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Article

Social pathways to health: On the mediating role of the social network in the relation between socio-economic position and health

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ABSTRACT

Good health is one of the key qualities of life, but opportunities to be and remain healthy are unequally distributed across socio-economic groups. The beneficial health effects of the social network are well known. However, research on the social network as potential mediator in the pathway from socio-economic position (SEP) to health is scarce, while there are good reasons to expect a socio-economical patterning of networks. We aim to contribute to our understanding of socio-economic inequalities in health by examining the mediating role of structural and functional characteristics of the social network in the SEP-health relationship. Data were from the second wave of the Norwegian study on the life course, aging and generation study (NorLAG) and comprised 4534 men and 4690 women aged between 40 and 81. We applied multiple mediation models to evaluate the relative importance of each network characteristic, and multiple group analysis to examine differences between middle-aged and older men and women. Our results indicated a clear socio-economical patterning of the social network for men and women. People with higher SEP had social networks that better protect against loneliness, which in turn lead to better health outcomes. The explained variance in health in older people by the social network and SEP was only half of the explained variance observed in middle-aged people, suggesting that other factors than SEP were more important for health when people age. We conclude that it is the function of the network, rather than the structure, that counts for health.

1. Background

Good health is one of the key qualities of life, but opportunities to be and remain healthy are unequally distributed across socio-economic groups. Research from high-income countries shows that the higher up in the social hierarchy people are, the healthier they are and the longer they live (Huisman, Read, Towriss, Deeg, & Grundy, 2013; Mackenbach et al., 2008; Marmot, 2004; Veenstra, 2000). Findings from a US study, for example, demonstrated that life expectancy for white men with 16 or more years of education was 14.2 years higher than for black men with less than 12 years of education (Olshansky et al., 2012). Research aimed at understanding the mechanisms by which socio-economic position (SEP) exerts such a consistent influence on health, has revealed a variety of pathways, among which physical activities (Gidlow, Johnston, Crone, Ellis, & James, 2006), food habits (De Irala-Estevez, Groth, Johansson, Oltersdorf, Prattala, & Martínez-González, 2000), and life styles (Shaw, McGeever, Vasquez, Agahi, & Fors, 2014). So far, few scholars have addressed structural and functional aspects of the social network as a mediator in the SEP-health relationship, but available results are mixed. Gorman and Sivaganesan (2007) employed data from a US study including 30,000 adults aged 25 and older, and found structural aspects of social networks (number of relations and contact frequency) to be related to health outcomes. They found no evidence for a mediating role of social support, i.e. a functional aspect of social networks. In a German study on the other hand (45–75 year olds), Vonneilich et al. (2012) observed significant mediating paths from SEP through both structural and functional aspects of the social network on health.

A possible explanation for the mixed results is that structural and functional aspects of the social network are not independent of each other. For example, a larger network may be capable of providing more support, but the relation with health may be different for support and network size. Not controlling for other network characteristics may therefore lead to biased results. The aim of this study is to enhance our understanding of the social network as a mediator in the SEP-health relationship by examining the unique contribution of various characteristics of the social network simultaneously. To our knowledge, no empirical study has done so before. Below, we provide the theoretical basis for the hypothesized mediation relation before moving on to the analyses.

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1.1. SEP inequalities in social networks

A social network is a 'collection of interpersonal ties that people of all ages maintain in varying contexts' (Litwin, 2001: p. 516). In general, two different but related aspects of the social network are of interest: the structure and the function. The structure of the network refers to the way the network is organized (e.g. network size, contact frequency). The function on the other hand, refers to what the network does for the individual, for example support received from the network. SEP is the social and economic standing of a person, and often involves measures of education, income and occupational status, or a combination of the three. Most authors agree that using different indicators of SEP, rather than only education or income, better captures the full contribution of SEP to health (Galobardes, Lynch, & Smith, 2007; Webb et al., 2017).

Socio-economically disadvantaged people often have poor social networks and low levels of social support (Weyers et al., 2008). The link between SEP and qualities of the social network is explained by sociologists in terms of differences in resources, that can be used to invest in new relationships (Lin, 1999). This implies that higher SEP individuals are better equipped to attract new people leading to larger networks. In addition, psychologists argue that the higher educated people may have a greater competence and mastery over their lives, which in turn increases social integration and network quality (Mirowsky & Ross, 2007). Empirical evidence to support these claims comes from a limited number of studies, and the outcomes are mixed. Some authors have found that people with high SEP have larger networks and more supportive non-kin relationships than people with low SEP (Ajrouch, Blandon, & Antonucci, 2005; Broese van Groenou & Van Tilburg, 2003), while others observed the opposite (Kubzansky, Berkman, Glass, & Seeman, 1998). Still, we expect that men and women with higher SEP have larger and more supportive networks compared to people with lower SEP.

