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Social Network Change After New-Onset Pain Among Middle-Aged and Older European Adults

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Abstract

Objective: This study examines how onset of chronic pain affects characteristics of personal social networks among adults aged 51+ across Europe.

Methods: We used population-based data from the Survey of Health, Ageing and Retirement in Europe (SHARE; 2011–2015; n=12,647). Using a change score analysis approach, we tracked changes in personal social networks of respondents experiencing new-onset chronic pain (n=3,803) compared to pain-free counterparts (n=8,844) in 11 European countries over four years.

Results: Overall, consistent with network activation theory, respondents with new-onset *mild-to-moderate* chronic pain reported increases in sizes and diversity of their personal social networks, compared to their pain-free counterparts. However, consistent with the "pain as threat to the social self" theory, respondents with new-onset *moderate* pain or *mild-to-moderate* pain reported a decrease over time in perceived satisfaction and closeness with networks, respectively. Estimates from interactions between new-onset pain severity and sex show that men with new-onset pain experienced greater decreases in network satisfaction (*mild* pain) and closeness (*severe* pain) than did women.

Discussion: This study highlights the complex social consequences of chronic pain, which may vary based on pain severity, gender, and type of social outcome considered.

Keywords

Personal/ego social network; chronic pain; aging; population-based study

Introduction

Social networks play a vital role in shaping individuals' health outcomes across the life course (Berkman & Glass, 2000; Ertel et al., 2009; House et al., 1988b; Smith & Christakis, 2008). Among older adults, engagement with social networks has been found to predict mortality, cognitive function, and physical function in later life (Ali et al., 2018; Li & Zhang, 2015; Miceli et al., 2019; Sharifian et al., 2019). Although they are treated in many studies

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as stable over time, personal (or ego) social networks can be very dynamic in response to changes in individuals' lives. Both role-transition events (e.g., marriage, becoming a parent, and retirement) and unexpected episodes (e.g., job loss, divorce) may lead to substantial changes in the structure and function of personal networks (Perry & Pescosolido, 2012).

Beyond family and labor-related drivers of social network change, health shocks or even subtle changes in health may influence social network characteristics in later life. However, research on how health affects social network characteristics among older adults has often yielded inconsistent conclusions. Health problems could constrain *or* promote individuals' ability to invest in personal networks (Cornwell, 2009). For example, some studies suggest that declining health may lead to smaller and less diverse networks (Aartsen et al., 2004; Sander et al., 2017). However, newly developed health problems (e.g., cancer) may also elicit a positive change in personal networks, sometimes referred to as "social network activation" (Latham-Mintus, 2019; Perry & Pescosolido, 2015). The exact nature of the health-network link may depend on the specific type and stage of the health problem, and on the specific network characteristics examined.

This research aims to understand how health is associated with the characteristics of personal networks by examining the newly-onset pain among adults age 51+ in European countries. We focus on pain for three primary reasons. First, acute and persistent pain is a highly prevalent and costly public health problem worldwide and is one of the leading causes of global disability (Blyth & Noguchi, 2017; Case et al., 2020; Makris et al., 2014; Patel et al., 2013). Pain is estimated to affect 30% to 60% adults aged 50+ across Europe, and in many European countries has been increasing over time (Zimmer et al., 2020). Second, unlike many other chronic conditions (e.g., cancer or diabetes) that have a clear pathology, pain (chronic pain in particular) often has neither an identifiable organic pathology (Turk & Monarch, 2002) nor a clear diagnosis (Glenton, 2003). Pain's unverifiability can lead friends and family to suspect that people with pain are exaggerating or malingering, potentially leading to strained social relationships. Lastly, pain is not merely a physical condition, but may also have substantial psychosocial consequences (Zajacova et al., 2021). For example, it could diminish individuals' quality of life (Leadley et al., 2014; Molton & Terrill, 2014; Turk et al., 2008) challenge their basic social needs (Emerson et al., 2018; Jaremka et al., 2014; Karos et al., 2018) and increase the risk of social isolation and loneliness (National Academies of Sciences & Medicine, 2020).

Given the potential impacts of pain on social life, rigorous research on this topic is needed, especially in countries that are rapidly aging and/or already have relatively large older adult populations. However, at present this topic is relatively understudied using large-scale, population-based data; and the limited findings were primarily on the *quantity* of the network, i.e., number of friends (Yang & Grol-Prokopczyk, 2021) but leaving the quality of the network (e.g., closeness, satisfaction) largely unstudied. Most large population-based surveys do not capture sufficiently detailed information on social networks to allow for an assessment of change over time. We fill this important research gap with an examination of the relationship between the onset of chronic pain and the characteristics of social networks among older adults across multiple European countries, where the proportion of the aging population is higher than in most other world region and continuing to rise rapidly (United Nations, 2019). We capitalize on population-based data with uniquely comprehensive measures of older adults' social networks alongside repeated measures of respondents' pain experiences.

