data directly from each country's ministry of health (https://github.com/open-covid-19/data#response). To account for vastly different population sizes across the considered countries and regions, we consider the total number of cases per 100,000 inhabitants. Because of the necessity to merge different sources of data, some harmonization measures were taken. First, while COVID-19 cases at the country level were collected on the last available date at the time of finalizing this work (27^{th} of April 2020), an exception has been made for Belgium and Estonia, for which the last available information was only available for two days earlier (25^{th} of April). Second, data at the subnational level were only available for some of the considered countries. Thus, the within-country analyses have been made possible only for 8 countries (France, Germany, Italy, Poland, Portugal, Spain, Sweden, Switzerland). Moreover, for France, the last available information on reported cases and deaths at the regional level was dated back to the 26^{th} of March 2020. We also notice that while the FSS2016 dataset provides data for all the Italian regions, the SHARE survey did not include cases for the Valle d'Aosta region.

Data on IR were taken from two sources: The Survey of Health, Ageing and Retirement in Europe (SHARE) and the Italian National Statistical Office (ISTAT) survey on family and social subjects (FFS2016). SHARE it is a longitudinal survey on individuals aged 50+ in several European countries plus Israel. We excluded Israel in order to focus on European countries only; thus, the analyses were carried out on 19 countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland). To maximize the sample size at the NUTS-2 level we have pooled all regular waves (1, 2, 4-6) and taken the first observation for each individual to avoid issues of selective attrition. We excluded waves 3 and 7 because they (mainly) collected retrospective information.

FFS is a repeated cross-sectional survey on the Italian population aged 18+. We have considered the last available wave (collected in 2016) which covers detailed information of about 24,753 individuals. These data allow obtaining estimates at NUTS-2 level (regions) with sufficient precision (sample size range 515 - 2050).

Variables

Information on family ties from SHARE and FFS data, aggregated at both country and regional levels, have been used to measure four specific aspects of IR: co-residence, geographic proximity, contact frequency and provision of grandchild care. In the case of the SHARE data we measured IR indicators restricting the sample to individuals 60+. The analyses based on FFS data used both the whole sample (18+) and the 60+ subsample. The rational of considering the 60+ population rests on the fact that older people are the most vulnerable to the COVID-19 disease. We also estimated all IR measures on the population 18+ because the whole population is at-risk of contracting the SARS-CoV-2 virus. By considering the 18+ population at the denominator of the IR indicators, we also automatically account for differences across geographical areas in the number of children, grandchildren, and parents people have (alive).

Intergenerational co-residence was assessed by calculating the prevalence of respondents (aged 18+ and/or 60+) living in multi-generational households (two or more generations).

Geographical proximity is differently measured in the SHARE and the FSS surveys. More specifically, we were able to use, alternatively, 5 and 25 Km as thresholds for geographic proximity in the analyses based on SHARE data and 16 Km for the FFS data. SHARE only provides information on geographical proximity to children. We calculated the percentage of individuals living close to at least one child and, for the FFS data only, also the percentage of individuals living close to at least one parent and grandchild.

Frequency of contacts was also measured differently in the SHARE and FFS surveys. SHARE collects information on contact frequency of any type (physical and non-physical) with each respondent's child. With FFS data we were able to measure physical contacts with parents and up to three children, and grandchildren (those with whom the respondent has the most contacts). With SHARE data we calculated the percentage of individuals aged 60+ who have weekly or daily contacts with at least one child. In order to provide a measure of contacts that accounts also for the number of children the respondent has, we additionally measured the mean of the (equivalent) total number of daily contacts with all children in a year. Similarly, with the FFS data we calculated the mean of the (equivalent) total number of daily contacts with parents, children, and grandchildren in a year, separately for the population 18+ and 60+.

Grandparental childcare is measured in SHARE by asking grandparents the frequency of care provided to their grandchildren, separately for each respondent's child. We estimated the percentage of individuals 60+ who provide any / daily / weekly care to at least one grandchild. Similarly to what we did for contact frequency, we estimated the mean of the (equivalent) total number of daily grandchild care. The FFS data do not provide frequency of grandchild care. In this case, we estimated the mean number of grandchildren for whom care is provided, both for the 18+ and 60+ populations.