1.2. The structure and function of social network and the relation with health

Based on theories from the early sociologist Durkheim and social network theorists (e.g. Lin, 1999), Berkman and colleagues (Berkman, Glass, Brissette, & Seeman, 2000) have argued that social networks might affect health along four different pathways. First, the social network is a resource for support that can be utilized in times of crisis. Second, the social network exerts a social pressure on its members to adjust their own attitudes and health behaviors (e.g. smoking, alcohol use, exercising) to that of the group. Third, social relationships may provide access to materials and goods that they do not possess themselves, but are beneficial for health, for example health-related information. Finally, also essential is the need for attachment "for its own sake" (Berkman et al., 2000, p. 845). The feeling of being attached to others, as opposed to feeling lonely (De Jong Gierveld, Van Tilburg, & Dykstra, 2016), may provide a safe haven that promotes self-esteem and health (e.g. Bowlby, 1982).

Both structural and functional characteristics of the network are found to be associated with health. In a meta-analytic review of studies including a total of 300.000 participants from Europe, North America, Asia, and Australia, Holt-Lunstad and colleagues (Holt-Lunstad, Smith, & Layton, 2010) found that large networks, high contact frequency and higher levels of received support relate to an increased likelihood of survival. Other scholars have also claimed that larger and more heterogeneous networks are associated with higher support potential, and as such to better health outcomes (Ellwardt, Van Tilburg, & Aartsen, 2015; McPherson, Smith-Lovin, & Cook, 2001).

With respect to our hypothesized mediation models, we expect that men and women with higher SEP have larger networks, and that larger networks provide a wider access to resources that benefits health, which in turn leads to better health. Further, we expect that people with higher SEP have more frequent contact with members of their network, which provides greater access to the network members' resources, leading to a stronger positive effect on health. We also expect that a higher SEP is related to a lower risk of loneliness and increased perceived support availability, which also positively affects health.

1.3. The moderating role of gender and age

Few studies have addressed the gendered nature of the total pathway from SEP to social network to health (Wrzus, Hänel, Wagner, & Neyer, 2013) but findings are inconsistent. Women may have larger networks and more supportive relationships than men (Antonucci & Akiyama, 1987), but it is not clear whether or not the network's effect on health is stronger for women than for men. Some have found a stronger effect for women (Antonucci & Akiyama, 1987; Walen & Lachman, 2000), others have documented a stronger effect for men (House, Landis, and Umberson, 1988; Shye, Mullooly, Freeborn, & Pope, 1995), and yet others did not detect any gender differences (Turner, 1994; Vinokur, Price, & Caplan, 1996). To account for the potential differences between men and women in the relation between SEP and health, we will estimate the models separately for men and women.

Age may moderate the paths from SEP to the network, and from the network to health, not only because of chronological age, but also because of cohort differences. Earlier born cohorts have in general lower levels of education, which may be reflected in lower levels of SEP and lower levels of physical health (Wrzus, Hänel, Wagner, & Neyer, 2013). It is uncertain whether associations are attenuated, or even reversed among older age groups (Grundy & Sloggett, 2003), and different theories predict contrasting outcomes. According to the cumulative advantage and disadvantage theory (e.g. Dannefer, 2003), health inequalities are expected to increase with age, whereas the age-as-leveler hypothesis (e.g. Dupre, 2007) expects a weaker association between SEP and health after retirement age.

1.4. Hypotheses

In sum, our expectations with respect to the mediating role of the network in the relation between SEP and health are as follows:

H1. People with higher SEP are in better health because they have larger networks, more frequent contact with network members, higher perceived access to support, and are less lonely.

H2a. Direct and indirect paths between SEP and health are stronger at higher ages (cumulative advantage hypothesis).

H2b. Direct and indirect paths between SEP and health are weaker at higher ages (age as leveler hypothesis).

2. Method

2.1. Study sample

Data were derived from the second wave of the Norwegian panel study on Life course, Ageing and Generation (NorLAG) comprising a nationally representative sample aged 18–84 (n = 15,109) (Slagsvold et al., 2012). Data collection was carried out in 2007/8 through (computer-assisted) telephone interviews and postal questionnaires. The combined response rate was 43.2 percent. Non-response was higher among people with basic education, which resulted in an overrepresentation of people with higher education (Table 1). Data from public registries were added with the respondents' informed consent. For the present study, we selected participants aged 40 years and older which resulted in a study sample of 4534 men and 4690 women ($M_{age\ men} = 56.8$; SD = 10.7, $M_{age\ women} = 56.4$; SD = 10.9). No other selection criteria were used.

