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Close Social Networks among Older Adults: The Online and Offline Perspectives

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Abstract
Qualitative studies have found that the use of Information and Communication Technologies is related to an enhanced quality of life for older adults, as these technologies might act as a medium to access social capital regardless of distance. In order to quantitatively study the association between older people's characteristics and the likelihood of having a network of close friends offline and online, we use data from the Survey of Health, Ageing and Retirement in Europe and from Facebook. Using a novel approach to analyze aggregated and anonymous Facebook data within a regression framework, we show that the associations between having close friends and age, sex and being a parent are the same offline and online. Migrants who use internet are less likely to have close friends offline, but migrants who are Facebook users are more likely to have close friends online, suggesting that digital relationships may compensate for the potential lack of offline close friendships among older migrants.

Keywords: Social Networks; Social Capital; Older People; Social Media Data; Europe

Introduction

Over the last decade there has been a rapid increase in the possibilities offered by online environments to cultivate meaningful social relationships. As more and more areas of life are "digitized", this process - often referred to as "digitalization of life" – creates both challenges and opportunities. On the one hand, unequal access to digital technologies and heterogeneous levels of digital literacy may amplify existing inequalities. On the other hand, for some socio-demographic groups, access to digital resources may help compensate for lower levels of social capital and serve as an equalizer, thus reducing overall inequalities in areas such as social support.

Older adults are part of a key demographic group that could potentially benefit largely from access to digital technologies, but that is also at risk of being excluded from reaping the gains of a digital world if they fall on the "wrong" side of the digital divide. Understanding the role of internet and Social Network Sites (SNS) in later life requires a broad and comparative perspective. In 2018, in Europe 75% of adults aged 55-64 declared to have used internet in the

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last 3 months, whereas for those over 65 the percentage dropped to 56% (Eurostat 2018). The use of Information and Communication Technologies by older adults -internet among them- is related to an enhanced quality of life (Francis et al. 2019; Sims, Reed, and Carr 2016). This relationship is believed to result from the access to social capital that these technologies offer (Neves 2013). In particular, SNS, such as Facebook and Twitter, play an important role among the Information and Communication Technologies resources that older people have access to, because they help older people to overcome perceptions of social isolation and loneliness (Jung and Sundar 2016; Ballantyne et al. 2010).

Demographers have used survey data to study population dynamics since the advent of the discipline. But there are certain populations that are still difficult to sample. These include, among others, migrants (Beauchemin and González-Ferrier 2011) and older migrants (Warnes and Williams 2006). The digital revolution has created new opportunities to passively collect socio-demographic and behavioral data through social media platforms like Facebook and Twitter (Edelmann et al. 2020; Alburez-Gutierrez et al. 2019; Lazer and Radford 2017). Even though these platforms were not conceived for research purposes, the fast growth of their worldwide user base has led researchers to consider them as a complementary data source for demographic research.

Facebook use can be considered a prime example of SNS, given that it is the most frequently used SNS worldwide with more than two billion users (Facebook Inc. 2019). The use of these data has advantages for demographic research. For example, it offers ways to obtain information about demographic characteristics and interests of subpopulations that otherwise would be difficult to reach and to study. Thus, Facebook data have already been used to study access to digital technologies (Fatehkia, Kashyap, and Weber 2018), immigrant's cultural assimilation (Stewart et al. 2019; Dubois et al. 2018), and to estimate migrant stocks across countries (Zagheni, Weber, and Gummadi 2017).

To the best of our knowledge, no study has investigated the use of Information and Communication Technologies in older populations using a combination of social media and more traditional survey data. Here, we use both traditional and new sources of data: the Survey of Health, Ageing and Retirement in Europe (SHARE) and Facebook data, respectively. These are used to expand the literature regarding: (1) the representativeness of Facebook data for ageing research; and (2) the association between older people's characteristics and having a close network of friends offline and online. This way we aim to offer new insights on who has access to the benefits that social capital could impart through the use of internet and SNS.

This paper aims to contribute to the literature both methodologically and substantively. First, we show how data from the Facebook Marketing Application Programming Interface (API) can be used to understand relationships in a way that mimics micro-level regression analysis, even though the data comes only in aggregate form. Second, we demonstrate how digital trace data can provide new insights into the use of SNS by older people.

In what follows, we first present the theoretical background of our work. We discuss the definition of social capital and its determinants; the role of social capital on health; and the relation between social capital, internet and SNS use, and older adults' health. We also explain why older migrants might be the ones that benefit the most from the use of internet and SNS. We then introduce the two databases we use for our analyses and explain the methodological

approach. After showing the results obtained from the analyses of each database, we summarize the findings and conclude.

Background

The concept of social capital offers a suitable theoretical framework to make hypotheses on the benefits that the use of internet and SNS may have for older adults (Rios, Wohn, and Lee 2019; Barbosa Neves 2015). According to Coleman (1988), the possession of social capital means that individuals are embedded in a system of normative obligations where they can find and provide help and support, whether within families or in larger communities. The general idea behind the concept of social capital refers to the features of social organization, such as networks, norms, and trust that facilitate coordination and cooperation for mutual benefit (Coleman 1988; Putnam 1993). Social capital is characterized by being a public good (Putnam 1993), that may be generated where there are dense, lateral networks involving voluntary engagement, trust, and mutual benefit (Onyx and Bullen 2000). As Lin (1999) emphasizes, the concept of social capital is anchored in social networks and embedded resources.

Social capital is recognized by a long body of literature as having a positive association with health. In their systematic review on social capital and health outcomes, Ehsan et al. (2019) show that there is a good amount of evidence to indicate that social capital is associated with better health and that social relationships are protective against mortality. It has also been argued that social capital may have a positive effect on self-related health among depressed people, though the causal relation remains unclear (Kobayashi et al. 2013). Depressed people are likely to have access to smaller networks and have less social contacts than healthy individuals.

