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Health inequalities in older Norwegians and the mediating role of social networks

INTRODUCTORY CHAPTER

Health inequalities in older Norwegians and the mediating role of social networks

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Introduction

(i) Social and Research Context

The Sustainable Development Goals 3 (SGD 3) strive to end injustices that underpin poor health by "ensuring a healthy life and promoting wellbeing for all ages" (United Nations, 2015). Vulnerability to disease and disability increases with age, although aging itself does not cause any disease (McMurdo, 2000), and most of the diseases during old age can be reduced or prevented (MacNee et al., 2014). It is estimated that by the year 2050**,** the world population aged above 60 will reach 2 billion, accounting for 22 percent of the world population (United Nations, 2017). In Europe, the number of people aged 65 and above is expected to reach 149 million by 2050**,** compared to 101 million in 2018, accounting for a 47.5 percent increment (European Union, 2019). Similarly, one study has shown there has been a shift in the pattern of global burden of disease resulting in a 23 percent rise in the burden of disease among older people (Prince et al., 2015). High-income countries accounted for nearly half of the increase in disease burden (Prince et al., 2015). Many European countries have changed their priorities with the new development in demographic structure and disease burden (Sowa et al., 2016). The new focuses of these counties are to ensure a lower level of morbidity, fewer years of disability, and aging with a high quality of life (Sowa et al., 2016). However, various health inequality studies have shown that health in terms of morbidity and mortality is distributed unevenly among people with different socioeconomic status (Mackenbach et al., 2003; Mackenbach et al., 2008; Park et al., 2009; Parker et al., 2013).

(ii) Relevance

Socioeconomic inequality in health has broader social, economic, and political implications. The health losses due to socioeconomic inequalities increases the cost of health care and social security schemes. In Europe, every year, 15 percent of the total cost of a social security benefit and 20 percent of total health care costs are the result of health loss due to socioeconomic inequality. The Global Burden of disease indicates that older people carry a higher proportion of ill health. In Norway, both fatal and non-fatal health loss is dominated by non-communicable diseases, which are more prevalent among people aged above 70 years (Knudsen et al., 2017).

Similarly, most death occurs in old age where only one in four deaths occur before 70 years (Knudsen et al., 2017). With the increasing old age structure, older people account for most poor health and deaths. Despite this , most health inequalities research does not include**,** or neglects these important demographics (Kröger et al., 2015; Victor, 1989). Countries like Norway are expected to have lower income-related health inequalities because of their generous and universal welfare provision, where the emphasis is given to equity of outcome (i.e., income, education). However, despite the universal and generous welfare system, there is no significant difference in health equality than other European counterparts. Further, studies have shown that Norway has more considerable inequality in health despite having lower absolute health inequality in terms of morbidity and mortality (Brekke et al., 2011).

(iii) Possibility to practice

Various theories indicate that socioeconomic status does not operate straightforward and has multiple mechanisms or pathways resulting in health inequality. Social networks are a range of interpersonal relationships that people of all ages maintain in different contexts (Aartsen et al., 2017; Litwin, 2001). These social networks are the form of social capital, i.e., a range of social contacts that provides access to social, emotional, and practical support (Litwin et al., 2011). The social network is one mechanism through which socioeconomic status operates and yields health inequality (Laaksonen et al., 2005; Lynch et al., 2000). In Bourdieu's social capital perspective, people in higher socioeconomic positions have a comparatively better social capital within their network that can provide social and material support, as well as health-enhancing information resulting in better health outcomes (Craveiro, 2017). This is similar to the Theory of Cumulative Advantage/Disadvantages' perspective that a higher socioeconomic position gives an advantage in the accumulation of social ties that are more intimate and larger in number (Dannefer, 2003). Berkman's model on "Social integration to health" implies that the socioeconomic context determines social network structure and the characteristics of network ties. These social networks influence access to resources and goods, social support, social engagement, and attachment. These social influences determine individual health behaviours, physiological and psychological status**,** and ultimately impact health outcomes (Berkman et al., 2000). Various studies have supported social network influence on health outcomes (Laugesen et al., 2018; Li, 2016; Lin, 2000; Litwin, 1998, 2001, 2010; Litwin et al., 2011); however, very little attention has been given to health