Table 1
Frequency distribution of education, by age group and gender.

	Men				Women			
	40–66 years	%	67–81 years	%	40–66 years	%	67–81 years	%
Education								
Low	595	16,68	244	25,71	704	19,03	325	33,03
Middle	1688	47,31	446	47,00	1525	41,22	470	47,76
High	1285	36,01	259	27,29	1471	39,76	189	19,21
Total	3568	100,00	949	100,00	3700	100,00	984	100,00

2.2. Analytical strategy

We applied multiple mediation models (see Fig. 1 for a graphical representation) and followed the procedures described by MacKinnon (2008), MacKinnon, Warsi, and Dwyer (1995) and, Preacher and Hayes (2008), MacKinnon, Warsi, and Dwyer (1995) to address critiques that have been raised on the use of mediation analyses. The multiple mediation model was set up as a Structural Equation Model (SEM), which allowed us to include latent variables and to evaluate the overall fit of the models. We followed criteria set by Hu and Bentler (1999) to evaluate whether the models represented the data well. A cutoff value close to 0.95 for TLI and CFI and a cutoff value close to 0.06 for RMSEA was used as criteria for model fit. To test whether the direct and indirect paths in the multiple mediation model were different for younger and older people, we conducted a multiple group analyses in which all direct and indirect paths were constrained to be equal. If the models fitted the data well, we concluded that there were no age differences.

Since the characteristics of the network are interdependent, we checked for multicollinearity, and excluded mediators with bivariate correlations with other mediators higher than 0.60 (Grewal, Cote, & Baumgartner, 2004). To avoid potential biases in the estimates of the B's, we took potential correlation between the mediators into account by letting all covariances between the mediators covary freely. For a precise estimation of the standard error (SE) of the effects, we applied bootstrapping, based on 5000 bootstrap samples, which is suggested as the most powerful method to obtain confidence intervals (CI) for the indirect effects (Preacher & Hayes, 2008). A significant indirect effect through an aspect of the social network indicated that the social network aspect mediated the effect of SEP on health, conditional on the other mediators in the model. An effect was judged to be significant if the 95% bias-corrected CI for the parameter estimate did not contain zero. All analyses were conducted separately for men and women.

We evaluated the total indirect effect, the unique indirect effects, and the relative importance of the distinguished characteristics of the network on health. We subsequently examined (1) the specific direct effects of SEP on health and on the four mediators, and the specific direct effects of the four mediators on health; (2) the specific indirect effects of SEP via the four mediators, conditional on the presence of other mediators; (3) the relative magnitude of the specific indirect effects of the mediators; (4) the total indirect effect of SEP on health; (5) the total explained variance of health by the SEM-model; and (6) whether the direct and indirect effects were different for middle-aged and older men and women. Mediation of the social network was demonstrated if the total indirect effect was significant, and/or specific indirect effects were significant. Note that if the model includes mediators and suppressors, the total indirect effect does not need to be significant, even if the specific indirect effects were highly significant (Preacher & Hayes, 2008). The standardized direct effects (β's) from SEP on the network variables (a_1–a_4), and the standardized effect from SEP on health (c') represented the amount of change in the mediators for every 1 standardized change in SEP; the standardized direct effects from the network variables on the dependent variable health (b_1 to b_4) represented the amount of change in health for every 1 standard deviation change in the mediator (Fairchild, MacKinnon, Taborga, & Taylor, 2009). The relative magnitude of each mediator in the total mediation of the network was assessed by means of the proportions mediated for each indirect path, which is calculated as $|ab/(ab+c')|$. The outcome reflected the ratio of the absolute values of the standardized indirect path (β) to the total effect (MacKinnon, 2008).

Missing values in the multiple mediator models were imputed based on all available data. We used the robust weighted least square estimator (WLSMV), which is robust against non-normality of the variables and the best option for modeling categorical and ordered data (Brown, 2006). In addition, WLSMV provided an overall fit of the models, which informed about how well our theoretical model fitted the observed data. Multiple mediator models were estimated with *Mplus* 7.0 (Muthén & Muthén, 1998–2015).

2.3. Measures

2.3.1. Dependent variable (Y)

Physical health was assessed in the telephone interview, with the Short-Form Health Survey 12 (SF-12), a widely used generic health measure (Ware, Kosinski, & Keller, 1996). The SF-12 contains 12 items of the longer version (SF-36), including items measuring physical functioning, role limitations due to physical health, bodily pain, general health perceptions, and vitality. The items were weighted and summed into the physical component scale (PCS-12). Scale scores were standardized with a mean set to 50 and SD to 10. Higher scores indicate better health.