Health, Pain, and Social Networks

Two competing theoretical perspectives consider the causal link between health problems and social network characteristics: theories of social withdrawal, and theories of social activation. On the one hand, pain has been theorized as a "threat to the social self" (Karos et al., 2018) that could lead to reduced social engagement or social withdrawal. Four potential mechanisms may link pain to a withdrawal from personal networks in later life. First, pain is associated with less physical activity (Stubbs et al., 2013) and higher mobility limitations (Karttunen et al., 2012), which may lead to social isolation and reduced social involvement (Blyth & Noguchi, 2017). Without physical mobility, it is hard for older adults to maintain social ties, especially weak ties. Second, depression is a common comorbidity of pain (Chou, 2007). Older adults with depression might be more likely to reduce their social participation compared with their depression-free peers, resulting in an adverse change in personal networks (Shouse et al., 2013). In addition to depression, cognitive function could be another pathway between pain and changes in social networks. Pain predicts a decline in cognitive function (Van Der Leeuw et al., 2016; Whitlock et al., 2017) and both general and social cognitive abilities are associated with older adults' personal social networks (Krendl et al., 2021; Shouse et al., 2013). Lastly, individuals with pain may experience doubt or judgment from people around them, because pain is often experienced without visible pathology and thus may lack verifiability as a physical ailment (Barker, 2005; Glenton, 2003; Holloway et al., 2007; Jackson, 2011). Individuals with pain might thus voluntarily avoid social interactions to avoid judgment or stigmatization (Smith & Osborn, 2007), leading to a withdrawal from social relationships.

On the other hand, some scholars argue that newly-developed health problems may elicit social network activation, i.e., a positive change in personal networks (e.g., Latham-Mintus, 2019; Perry & Pescosolido, 2015). In the early stages of crises such as illnesses, supporting ties may be activated and networks may grow in size. Both verifiable and life-threatening diseases such as cancer (Latham-Mintus, 2019), and less verifiable conditions such as depression (Perry & Pescosolido, 2015) have been found to predict an expansion in network size in their early stages. Yang and Grol-Prokopczyk (2021), using U.S. data, found that the effect of pain on friendship networks depends on pain severity: new-onset *severe* pain is associated with a decrease in number of friends, but new-onset *moderate* pain is associated with an increase in number of friends, as well as in contact frequency with friends.

Although there is an emerging literature examining the health-network link, as described above, those studies often suffer from methodological limitations. First, social network data in population-based surveys are commonly based on broad summary questions instead of a name generator approach (e.g., in the Health and Retirement Study, respondents report the number of friends they have and the overall contact frequency across all these friends). Although asking such broad questions may be efficient for collecting data from a large population, it may oversimplify and/or overlook many important characteristics of the social network (e.g., network diversity, satisfaction, and closeness). Second, studies aiming to collect more comprehensive information on personal network are often conducted with small or regional samples; their findings thus lack generalizability. Third, often only one type of relationship (e.g., friendships) is examined; thus little is known about how health problems are associated with broad personal networks, comprising multiple types of relationships. Lastly, studies using cross-sectional design are not able to address the causal direction of the health-network link.

Current Study

In the present study, we aim to understand the social consequences of chronic pain by focusing on changes in characteristics of personal networks. As noted, such changes could have substantive, long-term ramifications for physical, mental, and cognitive health and for overall quality of life. We use longitudinal data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), a population-based study of many European countries, which will help us overcome the generalizability problems in previous studies with small or regional data. Moreover, SHARE's measurement of social networks is quite comprehensive: the survey begins with the name generator approach and then collects detailed information on each member of the network. Another benefit of the dataset is that SHARE collected network data in more than one wave, so we can track changes in social networks over time as a response to a change in health (in the case, new-onset pain), instead of treating social networks as stable. With SHARE's comprehensive measures of personal networks, we can examine multiple types of relationships, unlike previous studies that typically can only investigate one type of network (e.g., friendships, see Latham-Mintus 2019; and Yang and Grol-Prokopczyk 2021). We can also systematically examine whether and how new-onset pain disrupts four distinct dimensions of social networks in later life—structure, function, strength, and content—to paint a fuller picture of the health-social network link.

Previous research in US and European countries shows that pain is more common among older women than men (Cimas et al., 2018; Grol-Prokopczyk, 2017). Moreover, men may find pain more psychosocially costly, given widespread cultural beliefs that "the ideal man" is better able to tolerate or ignore pain than "the ideal women" (Fillingim et al., 2009; Pool et al., 2007). Admitting to pain could threaten men's sense of gender identity (Courtenay, 2000).

Furthermore, personal networks in later life differ between men and women due to the gendered nature of family and work (Fischer & Beresford, 2015). Women tend to have larger and more diverse social networks, including connections with family, friends, and neighbors, while men are more likely to maintain connections with coworkers and to be more severely affected by loss of contacts after retirement (McDonald & Mair, 2010; Shaw et al., 2007). Relatedly, coping styles differ by gender: women are more likely than men to seek social support and use emotion-focused coping strategies such as distracting themselves or releasing their feelings (Carr & Umberson, 2013), while men are less likely to have close and confiding relationships, to share their feelings with others, and to provide and seek emotional support from others (Umberson et al., 2014).