When restricting the population to older people, results are similar: higher social capital is associated with lower mortality rates (Coll-Planas et al. 2017; Nyqvist et al. 2014). However, the association may be confounded by factors such as physical and mental health. Therefore, reverse causality cannot be excluded (Coll-Planas et al. 2017; Nyqvist et al. 2014). By means of older people's social networks, Seeman et al. (1993) show that there is a direct negative effect between social ties and mortality risk. Among older people's networks, family has been at the center of attention in ageing studies, given the shift towards closer relationships in later life (Cornwell, Laumann, and Schumm 2008; McPherson, Smith-Lovin, and Brashears 2006; Carstensen, Isaacowitz, and Charles 1999).

With shrinking kin relationships in ageing societies characterized by increasing absence of children and partners, a serious threat might be posed to health in later life, especially in countries where welfare state services are poorly developed (e.g. Kohli and Albertini 2009; Brandt, Haberkern, and Szydlik 2009). Indeed, loneliness, referring to the subjective feeling of lack or loss of companionship (Gierveld 1998), and social isolation, referring to the objective social situation of lack of relationships (Dykstra 2009), are considered among the major hazards to older people's health (Gierveld, Tilburg, and Dykstra 2006). Both loneliness and social isolation are linked to depression and early mortality (Holt-Lunstad et al. 2015; Pantell et al. 2013; Luo et al. 2012; Perissinotto, Stijacic Cenzer, and Covinsky 2012). Furthermore, individuals with larger and stronger networks are healthier and experience reduced levels of cognitive decline than those with lower levels of social connection (Cherry et al. 2013; Seeman et al. 2011; Smith and Christakis 2008).

Following the fast and global spread of digital technology, research has started to explore whether and how the use of Information and Communication Technologies, in particular internet and SNS, could help older adults to improve their health. The internet may act as a medium for older adults to achieve better health through access to information and social relationships (Rios, Wohn, and Lee 2019; Sum et al. 2008). It may also help maintain close relationship (i.e. bonding social capital) (Barbosa Neves 2015). Similarly, the use of SNS represents an accessible and relatively low-cost mechanism to enhance social connections at older ages (Vitak 2014). For example, it has been shown that SNS can reduce loneliness experienced at particular moments of the day and related to not being part of a community (Ballantyne et al. 2010). They also allow older people to communicate with family and acquaintances and to receive support from them (Lee, Noh, and Koo 2013). It is believed that Communication Technologies can help older adults to connect with geographically distant kin (Quan-Haase et al. 2018) and with relatives that live abroad or far away (Neves et al. 2018).

Among older people, migrants are the ones that might benefit the most from these technologies, given that they are the ones that have more links with people living abroad (Näre, Walsh, and Baldassar 2017), and that they report the highest levels of loneliness compared to people without a migration background (Tilburg and Fokkema 2020; Fokkema and Naderi 2013). Qualitative studies suggest that migrants rely on Information and Communication Technologies to exchange emotional care over distance (Baldassar et al. 2016; Bates and Komito 2012; Komito 2011), but still little is known from quantitative analyses at the population level.

In this work we build on the literature on social capital and population aging, with a particular focus on immigrants. We consider having close friends as a proxy for access to social capital and its health benefits. We test, at the population level, which older people are more likely to have close friends depending on whether they are internet users, Facebook users (as a proxy for SNS usage), or offline. More broadly we want to assess whether internet and SNS use help increase access to social capital for populations that typically have lower access.

Data

We use two sources of data to analyze and contrast the characteristics of people's online and offline social networks. To do so, we draw on data from SHARE and from the Facebook Marketing API.

SHARE Database

SHARE is a longitudinal survey representative of the population aged 50 years and over in Europe. The SHARE survey design enables scientists to draw inferences about the population of 50 years and older across countries by using probability-based sampling. For this study we use wave 6, conducted in 2015 in 17 European countries (Appendix B) with 66,153 participants, because it is the most recent wave including the module on Social Networks. The target population of SHARE wave 6 "[...] consists of persons born in 1964 or earlier, and persons who are a spouse/partner of a person born in 1964 or earlier, who speak (one of) the official language(s) of the country (regardless of nationality and citizenship) and who do not live either abroad or in institutions such as prisons and hospitals during the entire fieldwork period" (Bergmann, De Luca, and Scherpenzeel 2017, 77).

For a complete description of the variables used in the study the reader can refer to Appendix A of this paper. Here we briefly summarize them. (1) *Sex* is a dummy variable with 1 meaning the person is a woman and 0 man. (2) *Age* is a categorical variable that can be either 0 if respondent's age is 50-64 or 1 if 65+. (3) *Education* is a categorical variable that can take values 0 if respondent's highest educational attainment is below college degree, 1 if it is college or above, and 2 if unspecified. (4) *Parent* is a dummy variable with 1 meaning that the person has at least one child and 0 otherwise. (5) *Immigrant* is a dummy variable taking value 1 if the respondent was not born in the country of interview and 0 otherwise. (6) *Friend* is a dummy variable taking value 1 when the respondent declares to have at least one person with whom they feel either very close or extremely close and 0 otherwise. (7) *Internet* is a dummy variable indicating whether the respondent used the internet at least once during the previous 7 days, for e-mailing, searching for information, making purchases, or for any other purpose.

Given the relevance of the variable *Friend* for our study, we now provide further details about it. The Social Network Module of SHARE is based on "[...] a name generating mechanism in which respondents identify the people who are important to them and then subsequently add information on each person (up to seven named)" (Schwartz, Litwin, and Kotte 2017, 22). This information includes the ties that were involved in social exchange (e.g., the financial or time transfers in which people engage).

As described by Schwartz, Litwin, and Kotte (2017), the interview starts with the question "Over the last 12 months, who are the people with whom you most often discussed important things?", to which the interviewee can answer with up to six names and name one additional person that is important for them "for some other reason". Afterwards, more details are asked about the named persons, if such information does not appear elsewhere in the interview (e.g., children's data). The information includes gender, year of birth, occupational status and marital status of each mentioned person, as well as their residential proximity, frequency of contact and emotional closeness to them.