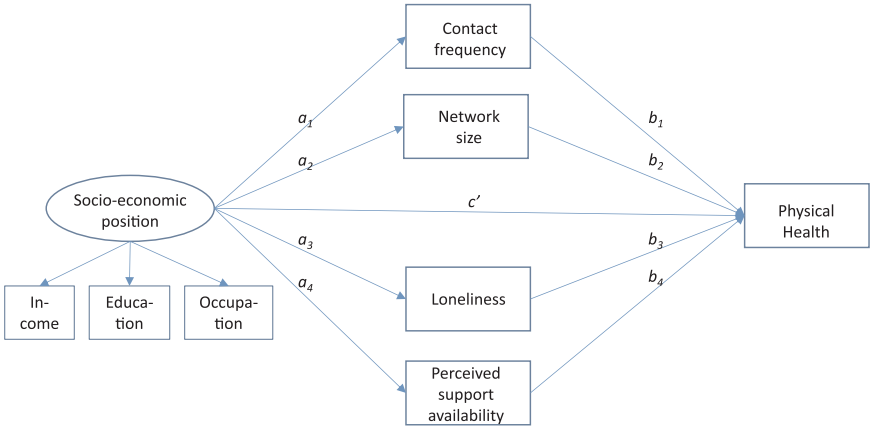

Fig. 1. Multiple mediation model of the relation between Socio-economic position (SEP) and physical health, mediated by four network characteristics: (1) contact frequency (2) network size (3) loneliness (4) perceived support availability.

2.3.2. Independent variables (X)

The variable SEP in the mediation model represents the socio-economic position of individuals. SEP is included in the models as a latent variable, with indicators income, education and occupational status. Each indicator captures a different aspect of SEP (for a more technical explanation see Muthén (2002)). For income, we used the respondent's gross income for the year 2007 in Norwegian Kroner (NOK) (registry data). If the respondent had a partner, we used the gross income of the partner if it was higher than that of the respondent. Incomes lower than 50.000 NOK were recoded into system missing (N = 150) as this is likely an inadequate reflection of the actual financial situation. Level of education was based on registry data and recorded using the International Standard Classification of Education (ISCED-97). To account for the lower level of education in older age groups, especially among older women, we reduced information to three categories: (1) no education or primary education, (2) basic secondary and secondary completed, and (3) higher secondary education, basic university, university completed, and Ph.D. Occupational status was based on the International Standard Classification of Occupations (ISCO-88) and reflects the current (if still at work) or last (if no longer at work) level of occupation. The scale ranged from 1 (unskilled labor) to 9 (administrative leaders and politicians) with higher scores indicating higher occupational class.

2.3.3. Mediators (M)

The structure of the network was assessed by two variables: network size and contact frequency. Network size refers to the total number of the following people in the respondents' network: the partner, own children, parents, siblings, and friends. Contact frequency is the total number of face-to-face contacts per year with network members *outside* the household, including children, friends, siblings, parents and grandparents, parents in law, grandchildren, stepchildren and others.

The function of the network includes two aspects: perceived support availability and loneliness. Perceived support availability reflects the general idea people have about the available support in their network (Thoits, 2011). Here, perceived support availability was assessed by asking which of the following relationships would most probably help in case of a personal crisis-situation: partner, children, grandchildren, parents, parents in law, siblings, friends, or others. The result was a count-variable, ranging from 0 (no one was expected to help) to 8 (all role relations would help). We also used loneliness as an indicator of the function of the network. Although closely related to social isolation, which is an objective and quantifiable structural aspect of the network, loneliness can be seen as a functional aspect of the network as it is often defined as a "subjective feeling based on an unpleasant or inadmissible lack of relationships or lack of quality" (Perlman & Peplau, 1981, p. 31). Loneliness was assessed with the six-item version of the De Jong Gierveld Loneliness scale (De Jong Gierveld & Van Tilburg, 2006), which includes questions as "I experience a general sense of emptiness" and "There are plenty of people I can rely on when I have problems". The scores on each of the six items were recoded into 0 (not indicative of loneliness) and 1 (indicative of loneliness) and summed into a loneliness index ranging from 0 (no loneliness) to 6 (severe loneliness) (see Table 2). Information on the mediators was based on a combination of telephone interviews and postal questionnaires, resulting in some fluctuation in the number of observations.

2.3.4. Moderators

Gender was coded as 1 (men) and 2 (women). Age was based on the respondents' year of birth. Both gender and birth year were derived from public registers. We examined the modifying role of age in two age groups; 40–66 and 67 and older. We chose the age of 67 as cut-off as this was the statutory retirement age in Norway at the time of interview, and retirement can be a disruptive life event resulting in changes in the structure and function of the network.