Given that pain prevelance, social norms surrounding pain expression, personal social network characteristics, and coping styles often vary by gender, we posit that pain might have different social impacts for men versus women. (This is consistent with Yang and Grol-Prokopczyk (2021), who found that men with severe pain had particularly large decreases in their number of close friends.) Specifically, we hypothesize that women with new-onset pain are more likely than men to have an increase in both quantity and quality of their social networks, as they are more likely to seek and receive social support from a wide range of contacts. We expect that women will show greater increases in network size and diversity, will feel closer with their network members, and will be more satisfied with their overall social network.

Data and Method

Data and Analytic Sample

This study used longitudinal data from the Survey of Health and Retirement in Europe (SHARE). SHARE is a population-based study that surveyed community-dwelling adults over the age of 50 and their spouses of any age from 11 European countries in 2004 (Wave 1), then expanded to 16 countries in 2011 (Wave 4), and 18 countries in 2015 (Wave 6). Detailed information on sampling and response rate have been documented elsewhere (Bergmann et al., 2019; Börsch-Supan, 2022a, 2022b; Börsch-Supan et al., 2013). Social network data were only collected in Waves 4 and 6, so the present study primarily used data from these waves, which we refer to as Time 1 (2011, Wave 4) and Time 2 (2015, Wave 6), respectively.

There were 34,771 respondents from 14 countries participating the main survey in both Waves 4 and 6 (see supplementary eTable 1). We first excluded individuals who were younger than 51 or whose age was missing at Time 1 (n=795). Because this study focused on new-onset pain, we further restricted our sample to participants who were not troubled by pain at Time 1 (Wave 4) by excluding 19934 respondents (58.67%). We further restricted our analytic sample to respondents who provided answers to pain questions at Wave 6 (excluding 28 cases) and answered at least one social network question at both Wave 4 and Wave 6 (excluding 444 cases). Lastly, we excluded individuals without valid information on their social demographic and socioeconomic characteristics, i.e., education (n=252, 1.86%), nativity (n=194, 1.43%), and ever worked for pay (n=706, 5.2%). This yielded an analytical sample of 12,647 in 14 counties (see supplementary eTable 1). The sample size varies across models because the rate of missingness varies across social network variables.

Measures

Social Network Characteristics—Building on multiple studies on social networks and health (Ali et al., 2018; Miceli et al., 2019), we used both structural and functional characteristics of social networks as outcome variables. In Waves 4 and 6, SHARE asked respondents to provide a roster of the people with whom the respondent most often discussed important things over the previous 12 months (up to 7 individuals), along with detailed information on each network members’ relationship with the respondent, gender, means of contact (e.g., in person vs. by phone/mail), closeness, satisfaction, and proximity.

Our study uses these data to examine four domains of social network characteristics: size, diversity, satisfaction, and closeness.

The network *size* was measured as the self-reported number of members in the respondent's network (from 0 to 7), obtained from the derived social network module; detailed information on methodology has been described elsewhere (Malter & Börsch-Supan, 2017). Network *diversity* was assessed, following Miceli et al. (2019), with the number of three sub-network types: family network, external network, and for-a-fee network. We classified respondents having a *family* network if one or more members in their network was a spouse, child, grandchild, or relative. We classified respondents as having an *external* network if one or more members was a friend, (ex-)colleague/coworker, neighbor, ex-spouse/partner, minister/priest or other clergy. And lastly, we coded respondents having *for-a-fee* network if one or more network members were the following: therapist or other professional helper, housekeeper, or home healthcare provider. Diversity ranged from 1 (one type of network) to 3 (three types of networks), with higher numbers indicating a more diverse network.

Network *satisfaction* was assessed with an average score (from 0 to 10) of self-reported overall satisfaction with their network; higher numbers indicated higher levels of overall network satisfaction. This variable, like network *size*, was from the derived social network module. Network *closeness* was assessed with the question "How close do you feel to...?", with response categories of "not very close", "somewhat close", "very close", "or extremely close." We created a closeness index by averaging the ratings for each member in the network, with a theoretical score ranging from 1 to 4, and higher scores indicating greater closeness.

New-onset pain severity—SHARE respondents were asked about pain in the physical health module, although question wording changed slightly between Waves 4 and 6. In Wave 4, SHARE asked one question related to pain: "For the past six months at least, have you been bothered by pain in your back, knees, hips or any other joint?" We used this variable to restrict our analytic sample to those who were not troubled by pain at analytic Time 1 (Wave 4). The pain questions in Wave 6 began with an opening question asking, "Are you troubled with pain?" and, for respondents answering yes, two follow-up questions asking about the severity ("How bad is the pain most of the time, is it mild, moderate, or severe?") and affected parts of the body (including back, hips, knees, and other locations). Because of the lack of information about pain duration, the measures account for the combination of acute and chronic pain (Zimmer et al., 2020). Moreover, previous study found that moderate and severity pain predicts friendship network differently (Yang & Grol-Prokopczyk, 2021), we thus constructed new-onset pain severity based on pain severity questions in Wave 6, which indicates how severe the new pain was. One limitation of the pain assessment in SHARE is that the survey did not asked respondents to identify the cause of their pain.