Each IR indicator was estimated using sampling weights both at the country- and at the NUTS-2 level.

Statistical analyses

We perform very simple statistical analyses to examine associations between IR and COVID-19 cases. Our analyses are organized in three steps. First, using SHARE data we examine country-level associations between several IR measures and COVID-19 cases (for 19 countries). Secondly, with the SHARE data we account for the within-country variability in both IR and COVID-19 and examine correlations at the NUTS-2 level. These analyses are restricted to the 8 countries for which we have subnational information on COVID-19 cases. For Germany, COVID-19 cases are available at the NUTS-1 level instead of NUTS-2. Finally, we zoom in on Italy and re-examine the associations at the NUTS-2 level using data from the nationally representative FFS survey on the 18+ and 60+ populations. We examine Italian data in more detail because, as discussed in the *Introduction*, there is a vast literature on the comparatively higher prevalence of intergenerational co-residence and frequent contacts in this country. Italy has also been among the first non-Asian countries to be severely hit by the COVID-19 pandemic. Finally, the spread of COVID-19 cases in Italy has been taken as an illustrative case for the "intergenerational contacts hypothesis" (Dowd et al, 2020; Balbo et al, 2020).

Associations at the country- and regional-level are estimated both using the standard Pearson (linear) correlation coefficient and the non-parametric Spearman's rank correlation coefficient. The advantage of the latter is that it only takes the ranks of the two examined variables into account and so it is less sensitive to outliers, deviations from a linear relationship and measurement errors, which are likely to be particularly serious for the number of COVID-19 cases. Using SHARE data, we also estimate a very simple linear regression model taking the 118 available regions as the unit of analysis. We first standardized and then decomposed each IR indicator in its regional and country components, as often done in multilevel or longitudinal analyses to separate between and within effects. More specifically, we calculated the country mean of each indicator (between or country effect) and the regional deviations from the country mean (within or regional effect). In this way, the same regression model is able to estimate both country- and regional- level associations. Also, differently from correlation coefficients, this model informs about the strength of the associations, i.e. it gives the "effect" of a standard deviation increase in each IR indicator on the number of COVID-19 cases. We accounted for within country correlation in the IR indicators by using clustered standard errors.

It is well-known that data on COVID-19 cases are affected by several methodological issues (see e.g., Bohk-Ewald et al, 2020), but they represent the best information available to date on infections covering many countries and regions. Measurement errors in the number of COVID-19 cases is not clearly associated with our key variables of interest, IR. However, if even measurement error was completely random estimates would be biased toward zero. In any case, estimates from macro-level analyses should be interpreted with caution.

Results

Between-country associations (19 European countries)

Table 1 reports weighted descriptive summary statistics at the country level of IR indicators sorted according to the mean number of COVID-19 cases per 100,000 residents. A greyscale has been used to split up the distribution of each variable in tertiles, with the lightest grey for countries below 33% and the darkest for those above the 66% percentile. From this table it does not emerge a clear pattern of association between the prevalence of COVID-19 cases and IR at the country level. In fact, in several cases, countries in the highest tertiles of COVID-19 cases fall in the lowest tertiles of IR indicators and vice versa. For example, Slovenia, Greece and Portugal display the highest values of intergenerational co-residence (≥ 40%) and comparatively low prevalence of COVID-19 cases.

The lack of a clear pattern of association at a country level is also confirmed by the correlation matrix and linear regression estimates presented in Table 2. Table 2 reports Pearson's and Spearman’s correlation coefficients between the number of confirmed cases of COVID-19 per 100,000 people and each IR indicator. Although no correlation is statistically significant, a positive association is observed for geographic proximity with children and for frequency of contacts with them, but a negative one is found for living in multi-generational households and for grandchild care provision, especially if intensive (i.e., daily).

Restricting the sample to the 8 countries for which data at the regional level are available (columns 4-5, Table 2) confirm the mixed findings about the association of COVID-19 cases and IR indicators: positive associations are found for co-residence, geographic proximity and intergenerational contacts, while a negative one for grandchild care provision.