In particular, based on the answer ((1) Not very close; (2) Somewhat close; (3) Very close; and (4) Extremely close) to the question "How close do you feel to [mentioned name]?", we built the dummy variable *Friend*, taking value 1 when the respondent declares to have at least one person with whom they feel very close or extremely close and 0 otherwise.

Facebook Database

The Facebook Marketing API is a tool that allows access to the Facebook Adverts Manager in a programmatic way. The Facebook Adverts Manager platform gives advertisers the approximate number of Facebook users that match certain characteristics, before an ad is launched and before any payment is performed or requested (for a detailed description the reader can refer to Zagheni, Weber, and Gummadi (2017)). This platform was built for marketing purposes, but demographers and sociologists, among others, have found an invaluable resource of information in it.

We use the Facebook API version 3.2[4] to retrieve the 'Daily Active Users' during one month- from June 9 to July 9 2019- that matched the combination of the following characteristics[5]: (0) Live in one of the 17 countries showed in Appendix B (the same as for SHARE); (1) *Sex*: Declared gender is either female or male; (2) *Age*: Declared age is either between ages 50-64 or 65+; (3) *Education*: Declared education is either Below-College, College-Or-Above, or Unspecified; (4) *Parent*: Classified as parents, coded as 1= yes and 0= no; (5) *Immigrant*: Classified as immigrants, coded as 1= yes and 0= no; (6) *Friend*: Classified as close friends of people with birthdays in a month, coded as 1= yes and 0= no. The detailed description of the variables can be found in appendix A.

Facebook does not specify whether the variables 4-6 come from users' self-declared characteristics or whether Facebook classifies the users based on their networks or other data[6]. Here we summarize some articles published by Facebook that shed some light on this. Articles based on the Facebook population, rather than surveys, show that Facebook researchers consider users' self-declared characteristics, but they also highlight the features of the users' networks. Backstrom et al. (2011) propose a measure for the analysis of personal networks, based on the way individuals divide their attention across contacts. Their metrics consider different modalities that can be summarized as communication- and viewing-based, that are used to rank users' close friends. In the case of parent-children relations, Burke, Adamic, and Marciniak (2013) show that "Overall, 37.1% of English-speaking, monthly-active US Facebook users have specified either a parent or child relationship on the site"; that children and parents tend to befriend the same family members on Facebook, as well as, some of the children's friends; and that their type of communication differs from the communication with non-nuclear family. Regarding immigrants, Herdağdelen et al. (2016) analyze users in the United States that specified home-town (home country) in a country different from United States. In order to make the analysis more accurate they constrain the sample to those with at least two friends currently living in their home country and another two friends currently living in the United States. Herdağdelen et al. (2016) also compare their results with US national statistics, showing that they are highly correlated.

Returning to our Facebook data, the total number of data points per country that we retrieved per day was $17 \times 2 \times 2 \times 3 \times 2^3 = 1632$. We did this for 31 days, resulting in a database with $31 \times (1632) = 50{,}592$ rows. Though Facebook returns both the daily and the monthly active users any time their data is retrieved, we use the Facebook Daily Active Users. This is because we are working with populations that can be smaller than 1000 users and the Facebook Monthly Active Users value has a lower bound of 1000, while the Daily Active Users lower bound is 100[7]. In order to simplify notation, we will refer to the Facebook Daily Active Users as Facebook users.

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[4] https://developers.facebook.com/docs/graph-api/changelog/version3.2/. Accessed 30 September 2020.

[5] These subsets are mutually exclusive.

[6] https://www.facebook.com/ads/about/?entry_product=ad_preferences. Accessed 30 September 2020.

[7] Though the lower bound is 100, we also occasionally retrieve zeros when querying the API.

Methodology

In order to study older people online and offline, first we need to assess whether Facebook users have demographic characteristics approximately similar to the ones of SHARE respondents who use internet. For this, we first compare both total and percentages of internet and Facebook users by demographic attributes. Assessing this is important to evaluate the extent of the bias when using Facebook users to approximate internet users in European countries.

Second, we check the proportions (P) of those older people in SHARE who declared to have used internet, against the proportions of older people in Facebook. We study the structure of the data by breaking it down into basic characterizations (Eq. 1). Specifically, we look at proportions of older people that are immigrant ($immigrant$), have close friends ($friend$), have children ($parent$), or none of the previous ($none$).

$$P_{ij}(s,a,e) = \frac{\#Users_{ij}(s,a,e)}{\sum_{s,a,e} \#Users_{ij}(s,a,e)} \qquad \text{(Eq. 1)}$$

In Equation 1 $\#Users$ is the number of older people that: use either internet in SHARE or Facebook represented by the index i; and have one of the following characterizations: immigrant, friend, parent, or none, represented as the index j. We break down those groups by demographic characteristics: sex $s \in$ {Female, Male}; age $a \in$ {50-64, 65+}; and level of education $e \in$ {Unspecified, Below College, College or Above}. This way, for example, the proportion of Facebook users that are mothers between 50 and 64, with an unspecified level of education would be given by:

$$P_{Facebook,parent}(female, 50-64, Unspecified)$$

The analysis of these proportions helps us to study the association between the demographic distributions of these databases. In this case, we would expect to see a positive correlation between the internet and Facebook demographic proportions by characterization. A positive correlation means that the Facebook and internet populations are associated, and that an increase in the internet (Facebook) proportions is related to an increase in the Facebook (internet) ones. A negative correlation is not to be expected, and a correlation close to zero would mean that there is no association between these databases.