Sociodemographic covariates—All control variables were assessed at Time 1 (Wave 4). They include age, sex, marital status, household size, whether respondents were native born, education, wealth quartiles, and whether respondents ever worked for pay (as shown in Table 1). Education was assessed using the International Standard Classification of Education (United Nations Educational & Organization, 2006) with 6 categories ranging from 0 (pre-primary education) to 6 (second stage of tertiary education). We used wealth instead of income because the latter is not an ideal measure of economic standing in a population with mixed retirement statuses. SHARE provided multiple imputations for many variables including wealth, which was defined as the total household net worth (total household financial assets minus liability). Wealth quartiles were calculated based on the full SHARE sample, not the smaller analytic sample, to convey relative economic standing vis-à-vis the population at large more accurately.

Analytic Strategy

Because only Waves 4 and 6 of SHARE collected personal network characteristics, we used both change score (CS) and lagged dependent variable (LDV) approaches to leverage the two time-point data (Johnson, 2005). In the CS method, $Y_2 - Y_1$ is regressed on X; in the LDV method, Y_2 is regressed on both Y_1 and X. Although there is debate on the reliability of the CS method, using CS under appropriate conditions can greatly enhance the ability to make causal inferences from nonexperimental data (Allison, 1990; Johnson, 2005). Because the outcomes were continuous variables, a series of ordinary least square regressions with both CS and LDV approaches were estimated. Because both produced similar coefficients and estimated standard errors, we reported the CS-based results in the main text and showed results from the LDV analyses in supplemental eTable 2. Given non-normal distributions of two count outcomes – network size and diversity, we also estimated models with negative binomial regressions. Results from negative binomial regressions were very similar to those from OLS models, we thus reported the OLS results in main text, for ease of interpretation. To establish temporal order, we used data from two time points and assessed changes in the network characteristics. We clustered standard errors at the household level and included country fixed effects. The equation for the CS models is:

$$Network\ \ characteristics_{i2}\ -\ Network\ \ characteristics_{i1} = \tau + \beta_{pain} NewOnset\ \ Pain_i + \beta_k Covariates_{i1} + \beta_{country} Country_j + \varepsilon^{*}_{ih}$$

Where i=1, …r, represents individuals; h=1,…p, represents households; j=1,…q, represents countries; k=1,…k, represents number of covariates; τ represents the change over time that applies to all individuals; the country fixed effects term is included as $\beta_2 Country$; $\varepsilon^{*}_{ih} = \varepsilon_{ih2} - \varepsilon_{ih1}$ represents the disturbance terms.

We built three nested models by adjusting different sets of covariates and tested whether sex modified the association between pain and change in each of the four social network characteristics. In the first series of models, we controlled for socio-demographic variables, including age in years, sex, marital status, household size, nativity, education, wealth, ever worked for pay. In the second series of models, we further adjusted for health conditions at Time 1 (that may predict social network changes that have been found in previous studies (Latham-Mintus, 2019; Perry & Pescosolido, 2015), including depressive symptoms, functional limitation, and five chronic conditions (i.e., cancer, heart attack or other heart problem; stroke or other cerebral vascular disease; diabetes or high blood sugar; and chronic lung disease). In the third series of models, we added interaction terms to test sex as a moderator to better understand the sex differences of the pain-network link.

Although our research design, with its two time points, is helpful for establishing temporal precedence, it could potentially lead to attrition bias if people with more severe new-onset pain were lost to follow-up. To test for such bias, we conducted sensitivity analyses using inverse probability of attrition weights (IPW) (Howe et al., 2016). IPWs were calculated based on respondents' characteristics at Time 1, including network characteristics, age, sex, marital status, nativity status, educational attainment, wealth, whether ever worked for pay, and household size. We then re-estimated our three main models using IPWs. Findings are shown in eTable 3.

Results

Table 1 shows the unweighted descriptive statistics for the analytic sample. Means for all network characteristics were slightly higher at Time 2 than at Time 1. Average network size was 2.48 (standard deviation [SD]=1.60) at Time 1 and 2.68 (SD=1.59) at Time 2. Similarly, average scores for diversity, satisfaction, and closeness were 1.32 (SD=0.47), 8.87 (SD=1.37), and 3.23 (SD=0.62) at Time 1, and 1.31 (SD=0.47), 8.97 (SD=1.32), and 3.32 (SD=0.59) at Time 2, respectively. About one-third (30.1%) of respondents experienced the new-onset any-level pain, and most of them developed moderate pain (16.0%) between Time 1 and Time 2.

Table 2 presents the OLS regression results for the 4-year change (i.e., between Time 1 and Time 2) in social network characteristics. Panel A shows results for the change in network size. In Panel A model 1, new-onset mild and moderate pain was significantly associated with an increase in network size (β=0.26, se=0.05 for mild pain; β=0.21, se=0.04, for moderate pain), controlling for sociodemographic covariates. Compared to men, women reported a positive and significant change in network size over the 4-year follow-up period (β=0.31, se=0.03). In model 2, which additionally controlled for health covariates, the results held—all levels of pain were associated with increase in network size. The magnitudes of coefficients slightly increased for moderate and severe pain from model 1 to model 2. The magnitudes are relatively small; compared to their pain-free counterparts, respondents with newly developed pain reported an additional 0.3 members in their social network. In model 3, the interaction term between sex and pain severity was not statistically significant, thus the association between pain severity and network size did not differ between men and women.