3. Results

Descriptives and bivariate correlations of all study variables are presented in Table 2, separately for men and women. Tests for the significance of differences between men and women are presented in Table 3. Gender differences were observed for all study variables, except age and education. The social networks of men were larger than the networks of women, and with a higher contact frequency with members outside the household. Also, men were found to be somewhat lonelier and reported lower levels of perceived support available than women. Finally, men had a better physical health compared to women.

The bivariate correlations between the four mediators indicated no risk for multicollinearity (largest $r = 0.46$), and thus we kept the four selected mediators in the multiple mediator models. The bivariate correlations between the three indicators of SEP and health are significant but weak ($r = 0.14$–0.21) for both genders, and in the expected direction, i.e. higher levels of education, income and occupational status were related to better health. The bivariate correlations between the three SEP indicators and the structural and functional aspects of the network were also in the expected direction for both genders, except for contact frequency. Higher education, occupational status, and income, were related to fewer contacts with network members outside the household (correlations are respectively $r_{men} = -0.13$; $r_{women} = -0.12$; $r_{men} = -0.03$; $r_{women} = -0.04$; $r_{men} = -0.09$; $r_{women} = -0.11$). Three of the four mediators correlated with physical health in both genders. Larger networks, more perceived support availability and lower levels of loneliness were related to better health ($|r_{men}|$ 0.10–0.16; $|r_{women}|$ 0.13–0.18). The relation between contact frequency and health was not significant. Bivariate correlations should be treated with caution, however, as they are prone to spurious or suppressor effects. To check whether the bivariate associations are sustained if the effect of all other variables are taken into account, we will now discuss the results of the multiple mediator analyses (Tables 4 and 5).

As shown in Table 4, the analytical models fitted the data well for middle-aged and older men, indicating no significant age difference in direct and indirect paths. The RMSEA value in women (0.08, Table 5) exceeded the cutoff of 0.06, indicating a mediocre fit. Nevertheless, we did not reject the model for women for two reasons. First, the RMSEA punishes over-identified models (Hooper, Coughlan, & Mullen, 2008), and there were more non-significant paths in the models for women than for men. Rerunning the models for men and women in the lowest quartile of health revealed comparable direct and indirect effects of SEP to the social network to health, but with more paths that were significant and, consequently, improved RMSEA of 0.06. Secondly, for reasons of comparison, we preferred the same models for men and women.

With respect to the specific direct effects, we observed that the adjusted effect of SEP on health (c') was significant for both men ($B_{middle\text{-}aged\ men} = 1.610$, $B_{older\ men} = 1.195$) and women ($B_{middle\text{-}aged\ women} = 1.676$, $B_{older\ women} = 1.576$; Tables 4 and 5). Higher SEP was found to relate to lower contact frequency, larger networks, lower levels of loneliness and higher levels of perceived support availability for both genders. Specific direct effects of the network characteristics on health were also in the expected direction, but only the association between loneliness and health reached the level of significance ($B_{men} = -0.643$; $B_{women} = -0.925$).

The specific indirect effects inform about the extent to which the network characteristics are significant mediators in the SEP-health relation. From Tables 4 and 5, it appears that the only network characteristic that had a unique significant mediating effect in the SEP-health relationship in women was loneliness ($B_{men} = 0.061$, $B_{women} = 0.132$). For men, we also observed a significant indirect path through perceived support availability ($B = 0.018$). Loneliness accounted for 3.7% and 4.9% of the total effect of SEP and the network on health for middle-aged and older men respectively, and 7.2% and 7.8% of the total effect of SEP and the network on health for middle-

Table 2
Descriptives and bivariate correlations of the study variables by gender.