Finally, estimates of a linear regression model on the available 118 regions are reported in the last two columns of Table 2. The country-level effects of IR indicators are always positive, although not statistically significant. The only exception is found for provision of grandchild care which display, consistently with the correlation analysis, a negative association with COVID-19 cases ($p<0.1$). At the regional-level, regression estimates show a negative association between the regional deviation from the country's mean level of IR and COVID-19 cases for all the considered variables except for the general prevalence of grandchild care provision and weekly grandchild care. However, none of these coefficients is statistically significant. The generally small and inconsistent correlations in Table 2 suggest that conclusive interpretations are impossible to be derived. Also, the opposite signs of regional effects compared to those at the country-level hint at the importance of accounting for within-country variability in both prevalence of COVID-19 cases and IR indicators.

Within-country associations (8 European countries)

We examined within-country associations between COVID-19 cases and IR indicators for the 8 countries for which we have sub-national data. Table 3 reports correlation coefficients at the NUTS-2 level (except for Germany for which the NUTS-1 level only is available). The associations at the regional level display substantial differences across the considered countries. The Pearson's correlation coefficient for living in multi-generational household ranges between –0.47 (Sweden, $p<0.1$) to +0.67 (Portugal, $p<0.1$). A negative association is also found for Spain, France, Poland, and Italy, although only for the latter country it is statistically significant (Spearman's coefficient: -0.46; $p<0.01$). The correlation at the regional level between COVID-19 cases and geographic proximity is negative for Switzerland, Sweden, Spain, France, and Italy (statistically significant at the 1% only for Spain and Italy) and positive for the other countries.

The frequency of contacts is negatively associated with COVID-19 cases at the regional level in Sweden, Portugal, Poland, and – particularly – in Italy ($p<0.001$), but the association is positive in France, Germany, Switzerland and Italy (for daily contacts, $p<0.001$). Finally, the provision of grandchild care is positively correlated with COVID-19 cases for Italy, Germany, Sweden, Switzerland, and Poland while both, Pearson's and Spearman's correlation coefficients are negative for Spain, France, and Portugal.

Within-country associations (Italy)

Tables 4 and 5 reports weighted descriptive summary statistics of IR indicators and number of COVID-19 cases per 100,000 residents for each region of Italy, sorted according to the tertiles of COVID-19 cases. In Table 4, the IR indicators are calculated on the population 18+, while the 60+ has been considered in the construction of the indicators in Table 5. In general, we observe a clear negative pattern of association between COVID-19 cases, geographic proximity and frequency of intergenerational contacts (in fact, darker cells corresponding to higher number of COVID-19 cases correspond, in general, lighter cells, i.e. lower values, for the IR indicators). However, an unclear pattern is found for the provision of grandchild care.

These associations have been formally tested and results are reported in Table 6. Findings strongly confirm evidence from SHARE data and display an even stronger negative association between intergenerational co-residence and geographic proximity and COVID-19 cases. These findings are consistently found also amongst individuals aged 60 + displaying a Pearson's correlation coefficient of about -0.70 ($p<0.001$) with regard to co-residence and of about -0.60 ($p<0.001$) with regard to living close (within 16 km) to children and/or grandchildren. The frequency of contacts with children and grandchildren is also negatively associated with COVID-19 cases at the regional level, showing a Pearson's correlation coefficient of about -0.56 and -0.61 ($p<0.001$). Again, consistently with the evidence drawn from the SHARE data, grandchild care provision at the regional level is positively correlated with COVID-19, cases although this coefficient is not statistically significant.

Conclusion and Discussion

The aim of this paper was to critically discuss the role of intergenerational relationships (IR) in the spread of COVID-19, providing empirical evidence to counterargue that a higher impact of the pandemic in some areas could be explained by more contact, proximity or functional solidarity (e.g., grandparental childcare) across generations within the family.

Notwithstanding positive associations between (most) IR indicators and COVID-19 cases at the country level, our analyses have largely shown opposite results at the sub-national level. We do not conclude from this that IRs negatively impact on the spread of COVID-19, but this evidence highlights the need for further investigation. Because of the inconsistent results we obtained at the country- and regional-level, we thus caution against over-interpretations of the empirical evidence on the association between IR and the spread of COVID-19.