Panel B shows results for changes in network diversity. In model 1, similar to results for network size, new-onset mild and moderate pain were associated with an increase in the diversity of social networks (β=0.05, se=0.01 for mild pain; β=0.05, se=0.01 for moderate pain). In model 2, the results hold after controlling for health covariates. In model 3, the interaction term between new-onset pain and sex were not statistically significant, indicating that the association between new-onset pain and network size were not significantly differ between men and women.

Panel C shows results for the 4-year change in network satisfaction. In contrast to the results for network size, the onset of moderate pain was significantly associated with a decrease in network satisfaction from Time 1 to Time 2 (β=−0.12, se=0.04 see Model 1). Similar to the results of network size and diversity, women reported a positive and significant change in satisfaction compared to men. In model 2, the results held after controlling for health covariates with a reduced magnitude in coeffects, indicates part of the effects of new-onset pain severity on satisfaction change could be explained by health conditions at Time 1. In model 3, we found the main effects of the mild and moderate new-onset pain was negatively associated with satisfaction, but the interaction terms between new-onset severe pain and sex were positive. The interaction term between mild pain and sex was statistically significant at 0.05, but the interaction terms between moderate or severe pain and sex were marginally significant at 0.10. The results indicate that new-onset mild pain was negatively associated with satisfaction among men, but not women (see Figure 1a).

Panel D presents results for the 4-year change in closeness with network members. Similar to results for network satisfaction, new-onset mild and moderate pain were associated with increases in network closeness ($\beta=-0.04$, se=0.02 for mild pain; $\beta=-0.05$, se=0.2 for moderate pain). The results held after additionally adjusting for health covariates (see Model 2). In model 3, the interaction term of new-onset severe pain and sex were statistically significant at 0.05 (and the interaction term of moderate pain and sex was marginally significant at 0.10). Compared to men, women experienced smaller decreases in closeness after new-onset of severe pain (see Figure 1b).

Lastly, results from sensitivity analyses using inverse probability weights, shown in eTable 3, were almost identical to the results reported in main text. This reassures us that bias due to attrition is likely to be minor. We performed additional sensitivity analyses to understand the association between pain and closeness and satisfaction by relationship type, and although sometimes sample size was too small to permit inference, whenever it was big enough, findings were similar to those from the main models, detailed findings available upon request.

Discussion

This study used a longitudinal, population-based sample of adults age 51+ in Europe to assess how new-onset pain is associated with changes in personal social network characteristics over time. We capitalized on detailed and repeated measures of social network characteristics unavailable in most population-based surveys of older adults to clarify whether pain, as an unverifiable and often socially-fraught health problem, functions as a “threat to the social self” (Karos et al., 2018), or whether new-onset pain in fact resembles newly diagnosed life-threatening conditions in leading to social network activation (Latham-Mintus, 2019).

Our findings invited a fusion of two theories that might otherwise be seen as mutually exclusive by provide evidence that support both hypotheses, since the associations between pain and later-life network characteristics appeared to depend on which characteristic of the social network (i.e., network size, satisfaction, closeness, or diversity) was examined. Compared with their pain-free peers, respondents with new-onset mild and moderate pain reported an increase in network size and diversity, but respondents with new-onset pain reported a decrease in average satisfaction (moderate pain) and closeness (mild-tomoderated) with their networks. The magnitude of the changes was relatively small but always statistically significant in all models. The associations between new-onset pain and reduced network satisfaction and closeness, but not network size and diversity, are different between men and women.

Our finding that, among respondents who were pain free at Time 1, new-onset mild and moderate pain was significantly associated with an increase in network structure (i.e., size and diversity) supports the social network activation theory (Perry & Pescosolido, 2015). It appears that both verifiable conditions with clear pathologies, such as cancer (Latham-Mintus, 2019), and less easily verified conditions such as chronic pain, can lead to expansion or intensification of social networks. This finding resembles that of a prior study using U.S.-based data to examine the effects of new-onset moderate pain on friendship network characteristics (Yang & Grol-Prokopczyk, 2021), although the present study is inclusive of a wider range of social network members, including family members. However, we also found that new-onset pain predicted a decline in perceived network quality (i.e., satisfaction and closeness): respondents with new onset moderate pain or mild-to-moderate pain predicted deceases in satisfaction and closeness with one's social network respectively. The findings are consistent with the theory of pain as a "threat to social self."