		N	M	SD	Min	Max	1	2	3	4	5	6	7	8
	Men													
1	Age (years)	4534	56.77	10.73	40.00	81.00								
2	Education (1–3)	4517	2.16	0.71	1.00	3.00	**-0.11**							
3	Income per year/100,000 NOK	4471	4.97	4.77	0.60	109.60	**-0.15**	**0.21**						
4	Occupational status (0–10)	3728	5.64	2.49	1.00	9.00	0.01	**0.51**	**0.24**					
5	Contact frequency (number per year)	4208	165.33	196.65	0.00	1983.00	0.02	**-0.13**	*-0.03*	**-0.09**				
6	Network size (0–24)	4534	9.45	3.29	0.00	21.00	**-0.30**	0.03	**0.08**	0.01	**0.19**			
7	Loneliness (0–6)	4498	0.98	1.33	0.00	6.00	**0.04**	**-0.06**	**-0.09**	**-0.08**	**-0.11**	**-0.32**		
8	Perceived support availability (0–8)	3315	3.45	1.65	0.00	9.00	**-0.31**	**0.08**	**0.10**	**0.06**	**0.13**	**0.42**	**-0.28**	
9	Physical health (PCS-12)	4482	49.66	9.28	10.55	66.63	**-0.19**	**0.19**	**0.16**	**0.15**	-0.02	**0.10**	**-0.16**	**0.12**
	Women													
1	Age (years)	4690	56.39	10.92	40.00	81.00								
2	Education (1–3)	4683	2.13	0.75	1.00	3.00	**-0.21**							
3	Income per year/100,000 NOK	4603	2.41	4.55	0.60	129.50	**-0.22**	**0.23**						
4	Occupational status (0–10)	3747	6.03	1.93	1.00	9.00	**-0.13**	**0.56**	**0.20**					
5	Contact frequency (number per year)	4503	148.19	159.65	0.00	1512.00	**0.05**	**-0.11**	*-0.04*	**-0.11**				
6	Network size (0–24)	4690	9.21	3.19	0.00	24.00	**-0.39**	**0.10**	**0.16**	**0.06**	**0.13**			
7	Loneliness (0–6)	4650	0.93	1.32	0.00	6.00	**0.10**	**-0.13**	**-0.10**	**-0.10**	**-0.12**	**-0.31**		
8	Perceived support availability (0–8)	3695	3.62	1.61	0.00	9.00	**-0.40**	**0.16**	**0.18**	**0.14**	**-0.05**	**0.46**	**-0.33**	
9	Physical health (PCS-12)	4606	47.47	11.01	10.99	66.83	**-0.19**	**0.21**	**0.14**	**0.16**	-0.01	**0.14**	**-0.18**	**0.13**

Significant correlations are printed in bold ($p < 0.01$) or italic ($p < 0.05$).

Table 3
T-tests and non-parametric (Wilcoxon-Mann Whitney) tests for gender differences in main study variables.

	Men		Women		T	Sign.	Z	Asympt. Sign.
	M	SD	M	SD				
Age (years)	56.77	10.73	56.39	10.92	1.70	0.09		
Education (1–3)	2.16	0.71	2.13	0.75			-1.08	0.28
Income per year/100,000 NOK	4.97	4.78	4.55	4.47	4.37	< 0.01		
Occupational status (0–10)	5.63	2.49	6.03	1.93			-3.95	< 0.01
Contact frequency (number per year)	165.33	196.65	148.19	159.65	4.45	< 0.01		
Network size (0–24)	9.45	3.29	9.21	3.19	3.59	< 0.01		
Loneliness (0–6)	0.98	1.33	0.93	1.32			-2.52	< 0.05
Perceived support availability (0–8)	3.45	1.65	3.62	1.61			-4.63	< 0.01
Physical health (PCS-12)	49.66	9.28	47.47	11.01	10.24	< 0.01		

aged and older women The total explained variance of health was 14.2% and 6.4% for middle-aged and older men respectively, and 11.1% and 5.4% for middle-aged and older women.

4. Discussion

4.1. Main outcomes

In the present study, we examined whether the social network is an intermediate factor in the often observed SEP-health relationship. More specifically, we evaluated whether structural and/or functional characteristics of the social network are socially patterned, which contributes to inequalities in health, while taking into account other characteristics of the network and potential age and gender differences. Our first hypothesis, that people with higher SEP have better social networks with respect to the quality and quantity, which in turn contributes to better health, is partly supported by the data. In line with our expectations, we observed that men and women with higher SEP do have social networks that better protect against loneliness, which in turn leads to better health outcomes. Although socially patterned, structural aspects of the network do not mediate the SEP-health relation. Further, our study reveals that the mediating role of the social network is comparable in middle-aged and older adult. Hence, there is no support for either the cumulative advantage/disadvantage theory (H2a) nor for the age-as-leveler hypothesis (H2b). Nevertheless, the explained variance of health in the oldest age group was half of the explained variance in younger age groups, indicating that factors other than SEP become more important for health when people age. The mediating role of the network in the SEP-health relation is modest, as indicated by the remaining unique effect of SEP on health. This is not surprising, given the abundance of studies observing significant mediators in other domains of functioning, including genes, personality and life style.