There are two additional important aspects to consider that further suggest carefulness in this respect. First, when analyzing the effect of IR on COVID, one should take, as usual, confounding factors into account. At the country-level, a positive association may be spurious because intergenerational contacts are more frequent in "weaker" welfare states (Künemund, 2008) where, for example, public health services tend to be less available and/or of lower quality. Similarly, at the regional level, a negative association between IR and COVID-19 cases may be due to the negative association between IR and the prevalence of older people in nursing and care home, which have been found to have a crucial role in the diffusion of COVID-19 cases (Comas-Herrera and Zalakain, 2020). An example of this pattern is the Lombardy region in Italy that, as showed in Table 4, is characterized by one of the highest rate of COVID-19 cases and by a comparatively low prevalence of intergenerational co-residence and contacts, and at the same time by a relatively high prevalence of older people living in care residences (Pelliccia, 2017).

Other confounding factors may be represented by population density and level of commuting for job related reasons, and social relationships other than IR which have also been proposed as correlates of the prevalence of COVID-19 cases (Harris, 2020; Mogi and Spijker, 2020). These confounding factors may operate in various ways, affecting the link between IR and COVID-19 cases, thus making any claim from simple unadjusted associations doubtful. The association between IR and spread of COVID-19 should therefore be analyzed at a finer geographic level to allow accounting for confounding factors. Ideally, one should use individual data complemented with social network information to examine the likelihood of COVID-19 infection as function of IR and other type of contact. Unfortunately, these data are not yet available and specific data collection efforts should be implemented in this direction to provide solid empirical evidence on this issue.

The "intergenerational contacts hypothesis" focuses on physical contacts and overlooks non-physical forms of IR that may help keeping the spread of the virus low. As emphasized by the multidimensional model of intergenerational solidarity (Bengtson and Roberts, 1991; Bengtson 2001), IR may take different forms, not all involving physical contacts (Albertini et al, 2007; Dykstra and Fokkema, 2011; Glaser et al, 2004; Tomassini et al, 2004). For example, geographical proximity determines the possibility of providing some forms of instrumental support (e.g., help in cooking or cleaning) but not others (like online shopping in today's digitalized world). Similarly, associational solidarity may include phone calls in digital form that are cheaper and offer the possibility of video interactions, allowing to manifest affect in a way that resembles physical contact (Quadrello 2005; Peng et al. 2018).

If IR are not limited to physical contacts, from a theoretical perspective, the association between IR and the spread of COVID-19 is even less clear cut. A wide array of studies has shown that IR are important for individuals' health and well-being (e.g., Arpino and Bordone, 2014; Thoits, 2011). Applying the theoretical arguments that were used to explain this evidence to the spread of COVID-19 one may even hypothesize a negative effect of IR. For example, the social control perspective (Umberson et al, 2010) postulates that close family members are interested in preserving their kin in good health and to achieve this goal they exert pressure and control to inhibit family members' unhealthy behaviors and to promote their positive habits. Thus, for example, children may positively influence their older parents in complying with the measures taken by the Government and/or local authorities to contrast the spread of COVID-19.

Along this line, social-behavioral models of IR posit that, satisfying social norms of family obligations, family members provide help and support to each other, thus complementing the role of the welfare state (Antonucci et al 2007, Carr & Springer 2010, Cooney and Dykstra, 2011; Marckmann, 2017; Silverstein & Bengtson 1991). In the time of COVID-19 pandemic, help provided by children (e.g. with (online) shopping) may aid older parents to stay at home and reduce their exposure to the virus. IR are also an important source of emotional support, which reduces risk of depression and loneliness (Mansson, 2016). This is another mechanism that may favor compliance with the "physical distancing" rule: people who receive more emotional support at home, or even at a distance (on the phone), may be less likely to go out to look for distractions and social contacts. As a side note, given the importance of non-physical interactions among humans we also suggest, as others did (e.g., Kumar, 2020), to replace the term "physical distancing" to "social distancing".

All in all, we have shown that empirically the association between IR and the spread of COVID-19 is not robust. We also argued that different forms of IR may have contraposing effects. Incorrect conclusions on the effect of IR on COVID-19 are not innocuous because policy implications based on not solid evidence may be ineffective and counterproductive. Help provided by family members may result to be particularly needed and useful in adverse situations to buffer their negative impact on mental health (Carr et al, 2017; Carr 2020). Some studies already documented increased mental health problems during the COVID-19 pandemic (e.g., Brooks et al, 2020). Thus, IR may be especially needed to cope with the stress caused by the restrictions and the climate of uncertainty in the time of the COVID-19 pandemic. Policies that fight against the spread of COVID-19 and those oriented at the so-called “phase 2”, i.e. the post-emergency phase, need to take into account the importance of instrumental and emotional support guaranteed by IR, which is particularly important in some countries, and for older people.