The second goal is to understand the association between older people's characteristics and their network of close friends, both for those that are online and those that are offline. For this, we use the same type of statistical analysis on two complementary data sets: non-internet users vs. internet users; and non-internet users vs. Facebook users. We want to test whether the use of internet or Facebook has a differential effect on having close friends from those that are offline. For this, we test whether the coefficients of the model for non-internet users are statistically different from the coefficients from the internet and Facebook models.

According to Brame et al. (1998), we can test whether the coefficients of two identical generalized linear models are the same, when these ones are run in two independent groups. In this case, we assume that the non-internet group is independent from both the internet and Facebook groups. This test, which is performed with a z-score test (Brame et al. 1998), is also called Wald test for no difference in two independent samples.

The statistical analysis is based on logit models (Eq. 2) that are run independently in our databases: (1) SHARE non-internet users, (2) SHARE internet users, and (3) Facebook users.

$$logit(\pi_{friend_i}) = \alpha + \beta_1 age_i + \beta_2 sex_i + \beta_3 parent_i + \beta_4 immigrant_i \quad \text{(Eq. 2)}$$

In Equation 2, i is an index that represents the data source for the model: (1) SHARE non-internet users, (2) SHARE internet users, and (3) Facebook users.

The dependent variable of the logit models is $friend$, a proxy for having close friends. As we explained in the data section, Facebook might build this variable by ranking users' attention to their friends' profiles (Backstrom et al. 2011). The explanatory variables are $parent$ and $immigrant$: from Facebook publications we infer that these variables are generated from users' specified relations and home country respectively (Burke, Adamic, and Marciniak 2013; Herdağdelen et al. 2016). We control by age and sex, but we do not use the variable $education$ because- as we show later- for Facebook the quality of data on education is low. For more information regarding these variables, the reader can refer to the data section and to the Appendix A.

One important reason to use the logit model is that the Facebook data are aggregated counts: we do not have micro-level data. However, for the logit model, the maximum likelihood estimates and standard errors are the same if we use the individual-level outcomes, or if we aggregate and classify them according to their categorical independent variables (Agresti 2013 [chap. 4, example 4.2.2]). In other words, we can obtain the same estimates from aggregate-level data, as if we had micro-level data. This statistical result, though being well-known in statistics, has not been considered for the analysis of associations of Facebook variables so far. It has important implications for the research community that uses aggregate-level advertisement data, as it opens up new ways of understanding and analyzing this type of data with approaches that rely solely on aggregate-level data that are becoming more and more available, but are still an untapped resource for statistical analyses.

The totals and proportions are calculated using the R package *survey* version 3.35-1 (Lumley 2004); the logit models are also run using the *survey* package. For SHARE we use the calibrated cross-sectional individual weights and consider the sample design in all of them (Bergmann, De Luca, and Scherpenzeel 2017). We also used the survey package for Facebook, except that we used a bootstrap procedure to resample observation units by day in order to determine standard errors. This way we can take into account the variability of the Facebook data in terms of daily usage over time, without biasing the expected values of the estimated totals, proportions, and coefficients.

Results

Representativeness of Facebook

In this section, first we discuss the representativeness of Facebook by comparing the structure of the data against the internet users in SHARE. Table 1 shows the totals and percentages by demographic characteristics. As Table 1 shows, the total number of users in Facebook is an underrepresentation of those that use internet in SHARE, but the percentages present important similarities.

In the case of sex, we see that, while in SHARE there are 2 percentage points more men than women, in Facebook there is a difference of 12 percentage points in favor of women. This outcome is also observed by Gil-Clavel and Zagheni (2019) in their results for Facebook users in Europe, where the median ratios of female users by country population are always greater than for men. Regarding age, we observe that in both databases there are more people in the younger age group, between 50-64, using internet and Facebook, two-thirds and three-fourths of the populations, respectively. For education, a large portion of the (self-reported) values are missing in Facebook: the unspecified category has a difference of 54 percentage points between the SHARE-Internet users and Facebook users. This difference skews the values for the other two categories, making the Facebook percentages differ from the SHARE-Internet ones. The high percentage of unspecified level of education is also observed by Ribeiro, Benevenuto, and Zagheni (2020) in their study of the population from the United States.

Table 1 Totals and percentages of population by characterization

	SHARE Internet Users		Facebook Users	
Variable	Totals standard error	% standard error	Totals standard error	% standard error
Sex:				
Male	35,839,112	51	14,365,738	44
	5,016,980	0.0063	192,410	0.0026
Female	33,979,165	49	17,925,429	56
	5,283,971	0.0063	232,634	0.0026
Age:				
50-64	47,152,426	68	24,044,928	74
	6,607,756	0.0101	313,146	0.0019
65+	22,665,851	32	8,246,239	26
	3,746,581	0.0101	102,173	0.0019
Education:				
Below College	67,387,133	97	13,092,715	41
	9,811,279	0.0029	149,879	0.0035
College or Above	1,206,362	2	1,099,281	3
	333,710	0.0025	14,217	0.0003
Unspecified	1,224,782	2	18,099,171	56
	196,844	0.0019	288,423	0.0035
Parent:				
No	7,717,093	11	26,434,603	82
	830,401	0.0079	376,762	0.0034

Yes	62,101,184	89	5,856,564	18
	9,546,248	0.0079	101,820	0.0034
Immigrant:				
No	69,060,400	99	29,268,278	91
	10,247,107	0.0021	368,824	0.0017
Yes	757,877	1	3,022,889	9
	124,946	0.0021	59,303	0.0017
Friend:				
No	50,142,763	72	28,441,110	88
	6,965,994	0.0101	321,197	0.0017
Yes	19,675,514	28	3,850,057	12
	3,377,911	0.0101	87,684	0.0017

Note: The values for SHARE were estimated using sample weights; for Facebook we bootstrapped by day. Beneath each value is its standard error.