4.2. Why loneliness might be important

Why the function, and not the structure, of the network mediates the relation between SEP and health, is not clear. One argument for a lack of effect of the structure of the network on health is that our sample, and especially the middle-aged, is relatively healthy, and structural characteristics of the network, such as the size and the contact frequency only become effective when health starts to decline and real support needs arise. However, reanalysing the models with people in the lowest quartile of physical health does not lead to different conclusions. Another alternative explanation for the absence of structural effects on health is that differences in network sizes may be only relevant if the number of relations is very small. With our models, we estimated linear effects of the mediators on health, which implicitly assumes that the role of network size for health is equal among those with many versus only a few social relations. The median number of contacts in our study sample was 10 (range 0–24) and only a very small percentage (less than 4%) of the sample had three or fewer social relations. Another argument for the finding that only loneliness exerts significant effects on health, is that loneliness also reflects poor health

Table 4
Specific direct effects, specific indirect effects, and total indirect effect of SEP on health for younger (40–66) and older (67–81) men.

	Men, 40–66 (N = 3581)				Men, 67–81 (N = 953)			
			95% CI of B (after 5000 bootstraps)				95% CI of B (after 5000 bootstraps)	
	B	β	Lower	Upper	B	β	Lower	Upper
Specific direct effects								
SEP - > Health	**1.610**	**0.341**	1.056	2.245	**1.195**	**0.215**	0.864	1.726
SEP - > Contact Frequency	**-0.312**	**-0.161**	-0.451	-0.215	**-0.312**	**-0.139**	-0.451	-0.215
SEP - > Network Size	**0.086**	**0.053**	0.017	0.169	**0.086**	**0.044**	0.017	0.169
SEP - > Loneliness	**-0.095**	**-0.137**	-0.138	-0.063	**-0.095**	**-0.126**	-0.138	-0.063
SEP - > Perceived support availability	**0.081**	**0.093**	0.036	0.143	**0.081**	**0.099**	0.036	0.143
Contact Frequency - > Health	0.029	0.012	-0.053	0.127	0.029	0.012	-0.053	0.127
Network Size - > Health	0.046	0.016	-0.061	0.148	0.046	0.016	-0.061	0.148
Loneliness - > Health	**-0.643**	**-0.094**	-0.891	-0.357	**-0.643**	**-0.087**	-0.891	-0.357
Perceived support avail.- > Health	0.226	0.042	-0.043	0.468	0.226	0.033	-0.043	0.468
Specific indirect effects								
SEP - > Contact Frequency - > Health	-0.009	-0.002	-0.047	0.012	-0.009	-0.002	-0.047	0.012
SEP - > Network Size - > Health	0.004	0.001	-0.003	0.017	0.004	0.001	-0.003	0.017
SEP - > Loneliness - > Health	**0.061**	**0.013**	0.038	0.099	**0.061**	**0.011**	0.038	0.099
SEP - > Perceived support availability - > Health	**0.018**	**0.004**	0.002	0.045	**0.018**	**0.003**	0.002	0.045
Total indirect	**0,074**	**0.016**	0.036	0.122	**0.074**	**0.013**	0.036	0.122
Explained Variance Health (%)	14.2				6.4			
Proportion mediated by specific indirect effects (%)*								
SEP - > Contact Frequency - > Health	0.590				0.939			
SEP - > Network Size - > Health	0.292				0.463			
SEP - > Loneliness - > Health	3.672				4.867			
SEP - > Perceived support avail. - > Health	1.106				1.376			
Fit statistics								
Chi2 (*df* = 32)	221.95							
p	0.00							
CFI	0.99							
TLI	0.97							
RMSEA	0.05							

* The proportion mediated by the specific indirect effect is calculated as the absolute value of the ratio of the specific standardized effect and the specific standardized effect plus the standardized effect of SEP on health (|ab/(ab + c')|, MacKinnon et al., 1995). Significant effects are printed in bold.

and emotional functioning (Luo & Waite, 2014), which is related to lower self-esteem and self-efficacy (Cacioppo, Hawkley, & Thisted, 2010; Luo & Waite, 2014). This in turn may also be associated with less successful occupational careers and lower SEP. Finally, loneliness may also be indicative of a particular set of genes that relates to loneliness and lower levels of physical functioning (De Jong Gierveld et al., 2016). Further research is needed to examine these alternative explanations in more detail.

The mixed findings with respect to social network characteristics and health resonate with meta-analytical findings by Holt-Lunstad et al. (2010). Their meta-analysis includes a substantial number of studies with no significant effects of structural or functional aspects of the network on health, as well as quite a number of studies showing significant effects of structural or functional characteristics of the network on health. It should be noted, however, that there is a great variety in measures of structural and functional characteristics across the studies included in the meta-analysis. For example, the structural characteristics could refer to network size and contact frequency, as in our study, yet they could also indicate marital status and household size (e.g., whether living alone). Not all characteristics of the social network may be equally relevant for health, and not all aspects of health may be equally sensitive to various characteristics of the network. Future studies on social networks and health should acknowledge that associations between the network and health can be very specific.