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Table 1 - COVID-19 cases and intergenerational relationships indicators across 19 European countries

Countries	**Covid-19**	**Co-residence**	**Geographical Proximity**		**Frequency of intergenerational contacts**			**Grandchild care**			
	Cases (100,000)	Multi-generational HH (%)	N. children < 5 Km (mean)	N. children < 25 Km (mean)	Children weekly contacts (number, mean)	Children daily contacts (%)	Children contacts	Grandchild care (%)	Weekly grandchild care (%)	Daily grandchild care (%)	Grandchild care
Luxembourg	605.62	16.19	0.71	1.28	1.43	0.60	348.79	27.77	17.86	5.51	28.14
Spain	490.88	36.84	1.47	1.79	1.81	1.00	498.77	25.17	17.05	9.91	38.21
Ireland	402.41	25.28	1.10	1.69	1.88	0.80	455.07	34.58	19.38	7.27	35.10
Belgium	392.78	13.66	0.88	1.52	1.57	0.48	340.48	37.24	22.42	6.26	34.95
Switzerland	338.49	16.27	0.72	1.24	1.43	0.31	269.58	24.48	14.13	2.43	17.84
Italy	329.33	40.91	1.21	1.54	1.60	1.00	463.41	23.20	17.86	10.87	40.12
Portugal	234.95	31.56	1.18	1.60	1.80	0.88	461.34	21.70	13.31	7.38	28.15
Netherland	223.69	8.38	0.97	1.50	1.76	0.40	357.01	38.29	18.63	1.69	21.58
France	197.05	12.90	0.64	1.09	1.58	0.44	332.41	33.70	12.81	3.69	20.49
Sweden	188.57	5.66	0.59	1.06	1.70	0.38	336.25	36.02	10.54	1.15	13.12
Germany	187.19	21.59	0.74	1.14	1.37	0.44	298.20	23.45	12.86	4.07	19.53
Austria	170.36	24.85	0.88	1.38	1.49	0.49	331.88	24.33	14.06	4.00	20.88
Denmark	150.69	5.67	0.60	1.19	1.70	0.34	324.38	42.13	12.09	0.87	15.14
Estonia	123.33	22.52	0.64	1.00	1.32	0.48	303.10	24.59	11.03	4.31	19.32
Czech Rep.	69.68	25.28	0.97	1.41	1.48	0.56	347.20	30.86	16.95	6.07	28.52
Slovenia	67.68	47.45	1.11	1.51	1.67	0.90	458.32	29.84	17.89	9.71	36.31
Poland	31.41	49.67	1.31	1.73	1.68	0.80	424.56	33.85	23.72	15.90	53.99
Hungary	27.32	35.14	1.03	1.37	1.38	0.77	378.16	24.06	15.99	6.16	27.46
Greece	24.19	42.41	1.10	1.38	1.62	0.99	470.32	26.29	17.89	11.08	39.34

Source: Authors' elaborations on data from Survey of Health, Ageing and Retirement in Europe (SHARE - Waves 1,2,4,5, 6). Sampling weights have been applied.
Note: The greyscale refers to the percentile distribution with the lightest grey for the cases below 33% and the darkest for those above the 66%. COVID-19 cases data were collected on the last available date at the time of finalizing the study (27th April 2020). HH = household.

Table 2 – Association (Pearson's (P), Spearman's (S) correlation coefficients or regression coefficients) between number of COVID-19 cases per 100,000 residents and intergenerational relations indicators at the country or regional level