When comparing the variable parent, we see that 89% of the SHARE-Internet users are parents, while in Facebook this is only 18%. This might be because Facebook likely does not identify many parents or users do not disclose their family ties, as this requires users to explicitly make the links in the SNS. In the case of immigrant, the percentages in both databases are quite similar, with more than 90% of the population not having this attribute. For the variable friend, we observe that in both cases less than one-third of the populations can be considered as having close friends, 28% and 12% for internet and Facebook respectively.

Figure 1 shows the demographic distribution of Facebook and internet users by characterization as described in Equation 1. When we consider education, the Pearson correlation between the Facebook and SHARE-Internet users is 0.44 (CI: [0.18, 0.64]): this can be seen in figure 1.a and is a consequence of the large fraction of Facebook users that do not disclose their educational history.

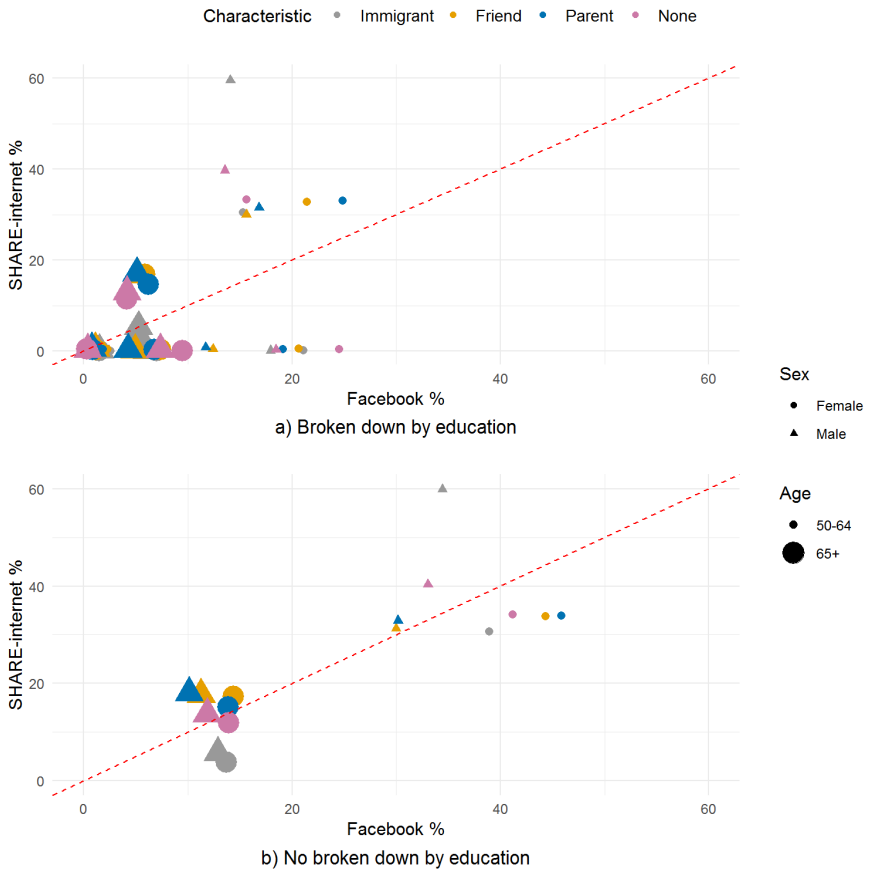

Fig. 1 Relationship between Facebook and SHARE-Internet proportions by characteristic. The red dashed line is the identity function.

If we do not break down by level of education ($P_{ij}(s,a) = \sum_e P_{ij}(s,a,e)$), the percentages have a Pearson correlation of 0.77 (CI: [0.45, 0.92]). Figure 1.b shows that the relation between these proportions is in general very linear (the values can be found in Figure C1 of Appendix C). The only exception is the immigrant population, where the point 50-64 male takes values of 60% in SHARE and 34% in Facebook. This results in an underrepresentation of the male 50-64 population in Facebook, while the rest of the groups are overrepresented in the SNS. We also observe that, on the one hand, for the 65+ population the values for women and men by characterization do not differ that much. On the other hand, for the 50-64 population, women are overrepresented in Facebook and men are underrepresented.

The three main highlights of this analysis are: (1) at the population level we observe that, while Facebook users are only a fraction of the total internet users, the distribution of demographic features is highly correlated across the two populations, except for the educational variable, which shows not to be a reliable measure in the Facebook data set; (2) though there are substantially more parents using internet than those estimated to be parents in Facebook, indicating that Facebook likely does not identify many parents or users do not disclose their family ties, we find that the demographic characteristics of parents in Facebook are linearly correlated with the ones in the SHARE-Internet users database; (3) the male 50-64 immigrant

group is highly underrepresented in Facebook, while the rest of the immigrant groups are overrepresented.

Characteristics of Close Social Networks

The original numerical results from the logit models for having close friends in SHARE and Facebook are summarized in Table D1 of Appendix D. Figure 2 shows a visual summary of the odds ratios and Table 2 shows the significance codes of the Wald test (the values are in Table D1). The baseline values represent the population of individuals between 50-64 that are men, not parents, and not immigrants.

The baseline probabilities of having a close friend are $0.1042/(1+0.1042) = 9.6\%$ for non-internet users, 21.7% for internet users, and 7.2% for Facebook users (for Facebook users, this refers to having an online close friend). Being a woman increases the odds of having close friends by 22% for non-internet users, while for both internet and Facebook users the odds increase by 10%. According to the Wald test, we cannot reject the null hypothesis that the difference between the non-internet model and both the internet and Facebook models are zero. In the case of age, we see that there is no statistical evidence that this variable is associated with having close friends either offline or online. For the internet model we observe that the p-value of the age coefficient is 0.0455, positioning the coefficient at the limit of not being significant, according to traditional definitions.