Why might new-onset pain have seemingly opposite associations with different social network outcomes? While we lack data to explore specific mechanisms, it is possible that the competing theories discussed above each apply most accurately to a specific aspect of pain-related social network characteristics. Individuals with new-onset mild-to-moderate pain may be motivated to actively draw on their social networks for social support, instrumental help, and/or pain-specific information and resources. Friends, relative, neighbors, and (ex-)coworkers may also reach out to individuals with new-onset pain. Meanwhile, older adults with pain might expand their network by including paid caregivers and/or healthcare professionals about pain and or other health problems, to meet their needs and try to maintain the overall well-being. Inclusion of the helpers and healthcare professionals may lead to larger and more diverse personal networks. However, our finding shows that the association only applied to new-onset *mild-to-moderate* pain, but not *severe* pain (with an exception: Panel A Model 2 shows new-onset *severe* pain was associated with an increase in network size). One of the reasons is that a relatively small number of participants (n=610) in our sample reported new-onset severe pain, thus the standard errors were relatively large and yielded limited statistical power to estimate the association in this group. It is also possible that mild-to-moderate pain is more likely to be fluctuating rather than continuous; individuals with mild-to-moderate pain may be more likely to have "good days" that enable positive social engagement. This could explain why new-onset *mild-to-moderate* pain is consistent with social network activation theory in terms of its effects on network size and diversity.

Simultaneously, new-onset pain may function as a threat to the social self by reducing *satisfaction* and *closeness* with social networks, as people with pain struggle to receive satisfying support from their network members. Qualitative studies of people with pain report "with remarkable consistency that pain patients experience skepticism and accusations of malingering or hypochondria from family, friends, employers", etc. (Zajacova et al., 2021). Thus, it is plausible that decreases in satisfaction could co-exist with increases in network size, diversity, etc. It is also possible that unsatisfying interactions could lead pain patients to withdraw socially and develop smaller social networks in the long term—over a period of many years, perhaps—something that our study, with its limited time frame, would not pick up. Future research with a longer follow-up could clarify this issue.

Although the interactions between new-onset pain and gender in association with social network changes in size and diversity were not statistically significant, we did observe some gender differences in the magnitude of association between new-onset pain and network satisfaction and closeness. Specifically, we found that men with newly developed pain were more likely to experience decreases in satisfaction and closeness, compared to women. It is possible that because women are more likely to experience pain (Grol-Prokopczyk, 2017), and are more likely to seek help (Addis & Mahalik, 2003); they may be more open to reaching out to their close network members and may receive more satisfying social support (Carr & Umberson, 2013; Umberson et al., 2014). In contrast, norms of masculinity, including cultural beliefs that “the ideal man” is able to tolerate or ignore pain (Fillingim, 2009; Pool et al., 2007), may lead men with pain to be more cautious in the variety of people they reach out to after the onset of pain, and to be less satisfied with their social relationships, as they may struggle to hide and/or justify their “unmasculine” struggle with pain. Pain may be more socially difficult for men than for women.

This study has several major limitations. First, we restricted our analytic sample to participants without pain at Time 1, and with valid information on social network characteristics at both Times 1 and 2. This strategy could lead to selection and/or attrition bias, e.g., if people with more severe new-onset pain were more likely to retreat from their social networks and also more likely to be lost to follow-up. This may introduce bias when estimating the pain-network link may be biased, since the sample was likely a healthier-than-average group. However, reassuringly, our sensitivity analyses using inverse probability weighting suggest that any such effect is likely to be small. Second, because SHARE only collected social network data in Wave 4 and 6 (four years apart), we are not able to extend our findings to examine longer-term social network changes as a function of pain. We encourage future research that uses data with a longer time frame, and/or that can examine the effects of exacerbations of pain rather than new-onset pain. The third limitation relates to our data on pain. Although we required respondents to be pain-free at Time 1, it is possible that some individuals had experienced chronic pain previously but had recovered temporarily and so reported no pain. For such individuals, their social networks might already have been shaped by pain at study baseline. Moreover, the pain questions in SHARE do not specify the pain’s cause, comorbidities, or its functional or psychological impact. Lacking such measures, we cannot assess what role they play in the complex effects of pain on social network outcomes. Lastly, while usually larger or more diverse social networks are considered better social networks, this may not always be the case. It is possible that people who begin to need more for-a-fee help, as from house cleaners or home health aides, will show up as having more diverse networks, but this does not necessarily mean that they are doing better socially; it could be a sign that they are doing worse. We encourage future research to further explore mechanisms of network change with more comprehensive measure of social ties.