Variables	**Country-level correlations (19 countries)**		**Country-level correlations (8 countries)**		**Regression coefficients (8 countries; 118 regions)**	
	P	S	P	S	Country	Region
Co-residence						
Multi-generational HH	-0.30	-0.36	-0.00	0.02	54.17	-49.44
Geographic Proximity						
N. Children living < 5 Km	0.01	-0.03	0.28	0.23	110.7	-54.62
N. Children living < 25 Km	0.20	0.22	0.24	0.33	117.4	-66.55
Frequency of intergenerational contacts						
Children weekly contacts	0.16	0.24	0.15	0.28	40.54	-29.60
Children daily contacts	-0.00	-0.03	0.31	0.33	66.27	-9.87
Children contacts	0.05	0.01	0.30	0.33	68.89	-13.28
Grandchild care						
Grandchild care	-0.03	0.02	-0.55	-0.38	-105.60*	6.56
Weekly grandchild care	0.14	0.10	-0.17	0.19	58.38	17.11
Daily grandchild care	-0.11	-0.11	-0.13	-0.04	50.05	-18.31
Grandchild care	0.00	-0.02	-0.09	0.00	67.39	-6.66

Source: Authors' elaborations on data from Survey of Health, Ageing and Retirement in Europe (SHARE - Waves 1,2,4,5, 6). Sampling weights have been applied.
Note: Columns 2-5: Pearson's (P) and Spearman's (S) correlation coefficients. Columns 5-6: Regression coefficients respectively referring to the intergenerational relation variables at the country level (column 6) and the regional deviations from the country level means (column 7). In the regression analysis, variables have been standardised. *** p<0.01, ** p<0.05, * p<0.1. HH = household.

Table 3 – Pearson's (P) and Spearman's (S) correlation coefficients between regional number of COVID-19 cases per 100,000 residents and intergenerational relations indicators, by country

Variables	ITALY		SPAIN		FRANCE		GERMANY		SWITZERLAND		SWEDEN		PORTUGAL		POLAND	
	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S
Co-residence																
Multi-generational HH	-0.25	-0.46 **	-0.31	-0.37	-0.15	-0.04	0.26	0.40	0.48 *	-0.05	-0.47 *	-0.45 *	0.67 *	0.68 *	-0.15	-0.14
Geographic Proximity																
N. Children living < 5 Km	-0.56 **	-0.63 ***	-0.32	-0.37	-0.19	0.13	0.07	0.008	0.28	-0.24	-0.28	-0.25	0.46	0.07	-0.14	0.31
N. Children living < 25 Km	-0.46 ***	-0.49 **	-0.51 **	-0.53 **	-0.23	0.09	0.05	0.12	-0.08	-0.23	-0.07	-0.09	0.54	0.54	-0.09	0.31
Frequency of contacts																
Children weekly contacts	-0.59 ***	-0.71 ***	-0.12	-0.19	0.42	0.23	0.18	0.11	0.21	0.02	-0.25	-0.26	-0.63	-0.75 *	-0.01	-0.02
Children daily contacts	-0.57 ***	-0.74 ***	0.11	-0.06	0.27	0.45	0.48 *	0.68 ***	0.63 *	0.13	-0.43 *	-0.41 *	-0.36	-0.43	-0.29	-0.14
Children contacts	-0.61 ***	-0.74 ***	0.07	0.005	0.34	0.45	0.35	0.59 **	0.61 *	-0.01	-0.22	-0.11	-0.51	-0.61	-0.18	-0.14
Grandchild care																
Grandchild care	0.26	0.18	-0.25	-0.41 *	-0.68 **	-0.53	0.19	0.31	0.52*	0.42 *	0.30	0.38	-0.34	-0.36	0.20	0.42
Weekly grandchild care	0.30	0.29	-0.15	-0.28	-0.34	-0.03	0.50 *	0.56 **	0.57 *	0.30	0.26	0.34	-0.08	-0.18	0.23	0.54
Daily grandchild care	0.30	0.33	-0.42 *	-0.45 *	-0.32 *	-0.17	-0.15	0.27	0.70 *	0.24	-0.07	-0.05	-0.02	-0.18	-0.07	0.31
Grandchild care	0.27	0.27	-0.33	-0.38	-0.43	-0.26	0.00	-0.15	0.74*	0.30	0.13	0.28	-0.11	-0.18	-0.12	0.54

Source: Authors' elaborations on data from Survey of Health, Ageing and Retirement in Europe (SHARE - Waves 1,2,4,5, 6). Sampling weights have been applied.
Note: Pearson's (P) and Spearman's (S) correlation coefficients. *** p<0.01, ** p<0.05, * p<0.1. Number of units (N): Italy = 19 (NUTS-2); Spain = 18 (NUTS-2); France = 11 (NUTS-2); Germany = 16 (NUTS-1); Switzerland = 24 (NUTS-2); Poland = 7 (NUTS-2); Portugal = 6 (NUTS-2).