Being a parent has a positive association with having close friends. It increases the probability to $0.1064 \times 2.2107/(1+0.1064 \times 2.2107) = 19\%$ for non-internet users. While in the online case, the probability increases by 4 and 14 percentage points for internet and Facebook users, respectively. The variable immigrant has a negative association with having close friends for internet users, decreasing the probabilities to 7.5%, while for non-internet users we cannot discard that there is no association. For Facebook users the association is positive, increasing the probability from 7.2% to 18.7%.

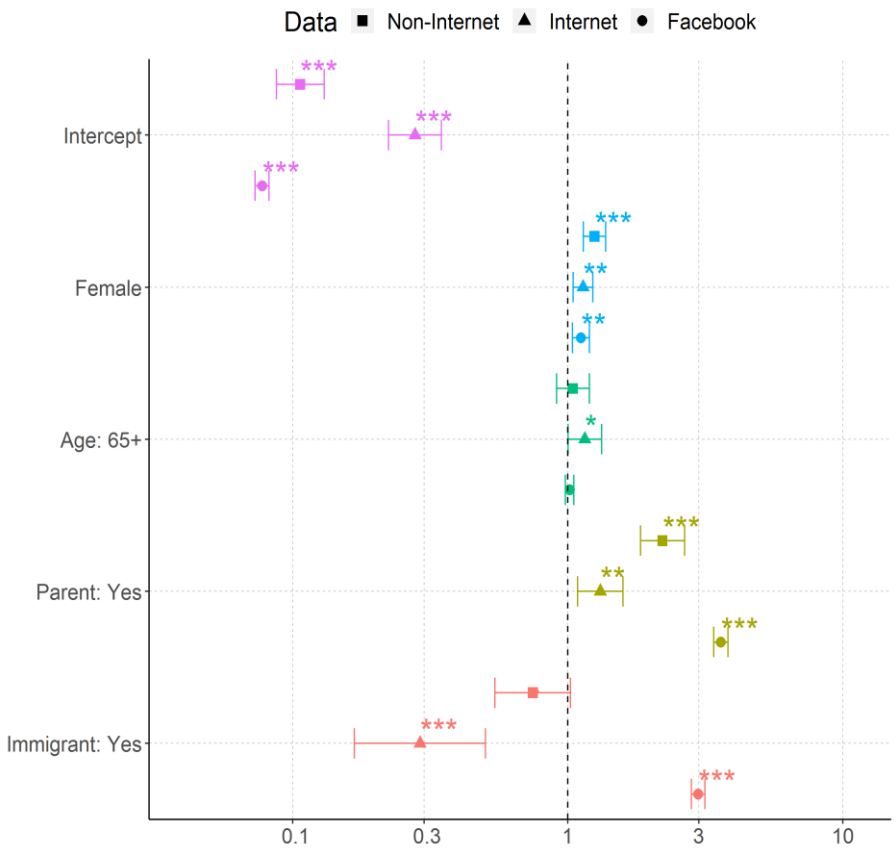

Fig. 2 Odd Ratios and Confidence Intervals of the friend logit models. The values were estimated using the survey weights for SHARE and bootstrapped for Facebook. Significance codes: p-value<0.001 '***', p-value< 0.01 '**', p-value< 0.05 '*'. The dashed line corresponds to the one x-axis intersection. Original values in log 10 scale.

Table 2 Wald test of the logit models coefficients

	Intercept	Sex: Female	Age: 65+	Parent: Yes	Immigrant: Yes
Non-Internet vs. Internet	***			***	**
Non-Internet vs. Facebook	**			***	***

Significance codes: p-value<0.001 '***', p-value< 0.01 '**', p-value< 0.05 '*'.

In summary, the main results shown in this section are the following ones: (1) being a woman has very similar effects on the probability of having close friends regardless of whether she uses internet or not, and a similar size effect is estimated for the probability of having close friends online; (2) age among older adults does not play a central role in determining the likelihood of having close friends either online or offline; (3) being a parent has always a positive association with having close friends - though compared to non-internet users being a parent has a smaller impact on having close friends for those that use internet, and a greater impact for those in

Facebook; (4) while being a migrant is not associated with having close friends for those offline, it is negatively associated for those that use internet and positively associated for Facebook users.

Conclusion and Discussion

Research on the use of Information and Communication Technologies by older adults points to an increase in their access to social capital (Neves 2013; Jung and Sundar 2016). This might be because these technologies facilitate older adults' communication with their families and friends regardless of geographical distance (Quan-Haase et al. 2018; Neves et al. 2018). In particular, older migrants might be the ones that benefit the most, given that they are the ones with more links with people living abroad, and thus far away, compare with natives (Näre, Walsh, and Baldassar 2017; Baldassar et al. 2016). This work offers three main contributions. First, we analyze the representativeness of older people in Facebook. Second, we test whether the internet and Facebook associations are statistically different from the offline ones. Finally, we analyze, at the population level, which older people are more likely to have close friends (or online ties) depending on whether they are internet users, Facebook users, or offline.

To study the representativeness of Facebook data for aging research, we compare the demographic features of the SHARE respondents who use internet (SHARE-Internet users) with those of Facebook users. We find that the demographic structure of the Facebook data is highly correlated with the structure of the SHARE-Internet users when we do not break down the sample by level of education. This is because, a large fraction of Facebook users does not disclose their educational history, resulting in high percentages of users with unspecified level of education, thus making the Facebook variable education not reliable.

Concerning information about migration background, the structure of the data differs between the two sources. This might be a consequence of the kind of migration that SHARE and Facebook capture. On the one hand, SHARE respondents not born in the country of interview tend to live there since more than 40 years (Bordone and De Valk, 2016) possibly not having strong connections with the country of origin any longer. On the other hand, Ciobanu, Fokkema, and Nedelcu (2017) notice that most international retirement migrants do not learn the host country's language. Therefore, given the restrictions that SHARE imposes on the people considered for interview, the survey might not capture retirement migrants, while Facebook might. A second kind of migration that Facebook might be capturing is the zero-generation, parents of migrant children who follow their adult children in migration or engage in back-and-forth mobility as a medium for inter-generational support (Ciobanu, Fokkema, and Nedelcu 2017).