In sum, this study contributes to the literature on the health–social network link by examining how onset of chronic pain is associated with social network outcomes. To our knowledge, this is the first study to quantitatively evaluate the impact of new-onset pain on changes in personal networks using comprehensive social network measures at the population level in Europe. We found that the effects of pain on social networks can be complex, simultaneously improving social networks in some regards and harming them in others: new-onset pain predicts an increase in *quantity* of contacts (i.e., network size and diversity) but a decrease in *quality* of relationships (i.e., network satisfaction and closeness). We also found associations between new-onset pain and network satisfaction and closeness vary significantly between men and women. Our findings show two theories – network activation and "pain as a threat to social self"—which previously seeing as mutually exclusive can co-exist. Focusing on quantity is important but overlooking quality could lead to misunderstanding of the true effects of pain on social networks, and to inefficient interventions. Given the importance of later-life social networks for midlife and older adults, understanding how illness experiences shape social networks is an important topic for researchers and policymakers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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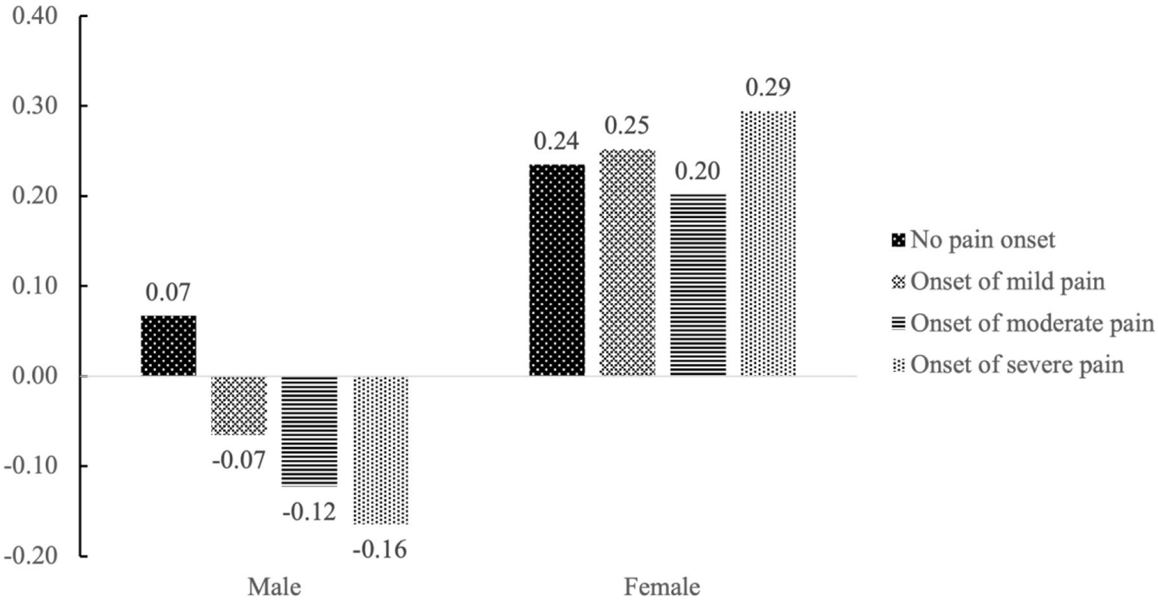

Figure 1a.

Predicted changes in social network satisfaction from Time 1 to Time 2 between men and women.

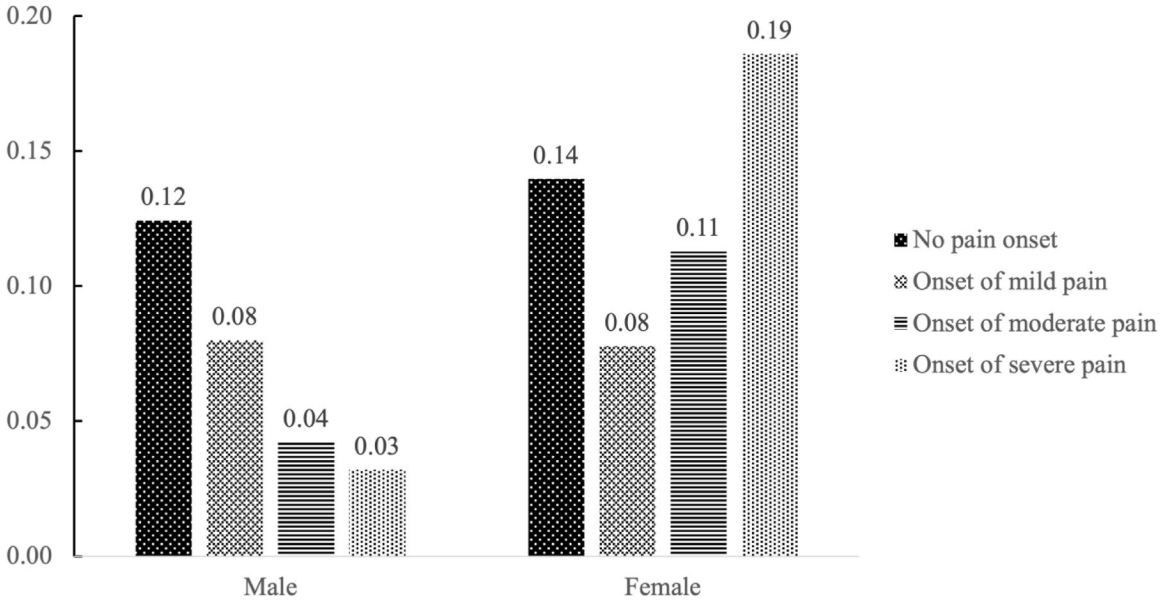

Figure 1b.

Predicted changes in social network closeness from Time 1 to Time 2 between men and women.

Table 1.