Table 4 - COVID-19 cases and intergenerational relationships measures by Italian regions – Population aged 18+

Italian regions	Covid-19	Co-residence	Geographic Proximity			Frequency of intergenerational contacts			Grandchild care
	Cases (100,000)	Multi-generational HH (%)	Parents close (%)	N. children close (mean)	N. grandchildren close (mean)	Parents contacts (mean, days)	Children contacts (mean, days)	Grandchildren contacts (mean, days)	N. grandchildren cared (mean)
Aosta Valley	875.26	53.13	45.87	0.71	0.30	121.22	90.98	72.30	2.93
Lombardy	729.10	58.36	44.07	0.82	0.35	107.89	107.94	81.91	2.90
Piedmont	573.28	58.37	42.31	0.83	0.39	98.00	103.04	86.03	2.88
Emilia-Romagna	554.67	56.47	38.82	0.80	0.36	83.49	103.55	75.97	2.95
Liguria	490.64	52.54	43.06	0.76	0.34	96.33	100.44	72.42	2.95
Alto-Adige	470.93	63.10	48.63	0.89	0.39	106.19	87.86	67.22	2.85
Marche	397.42	64.11	46.14	0.81	0.38	113.18	104.95	100.56	2.93
Trento	373.24	62.54	49.00	0.79	0.33	120.21	101.96	85.43	2.97
Veneto	361.30	63.09	48.06	0.87	0.40	116.16	104.81	85.79	2.87
Tuscany	245.26	59.63	43.60	0.85	0.42	106.82	103.83	93.35	2.93
Friuli Venezia Giulia	244.71	55.09	39.90	0.80	0.41	86.47	107.83	84.95	2.89
Abruzzo	219.73	64.08	47.27	0.82	0.42	112.80	112.24	101.36	2.90
Umbria	154.10	62.22	45.27	0.88	0.45	109.59	123.98	101.36	2.93
Lazio	108.38	61.58	46.64	0.78	0.35	109.62	89.26	74.09	2.91
Apulia	97.39	68.42	56.46	0.98	0.51	140.69	137.08	123.58	2.90
Molise	95.95	67.20	50.39	0.81	0.39	123.40	111.19	102.90	2.92
Sardinia	77.67	68.41	53.04	0.82	0.34	127.08	98.54	86.44	2.93
Campania	74.10	73.41	55.25	0.88	0.43	112.00	106.26	89.19	2.86
Basilicata	63.55	66.89	53.70	0.86	0.40	126.97	131.39	93.77	2.89
Sicily	61.33	68.18	53.36	0.93	0.49	139.26	120.82	110.70	2.87
Calabria	55.33	66.77	54.66	0.79	0.38	137.12	113.53	107.82	2.90

Source: Authors' elaborations on data from Family and Social Subjects (FSS 2016).

Note: The greyscale refers to the percentile distribution with the lightest grey for the cases below 33% and the darkest for those above the 66%. Columns' labels: cases = the number of COVID-19 cases per 100,000 residents (at the time of finalizing the study, 27th April 2020); co-residence = prevalence of residents living in multi-generational household; parents close = prevalence of residents reporting at least one parent living within 16 km; n. children close =mean of number of children; living within 16 Km from the respondent; n. grandchildren close = number of grandchildren living within 16 km from the respondent; parents/children/grandchildren contacts = mean number of days in a year spent together with; n. grandchildren care = mean number of grandchildren cared from the respondent if she/he is over 60. HH = household.