4.3. Limitations and strengths

An important limitation of our study is that it is mainly cross-sectional and thus we cannot rule out reversed causality. For example, the "health selection" hypothesis causally links poor health to the structure and function of the network, which in turn may affect people's SEP. In line with this is the finding that physical limitations can enhance feelings of loneliness (Aartsen & Jylhä, 2011), which may further affect SEP. However, it can be defended that part of our mediation model is causal as people's SEP refers to information that are established prior to the start of our study (education, occupational status). Our arguments are therefore generally in line with "social causation" hypothesis, for which stronger evidence exists (Adler & Ostrove, 1999; Mulatu & Schooler, 2002).

To our knowledge, this study is one of the first to examine the mediating role of various aspects of the social network simultaneously in the well-known relation between SEP and health. By means of a multiple mediator model, we examined the socio-economic patterning of social networks, and tested which of the structural and functional characteristics of the networks significantly contributes to the relation between SEP and health. This simultaneous testing allowed us to conclude on the precise mechanism through which social networks benefits health in the general population. The large dataset and wide age range contributes to precise estimates of the effects of the mediators.

4.4. Conclusion

Our main finding is that SEP affects health in middle-aged and older men and women through loneliness. This suggests that interventions to reduce health inequalities can become more effective when they include practices to reduce loneliness, especially when applied to middle-aged people. Although the effect of the network is modest, it is significant and adds to our further understanding of why SEP exerts such a consistent effect on health. While all four aspects of the social

Table 5
Specific direct effects, specific indirect effects, and total indirect effect of SEP on health for younger (40–66) and older (67–81) women.

	Women, 40–66 (N = 3706)				Women, 67–81 (N = 984)			
			95% CI of B (after 5000 bootstraps)				95% CI of B (after 5000 bootstraps)	
	B	β	Lower	Upper	B	β	Lower	Upper
Specific direct effects								
SEP - > Health	**1.676**	**0.295**	1.008	2.565	**1.576**	**0.188**	0.894	2.835
SEP - > Contact Frequency	**-0.257**	**-0.157**	-0.392	-0.160	**-0.257**	**-0.119**	-0.392	-0.160
SEP - > Network Size	**0.343**	**0.217**	0.246	0.471	**0.343**	**0.148**	0.246	0.417
SEP - > Loneliness	**-0.143**	**-0.209**	-0.206	-0.094	**-0.143**	**-0.140**	-0.206	-0.094
SEP - > Perceived support availability	**0.252**	**0.306**	0.153	0.378	**0.252**	**0.248**	0.153	0.378
Contact Frequency - > Health	0.045	0.013	-0.084	0.184	0.045	0.012	-0.084	0.184
Network Size - > Health	0.112	0.031	-0.021	0.235	0.112	**0.031**	-0.021	0.235
Loneliness - > Health	**-0.925**	**-0.111**	-1.226	-0.601	**-0.925**	**-0.113**	-1.226	-0.601
Perceived support availability - > Health	-0.233	-0.034	-0.627	0.149	-0.233	-0.028	-0.627	0.149
Specific indirect effects								
SEP - > Contact Frequency - > Health	-0.012	-0.002	-0.065	0.016	-0.012	-0.001	-0.065	0.016
SEP - > Network Size - > Health	0.038	0.007	-0.004	0.082	0.038	0.005	-0.004	0.082
SEP - > Loneliness - > Health	**0.132**	**0.023**	0.084	0.205	**0.132**	**0.016**	0.084	0.205
SEP - > Perceived support avail. - > Health	-0.059	-0.010	-0.223	0.027	-0.059	-0.007	-0.223	0.027
Total indirect	0.100	0.018	-0.048	0.195	0.100	0.012	-0.048	0.195
Explained Variance Health (%)	11.1				5.4			
Proportion mediated by specific indirect effects (%)*								
SEP - > Contact Frequency - > Health	0.683				0.535			
SEP - > Network Size - > Health	2.318				2.591			
SEP - > Loneliness - > Health	7.233				7.843			
SEP - > Perceived support avail. - > Health	3.509				3.867			
Fit statistics								
Chi2 (*df* = 32)	528.67							
P	0.00							
CFI	0.97							
TLI	0.95							
RMSEA	0.08							

* The proportion mediated by the specific indirect effect is calculated as the absolute value of the ratio of the specific standardized effect and the specific standardized effect plus the standardized effect of SEP on health (|ab/(ab + c')|, MacKinnon et al., 1995). Significant effects are printed in bold.

network are clearly socially patterned, it is the function of the network, rather than the structure, that counts for health.

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