inequality (Craveiro, 2017; Dahl et al., 1997; Smith et al., 2008; Victor, 1989). Thus, in this paper, I will try to validate previous observed health inequalities in Norway with the large and representative data of NorLAG while answering the following questions; (i) Does socioeconomic inequality in health among older adults interact with the social network? (ii) Do the characteristics of the social networks relate to variations in health. Findings from this paper aim to help policymakers to develop an appropriate welfare strategy using the clearly defined role of the network in order to minimize the socioeconomic gradient in health among older adults. The article will be submitted to the Journal of Ageing & Society from Cambridge University Press publication for broader dissemination. Therefore, the main research article follows the Journal of Journal of Ageing & Society manuscript guidelines.

Literature Review

Socioeconomic position (SEP) and Health

Several public health and social science studies, including the famous 'The Black Report 1980', have revealed the influential role of socioeconomic factors on health inequality (Gray, 1982). That is, health outcomes at the individual and population levels are determined and differ according to peoples' education, income, working conditions, and other socioeconomic factors that lie outside of the health care system (Oversveen et al., 2017). A study on socioeconomic inequality in health in 22 European countries showed that people with less education have higher mortality than people with high education (Mackenbach et al., 2008). Similarly, throughout Europe, relative inequality in self-assessed health is worst among people with low education (Mackenbach et al., 2008). A comparative study of inequalities in risk factors for shorter life expectancy in Europe found a significant gap in partial life expectancy of 2.3 to 8.2 years (men) and 0.6 to 4.5 years (women) between people with low education and high education (Mackenbach et al., 2019). In Norway, there is a three year difference in life expectancy between people with high and low education (Dahl, 2002). Similarly, Inequalities in mortality are higher among people with lower income in all European countries (Mackenbach, 2006). These mortality inequalities can be found among all ages, from the youngest to the oldest (Mackenbach, 2006). Data from a U.S. Panel Study of Income Dynamic shows that the low-income group with a household income less than $15,000 per year had a 3.9-time higher mortality than those with a household income of more than $ 70,000 per year

(Marmot, 2002). Thus, health inequality studies have established the link between lower SEP and poor health outcomes (Mackenbach et al., 2003; Mackenbach et al., 2008; Mackenbach et al., 2019; McCartney et al., 2019; McCartney et al., 2013; McMunn et al., 2008).

SEP and the mediating role of social network

Evidence shows that the causal relationship between SEP and health outcomes is not straightforward and often goes through a complex mechanism and often involves a biopsychosocial process (Braveman et al., 2014). Among many pathways**,** the role of social relationships are crucial (Faber Ashley et al., 2002; Lin, 2000; Pinquart et al., 2000) because the structure of social networks, support received from others, quality and quantity of social interactions, and feelings of isolation and loneliness are significant predictors of health and wellbeing (Cacioppo et al., 2002; Cohen, 2004; Seeman et al., 1988). For example, socially isolated people have between 1.9 to 5 times greater risk of mortality than those with better social connections (Adler et al., 2002). Weyers, S et al. presented Bourdieu's argument in his paper that economic capital can be transferred into social capital and vice versa (Weyers et al., 2008). That means people in higher socioeconomic positions are in a position to have better social relationships using their economic resources (Letki et al., 2015). This is supported by the Germany Heinz Nixdorf Recall Study findings showing that people with low SEP have poor social networks and social support (Weyers et al., 2008). This study further shows that education level positively influences the number of close ties (Weyers et al., 2008).