Table 5 - COVID-19 cases and intergenerational relationships measures by Italian regions – Population aged 60+

Italian regions	Covid-19	Co-residence	Geographic Proximity			Frequency of intergenerational contacts			Grandchild care
	Cases (100 000)	Multi-generational HH (%)	Parents close (%)	N. children close (mean)	N. grandchildren close (mean)	Parents contacts (mean, days)	Children contacts (mean, days)	Grandchildren contacts (mean, days)	N. grandchildren cared (mean)
Aosta Valley	875.26	12.49	18.38	1.04	0.72	121.22	207.72	173.16	2.93
Lombardy	729.10	14.58	14.99	1.20	0.78	107.89	238.04	189.94	2.90
Piedmont	573.28	15.25	11.51	1.22	0.88	98.00	219.79	191.68	2.88
Emilia-Romagna	554.67	14.97	13.97	1.12	0.75	83.49	208.36	168.92	2.95
Liguria	490.64	14.53	17.31	1.04	0.69	96.33	193.38	152.23	2.95
Alto-Adige	470.93	12.54	11.79	1.37	1.03	106.19	208.90	179.32	2.85
Marche	397.42	18.42	17.95	1.20	0.84	113.18	230.63	237.02	2.93
Trento	373.24	13.41	13.43	1.18	0.84	120.21	240.85	219.99	2.97
Veneto	361.30	17.36	14.11	1.37	0.98	116.16	247.42	214.99	2.87
Tuscany	245.26	17.66	14.62	1.22	0.83	106.82	210.28	202.46	2.93
Friuli Venezia Giulia	244.71	14.20	11.03	1.10	0.82	86.47	213.95	175.17	2.89
Abruzzo	219.73	18.57	15.74	1.24	0.91	112.80	241.13	228.90	2.90
Umbria	154.10	17.94	12.89	1.32	0.97	109.59	269.01	236.77	2.93
Lazio	108.38	16.74	15.44	1.21	0.81	109.62	206.20	180.89	2.91
Apulia	97.39	19.05	18.49	1.59	1.19	140.69	306.75	295.69	2.90
Molise	95.95	17.79	17.67	1.19	0.91	123.40	243.01	242.61	2.92
Sardinia	77.67	21.29	14.43	1.31	0.77	127.08	215.82	199.07	2.93
Campania	74.10	18.50	14.89	1.46	1.05	112.00	256.17	229.20	2.86
Basilicata	63.55	18.46	15.72	1.42	0.90	126.97	287.81	213.46	2.89
Sicily	61.33	16.84	15.37	1.48	1.18	139.26	280.00	276.77	2.87
Calabria	55.33	15.59	15.42	1.29	0.99	137.12	282.95	282.70	2.90

Source: Authors' elaborations on data from Family and Social Subjects (FSS 2016).

Note: The greyscale refers to the percentile distribution with the lightest grey for the cases below 33% and the darkest for those above the 66%. Columns' labels: cases = the number of COVID-19 cases per 100,000 residents (at the time of finalizing the study, 27th April 2020)); co-residence = prevalence of residents living in multi-generational household; parents close = prevalence of residents reporting at least one parent living within 16 km; n. children close =mean of number of children; living within 16 Km from the respondent; n. grandchildren close = number of grandchildren living within 16 km from the respondent; parents/children/grandchildren contacts = mean number of days in a year spent together with; n. grandchildren care = mean number of grandchildren cared from the respondent if she/he is over 60. HH = household.

Table 6 - Pearson's (P) and Spearman's (S) correlation coefficients between regional number of COVID-19 cases per 100,000 residents and intergenerational relations indicators. Italian regions, population 18+ or 60+

Variables	Italian regions – Population 18+		Italian regions – Population 60+	
	P	**S**	**P**	**S**
Co-residence				
Multi-generational HH	-0.75 ***	-0.77 ***	-0.69 ***	-0.62 ***
Geographic proximity				
Parents close	-0.62 ***	-0.74 ***	-0.03	-0.16
Children close	-0.48 **	-0.32	-0.59 ***	-0.61 ***
Grandchildren close	-0.56 ***	-0.47 **	-0.55 ***	-0.56 ***
Frequency of intergenerational contacts				
Parents contacts	-0.47 **	-0.62 ***	-0.47 **	-0.62 ***
Children contacts	-0.50 **	-0.55 ***	-0.56 ***	-0.65***
Grandchildren contacts	-0.61 ***	-0.70 ***	-0.61 ***	-0.66 ***
Grandchild care				
N. grandchildren cared	0.19	0.30	0.07	0.18

Source: Authors' elaborations on data from Family and Social Subjects (FSS 2016).
Note: Pearson's (P) and Spearman's (S) correlation coefficients. *** p<0.01, ** p<0.05, * p<0. HH = household.