Sample Characteristics (SHARE: N=12,647; 2011/2012 Wave 4 as Time 1, 2015 Wave 6 as Time 2)

	n	Mean or %	SD	Range
Network size at Time 1	12,647	2.48	1.60	0–7
Network size at Time 2	12,647	2.68	1.59	0–7
Network diversity at Time 1	11,785	1.32	0.47	1–3
Network diversity at Time 1	11,785	1.31	0.47	1–3
Network satisfaction at Time 1	12,468	8.87	1.37	0–10
Network satisfaction at Time 2	12,468	8.97	1.32	0–10
Network closeness at Time 1	11,725	3.23	0.62	1–4
Network closeness at Time 2	11,725	3.32	0.59	1–4
New-onset pain severity by Time 2				
No pain (ref.)	8,844	69.93		
Mild pain	1,168	9.24		
Moderate pain	2,025	16.01		
Severe pain	610	4.82		
Age at Time 1 (in years)	12,647	64.79	8.95	51–98
Sex				
Male (ref.)	6,248	49.40		
Female	6,399	50.60		
Marital status at Time 1				
Married/partnered (ref.)	9,280	73.38		
Divorced	1,158	9.16		
Widowed	1,444	11.42		
Never married	765	6.05		
Native born (ref.: foreign born)	11,578	91.55		
Education (ISCED1997)	12,647	3.03	1.45	0–6
Wealth quartiles at Time 1				
Quartile 1 (ref.)	2,352	18.60		
Quartile 2	2,945	23.29		
Quartile 3	3,402	26.90		
Quartile 4 (wealthiest)	3,948	31.22		
Ever worked for pay (ref.: no)	12,361	97.74		
Number of people in a household	12,647	2.19	1.01	1–12
Depression at Time 1	12,469	1.87	1.89	0–12
Activity limitation at Time 1				
Not limited (ref.)	9,274	73.34		
Limited, but not severely	2,600	20.56		
Severely limited	771	6.1		
Cancer at Time 1	557	4.40		
Diabetes at Time 1	1,151	9.10		
Heart attack at Time 1	1,160	9.17		

	n	Mean or %	SD	Range
Lung disease at Time 1	522	4.13		
Stroke at Time 1	324	2.56		

[a] Wealth quartiles were not exactly 25% each, because they were created using the full SAHRE sample rather than only the analytical sample.

Table 2.

OLS Regression of New-Onset Pain Severity on Social Network Characteristics Using a Change Score Approach.

	Model 1		Model 2		Model 3	
Panel A: Network size (n=12,647)	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
New-onset pain (ref: no pain)						
Mild pain	0.256***	0.047	0.265***	0.048	0.261***	0.064
Moderate pain	0.211***	0.037	0.229***	0.038	0.288***	0.057
Severe pain	0.101	0.062	0.158*	0.064	0.236*	0.104
Female (ref: male)	0.307***	0.026	0.313***	0.027	0.337***	0.031
New-onset pain X Female						
Mild X Female					0.005	0.090
Moderate X Female					−0.108	0.073
Severe X Female					−0.133	0.128
Panel B: Network diversity (n=11,785)	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
New-onset pain (ref: no pain)						
Mild pain	0.050***	0.014	0.050**	0.014	0.046*	0.019
Moderate pain	0.047***	0.011	0.048***	0.012	0.046**	0.016
Severe pain	0.011	0.019	0.012	0.019	0.010	0.010
Female (ref: male)	0.089***	0.008	0.088***	0.009	0.090***	0.010
New-onset pain X Female						
Mild X Female					0.006	0.029
Moderate X Female					0.000	0.022
Severe X Female					−0.000	0.037
Panel C: Network satisfaction (n=12,468)	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
New-onset pain (ref: no pain)						
Mild pain	−0.050	0.038	−0.043	0.038	−0.129*	0.055
Moderate pain	−0.122**	0.035	−−0.095**	0.036	−0.163**	0.057
Severe pain	−0.112	0.069	−0.036	0.066	−0.181	0.125
Female (ref: male)	0.185***	0.024	0.217***	0.024	0.171***	0.034
New-onset pain X Female						
Mild X Female					0.174*	0.075
Moderate X Female					0.125†	0.070
Severe X Female					0.244†	0.143
Panel D: Network closeness (n=11,725)	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
New-onset pain (ref: no pain)						
Mild pain	−0.043*	0.018	−0.042*	0.018	−0.040	0.026
Moderate pain	−0.047**	0.014	−0.043**	0.014	−0.074**	0.022

	Model 1		Model 2		Model 3	
Panel A: Network size (n=12,647)	**Coef.**	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
Severe pain	−0.010	0.025	−0.006	0.025	−0.083 *	0.039
Female (ref: male)	0.012	0.010	0.017 †	0.010	0.007	0.012
New-onset pain X Female						
Mild X Female					−0.005	0.035
Moderate X Female					0.053 †	0.028
Severe X Female					0.124 *	0.049

Notes:

† $p < .1$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

OLS = ordinary least squares.

Model 1 includes controls for age in years, marital status, nativity status, educational attainment, wealth quartiles, ever worked for pay, and household size

Model 2 additionally adjusts for health covariates including depressive symptoms, functional limitations, and five chronic conditions (cancer, diabetes, heart attack, lung disease, and stroke)

Model 3 additionally includes interactions between new-onset pain severity and sex. All models included clustered standard errors at the household level and country fixed effects.