Similarly, Older adults with high education and income have more contact with friends to get more support from others, and they have a higher level of satisfaction with the support they receive (Krause et al., 1995). Brooks and colleagues evaluated the relationship between SEP and social capital structure and found that higher SEP relates to more extensive and denser social networks (Brooks et al., 2011). There is limited research on social network structure in relation to the achieved and ascribed roles of the network and how these influence health outcomes. Achieved relations require effort to form, such as friendships, whereas ascribed relations are present from birth, such as kinship relationships (Banton, 1966, pp. 29-31). This paper focuses on friendship relations, since it is accepted that SEP inequalities in health are more apparent for achieved relations (such in friendship, which take effort to form) than ascribed relations . Also, friendship

is a unique social relation based on two crucial foundations; liking and trust (Sias et al., 2007, p. 460). These friendship characteristics provide unsolicited social support and minimize the risks faced by an independent and capable person (Sias et al., 2007, p. 461). Furthermore, it is accepted that people with higher socioeconomic positions have better social structure and support, facilitating better health outcomes. Therefore**,** the above discussion leads to the following hypotheses:

Hypothesis

H1: Older adults living in Norway with a higher level of income and education have higher physical health scores.

H2a: A higher income is associated with more frequent contacts with friends, which in turn is related to a higher physical health score

H2b: A higher income is associated with more support potential with friends, which in turn is related to a higher physical health score

H3a: A higher level of education is associated with more frequent contacts with friends, which in turn is related to a higher physical health score

H3b: A higher level of education is associated with more support potential of friends, which in turn is related to a higher physical health score

Theoretical framework

(i) Theory of Fundamental Causes

From the above discussion, it is clear that socioeconomic position (SEP) is associated with health inequality throughout the life course. Various medical and social epidemiologists provide a possible explanation for the underlying mechanism to understand the role of SEP in the inequality of health outcomes. Some researchers present SEP merely as an explanatory or placeholder variable as the real cause that affects health. Link and Phelan developed the 'theory of the fundamental causes' to explain the relationship between SEP and mortality in 1995 (Link et al., 1995). The **'**theory of the fundamental causes' can be traced back to the concept of primary cause proposed by Lieberson in 1985 (Phelan et al., 2004), which was used by House et al. to explain

the relationships between SEP and mortality (Phelan et al., 2010). Link and Phelan argued that SEP is a fundamental cause of health outcomes as it works through some meta-mechanism that specifies various mechanisms over time that preserve the direction of enduring association (Lutfey et al., 2005). In other words, the SEP works through the "factors that put people at risk of risk" (Lutfey et al., 2005). The fundamental social cause of health inequalities has four essential features (Link et al., 1995; Lutfey et al., 2005; Phelan et al., 2004; Phelan et al., 2010) (i) it influences multiple disease outcomes, i.e., it is not only limited to one or a few diseases or health problems; (ii) it affects health outcomes through multiple risk factors; (iii) it involves access to resources that can be used to avoid risks or to minimize the consequences of a disease once it occurs; (iv) the association between a fundamental cause and health is reproduced overtime via the replacement of intervening mechanisms (Lutfey et al., 2005; Phelan et al., 2004; Phelan et al., 2010). SEP has been considered a fundamental cause of health outcomes primarily because it allows access to resources that help individuals avoid diseases and their negative consequences through various mechanisms. These resources include money, knowledge, prestige, power, and beneficial social connections used for health advantage. People with higher social and economic status enjoy greater access and effective utilization of resources, as well they attain greater longevity and better health outcomes (Lutfey et al., 2005; Phelan et al., 2010). The theory of fundamental cause identifies social networks as one of the major serviceable resources people can use to avoid or minimize health risks and prolong life (Link et al., 1995; Phelan et al., 2004; Phelan et al., 2010). The mechanism of how social networks influence health is explained by Berkman on his popular conceptual model of social integration to health.

(ii) Berkman's model on "Social integration to health."

The social network determines the individual's attitude, behavior, and access to the resources' flow (Berkman, Glass, Brissette, & Seeman, 2000; Letki & Mieriņa, 2015; Nam, Redeker, & Whittemore, 2015). Berkman et al. proposed a conceptual model that shows the impact of social networks on health. Social networks are the web of social relationships that surround an individual and those ties' characteristics (Berkman et al., 2000). Social networks are embedded in a larger social and cultural context that determines the extent, shape, and nature of the social network (Berkman et al., 2000). Social network structure (range, size, density, reachability) and its characteristics (intimacy, duration, frequency of contact, reciprocity) operate through four primary