Regarding whether older people who are internet users or Facebook users (as a proxy for SNS usage) are more likely to have close friends or online close friends than those that are offline, we observe that being a woman is positively associated with having close friends both online and offline. However, the difference between the non-internet and both the internet and Facebook coefficients is not statistically significant, which can be interpreted as the differences in the means being zero. According to our results there is no statistical evidence that age plays a major role among older adults in having close friends neither offline nor online, whereas being a parent has a positive association in both cases. Our results corroborate the findings from McPherson,

Smith-Lovin, and Brashears (2006) for the American population. In general, people lose or cut contact with acquaintances as they get older, but maintain strong ties with their nuclear family; and women have a slight advantage over men on maintaining their friends.

From the literature, we expected to observe a positive association between having close friends and being an immigrant for both internet and Facebook users, and a negative association for non-internet users. Differently from previous research, our analysis shows that, for the non-internet users being a migrant does not play a role on having close friends, whereas for internet users the association is negative. This might be related to a selection effect, where those who have fewer friends are more likely to use internet. However, more research has to be done to study the relationship between internet use and friendships. In the case of Facebook, the association between having close friends online and being an immigrant is positive, which is what we expected from qualitative analyses (Baldassar et al. 2016; Bates and Komito 2012; Komito 2011). This suggests that older migrants may be more likely to use SNS to maintain social relationships. Interaction online can partially compensate for the lower level of close friends offline and could be the result of a selection process whereby having fewer friends offline might lead migrants to establish or maintain digital friendships.

Our work has important limitations that we would like to acknowledge. First, we assume that Facebook is representative of the use of all SNS. This is not necessarily the case. However, Facebook is currently the biggest SNS worldwide; therefore, a large section of social network site users are Facebook users. So, we can still think about our results as representative of a large number of SNS users. Second, Facebook data was not designed with researchers in mind, so we had to leverage the limited information about the data made available by Facebook. For this paper, we inferred the definitions of the Facebook variables from publications that come from the Facebook Data Science Team. We acknowledge that further research needs to be done in order to have a better understanding of how different types of measurements were operationalized. This will be a continuous process that involves two avenues that we are already pursuing: on the one hand, we are developing research partnerships with the Facebook Data Science Team who have access to raw data and produce aggregate estimates. On the other hand, we are working on developing surveys of Facebook users that can give us more information about the biases in the data and the reliability of different types of measures of socio-demographic characteristics. Third, we focus on countries that are represented in SHARE, as we wanted to anchor our analysis to a probabilistic survey. However, further research with Facebook data can go beyond Europe to assess how social networking sites affect social capital across a broader range of geographic settings, including at the subnational level. Even though there are clear limitations when working with digital trace data, we believe that there is value in combining analyses that include both probabilistic surveys and passively-collected information. We hope that this article, beyond providing substantive results, also contributes to a methodological discussion on how to best use increasingly available digital trace data to complement surveys.

In summary, in this article we studied the association between older people's characteristics and the likelihood of having close friends offline and online. Our statistical analysis concluded that being online has an important differential effect for the population of migrants. In particular, we estimated a positive association between being a migrant and having close friends online for older people using Facebook. Previous research has highlighted the health benefits that the use of Information and Communication Technologies could bring to older people (Rios, Wohn, and Lee

2019; Sum et al. 2008), as these technologies ease older people's access to social capital (Neves 2013). In this work, we show that, among older people, the ones that seem to benefit the most from these technologies are migrants. While more research has to be done to understand the potential causal mechanisms behind what we observed, our article also made a methodological contribution to the study of online relationships by showing how classic regression models can be leveraged when using freely available aggregate-level data from advertisement platforms of major social media companies.

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This paper uses data from SHARE Waves 6 (DOI: 10.6103/SHARE.w6.700), see (Börsch-Supan et al. 2013) for methodological details.[8]

Declarations

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Conflicts of interest/Competing interests None

Availability of data and material SHARE data are available free of charge at http://www.share-project.org. Regarding the Facebook data, we will make the data available to individual researchers for the purposes of reproducing the results. We will not post the data on a freely accessible webpage as it goes against the Facebook's terms and conditions.

Code availability The codes to replicate this work are available at https://github.com/SofiaG1l.

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Appendix A

SHARE Variables

In parentheses are the original SHARE names of the variables.

- age_{SHARE}: Transformation of the SHARE variable year of birth (dn003_) to a categorical variable with the values 50-64 or 65+.
- $education_{SHARE}$: The highest school degree obtained according to the ISCED classification (isced1997_r):
  - Below College: either ISCED-97 code 1, ISCED-97 code 2, ISCED-97 code 3, ISCED-97 code 4, or ISCED-97 code 5.
  - College or Above: ISCED-97 code 6
  - Unspecified: either Refusal, Don't know, None, Other, or Still in school.
- $parent_{SHARE}$: Transformation of the number of children (ch001_) into a dummy variable with 1 meaning the person has at least one child and 0 otherwise.
- $immigrant_{SHARE}$: It is a dummy variable with 1 meaning the person was not born in the country of interview (dn004_) and 0 otherwise.
- $friend_{SHARE}$: Transformation of the variable network closeness (sn009_X) into a dummy variable with 1 when the person declared to have at least one person with whom she or he feels either *Very close* or *Extremely close* and 0 otherwise.
- $internet_{SHARE}$: Dummy variable of whether the person used internet during the past 7 days, either for e-mailing, searching for information, making purchases, or for any other purpose at least once (it004_). With one meaning *yes* and zero *no*.

Facebook Variables

In parentheses are the original Facebook names[9] of the variables.