mechanisms; provision of social support, social influence, social engagement and attachment; and access to resources and goods. These pathways determine individual health behavior, physiological and psychological status and ultimately impact health outcomes. On an individual level, the structure of these ties' network ties and characteristics provides and determines various supports such as emotional, instrumental, appraisal, and informational support that influence peoples' health status (Berkman et al., 2000). The social network also influences peoples' attitudes, norms, and values towards health behavior such as dietary patterns, alcohol use, smoking, health services utilization, etcetera (Berkman et al., 2000). Furthermore, the social network provides access or restricts an individual to various life opportunities, goods, and services that can influence health outcome (Agadjanian, 2002; Berkman et al., 2000; L. F. Berkman et al., 1979).

Berkman argued that social networks are embedded in a larger social context, which in this paper is considered as SEP. On the other hand, fundamental cause theory shows SEP yields inequalities in health outcomes through multiple mechanisms by affecting various resources. According to the fundamental cause theory, serviceable or flexible resources play a crucial role in yielding health inequality. Among many, social networks are one of the serviceable resources that allow people to avoid risk and minimize adverse health outcomes, supported by the Berkman's model of social integration to health. Therefore, in this paper, I will explore how social networks mediate the relationship between individual socioeconomic status and health.

Method and data

This paper is based on longitudinal survey data and annual national registered data from the second and the third wave of the Norwegian Life Course, Ageing, and Generation Study (NorLAG). The detailed description of NorLAG, i.e., study population, sample size, sampling selection technique, data collection process, attrition, and non-response, is presented in the main article. This section will discuss the quality of the different variables used in the data analysis process. Furthermore, I will also present the advantages and disadvantages of using NorLAG for this study purpose.

Primary data screening and normality test of the variable's physical health score, income, education, contact frequency with friends, and support potential of friends was performed before conducting any statistical analysis to ensure the accuracy and eligibility of data. The table below

shows the value of skewness and kurtosis for dependent and independent variables where values for skewness are $|< 2|$ and kurtosis are $|< 7|$, which shows these variables are normally distributed (Kim, 2013).

Table 1 Test of Normality of variables

Variables	N	Skewness	Kurtosis
PCS-12 Physical health score	2794	-1.23	.61
gross income	2812	.056	-1.27
contact frequency with friends	2398	-1.16	2.87
support potential of friends	2414	-.24	-1.19
level of education	2853	.14	-1.10

Furthermore, other assumptions for the regression analysis were performed before conducting the multiple mediation models. The linear relationship between (a) the dependent variable and each of the independent variables and (b) the dependent variable and the independent variables collectively was tested using scatterplots. Homoscedasticity, i.e., a constant variance of errors, is ensured by selecting an HC4 robust standard estimator option on the Hayes PROCESS (Hayes et al., 2007). The multicollinearity test in the two models was evaluated using collinearly statistics Tolerance and variance inflation Factor (VFI) value. The tolerance value is greater than 0.2, and the VFI value less than 5.0, indicating no multicollinearity between dependent and independent variables (O'Brien, 2007).

Two separate parallel multiple mediation models were used to evaluate whether the association between SEP and health status is mediated by social support and network structure. The first model shows social networks (i.e., network structure and social support) as a mediating pathway between income and health status. Likewise, the second model shows the mediation role of the social network between education and health status. A multiple mediation model is used because it allows for a test of all the proposed mediators' combined effects (i.e., the total indirect effect) and examines and reports each mediator's effects while controlling for the others (Hayes et al., 2017). Descriptive statistics and PROCESS macro-regression analysis developed by Hayes were used to

predict the mediating effect of social support and network structure on the impact of SEP on health outcomes. Hayes PROCESS macro-regression is used to generate thousands of empirical samplings (Bootstrapping) to test the indirect effect of mediation (Hayes et al., 2017). This overcomes the problem that the product of two normally distributed coefficients may not follow a normal distribution, leading to the wrong conclusion.