- country: geographical targeting field from country, region, city or zip (geo_locations). In our case any of the 17 countries show in the Appendix A.
- sex_{FB}: User declared gender either male (0) or female (1).
- age_{FB}: User declared age. Either between ages 50 and 64 (0) or 65 or above (1).
- $education_{FB}$: User declared education (education_statuses). It is a categorical variable with the next categories- using Facebook nomenclature[10]:
  - Below College: either HIGH_SCHOOL, UNDERGRAD, HIGH_SCHOOL_GRAD, or SOME_HIGH_SCHOOL.

[9] https://developers.facebook.com/docs/marketing-api/audiences/reference/basic-targeting. Accessed 30 September 2020.

[10] https://developers.facebook.com/docs/marketing-api/audiences/reference/advanced-targeting#education_and_workplace. Accessed 30 September 2020.

  - College or Above: either SOME_COLLEGE, ASSOCIATE_DEGREE, IN_GRAD_SCHOOL, SOME_GRAD_SCHOOL, MASTER_DEGREE, PROFESSIONAL_DEGREE, or DOCTORATE_DEGREE.
  - Unspecified: UNSPECIFIED.
- $parent_{FB}$: People who are parents (Parents (All)), coded as 1= yes and 0= no.
- $immigrant_{FB}$: People living outside their home country (Expats (All)), coded as 1= yes and 0= no.
- $friend_{FB}$: Close friends of people with a birthday in 7-30 days (Close friends of people with birthdays in a month), coded as 1= yes and 0= no.

Appendix B

List of countries that constitute the bases:

Austria	Italy
Belgium	Luxembourg
Croatia	Poland
Czechia	Portugal
Denmark	Slovenia
Estonia	Spain
France	Sweden
Germany	Switzerland
Greece	

Appendix C

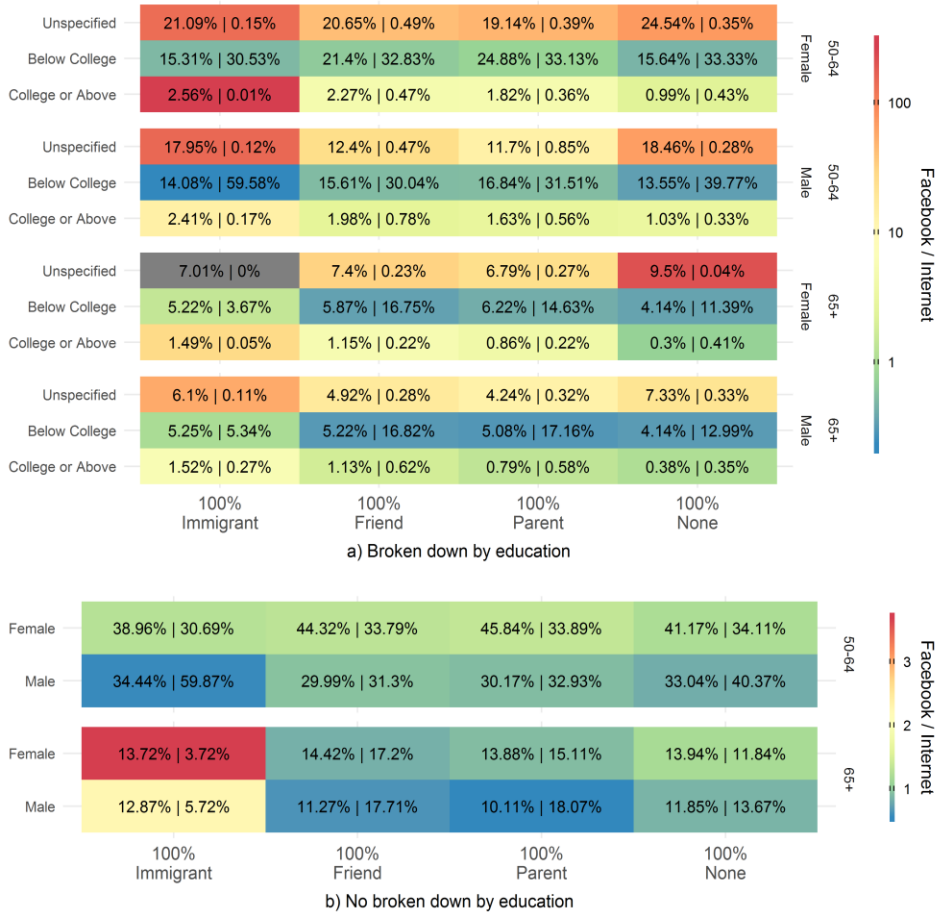

Fig. C1 Proportions of Facebook and SHARE-Internet users by characterization and demographic characteristics. In the cells the left value corresponds to Facebook and the right value to SHARE-Internet. The color shows the ratio of Facebook percentage by Internet percentage.

Appendix D

Table D1 Log Odds and Confidence Intervals of the friend logit models and Wald Test results

	Log Odds			Wald Test	
	No Internet (NI)	Internet (I)	Facebook (FB)	NI - I	NI - FB
Intercept	-2.2402 *** (-2.4407, -2.0397)	-1.2797 *** (-1.5007, -1.0587)	-2.5601*** (-2.6191, -2.5012)	-0.9605 ***	0.3199 **
Sex: Female	0.2247 *** (0.1313, 0.3182)	0.1275 ** (0.0449, 0.2100)	0.1099 ** (0.0388, 0.1890)	0.0972	0.1148
Age: 65+	0.0433	0.1429 *	0.0167	-0.0996	0.0266

	(-0.0947, 0.1813)	(0.0029, 0.2828)	(-0.0188, 0.0522)		
Parent: Yes	0.7933 *** (0.6091, 0.9775)	0.2716 ** (0.0815, 0.4617)	1.2820 *** (1.2219, 1.3420)	0.5217 ***	-0.4887 ***
Immigrant: Yes	-0.2930 (-0.6093, 0.0234)	-1.2381 *** (-1.7874, -0.6888)	1.0920 *** (1.0351, 1.1489)	0.9451 **	-1.385 ***

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