Tabel 2 Multicollinearity test

		Collinearity Statistics				Collinearity Statistics	
	Model 1 Outcome Variable (PCS-12)	Tolerance	VIF		Model 2 Outcome Variable (PCS-12)	Tolerance	VIF
Model 1 Predicators Variables	Gross income	.84	1.18	Model 2 Predicators Variables	Education	.95	1.04
	Contact frequency with friends	.86	1.15		Contact frequency with friends	.86	1.15
	Support potential of friend	.84	1.18		Support potential of friend	.83	1.19
	gender	.80	1.24		Gender	.92	1.07
	Marita status	.95	1.05		Marita status	.95	1.04

Advantages and Disadvantages of Using NorLAG

The NorLAG data is the combination of longitudinal survey and register data, which allows for making causal inferences about associations between SEP, Social Network, and Health among older adults (Slagsvold et al., 2012; Veenstra et al., 2021). Furthermore, NorLAG is a representative nationwide sample, so this paper's findings are generalizable for all older adults in Norway. The main challenge is attrition between waves in longitudinal studies; however, in

NorLAG, this problem is addressed by oversampling the older adults (Slagsvold et al., 2012; Veenstra et al., 2021). During the data collection process, ethical issues were taken into account, such as informed consent before collecting any information. Furthermore, NorlAG includes various validated scales (Slagsvold et al., 2012; Veenstra et al., 2021) , such as the health status scale (PCS-12). Furthermore, NorLAG has maintained high ethical standards, where participation in the study was voluntary, informed consent was taken, and collected data adheres according to national laws and regulations. The respondent's anonymity was maintained by protecting individually identifiable information such as national-ID in all the waves.

Findings

Altogether, 2856 older adults from wave three were included in the analysis, of which 49.4 % are men and 50.6 % are women. The study population's mean age was 63.57 (SD= 6.57), where the minimum age was 55 years, and the maximum age was 85 years. The mean age for men and women was 63.46 (SD =6.42) and 63.68 (SD=6.63). The mean PCS-12 physical health status score was 46.93 (SD =10.39). The mean PCS-12 physical health score is higher for males, 48.07 (SD = 9.64) than their female counterparts, 45.82 (SD = 10.97). The average annual gross income of older adults was 285,906 NOK (SD=219,526 NOK). The male older adults have a higher average gross income (M= 340, 465 NOK, SD= 282, 823 NOK) than women (M=231,194 NOK, SD=10, 532 NOK). Most older men (16 %) fall in the 10th income deciles while**,** only 3.6 % of female older adults were in the corresponding income group. More than three-fourth (77.6 %) of male older adults and 61.1% of female older adults were with partners. The majority of male and female older adults with at least basic higher education accounts for 26.8 % and 33.2 %. The percentage of male older adults having higher university education was higher than their female counterparts, with 13.6 % and 5.1 % respectively.

Figure 1 provides a summary of the multiple meditation models' outcome (for detailed results, see the main article). The total effect of income on health status via mediators' social support and network structure was observed as 0.83 [c1=0.83, SE 0.78, CI (0.67,0.98)]. The direct effect of income on health status was, c′1 = 0.78 [c'1=0.78, SE 0.79, CI (0.62,0.94)]. The unstandardized indirect effect (a1*b1) of income on health status via the network structure was 0.0003, but was not statistically significant [a1b1= - 0.002, SE= 0.002, CI (-0.005, 0.005)]. Whereas

unstandardized indirect effect (a2*b2) of income on health status via the social support was statistically significant a2b2= 0.04 [a2b2 =0.04, SE= 0.01, CI (0.01,0.07)]. The total indirect effect of social network and social support is observed as 0.04, [a1b1+a2b2=0.04, SE 0.01, CI (0.018,0.07)]. The total effect of education on health status via the mediators social support and network structure is observed as 1.23 [c2 =1.23, SE 0.172, CI (0.89, 1.57)]. Similarly, the direct effect of education on health status was c′2 = 1.10 [c'2 = 1.10, SE= 0.175, CI (0.76, 1.45)]. The unstandardized indirect effect (a3*b3) of education on health status via the network structure was 0.0003, but was not statistically significant a3b4= 0.0005 [a3b3 = 0.0005, SE= 0.005, CI (-0.010, 0.12)]. Whereas the unstandardized indirect effect (a4*b4) of education on health status via the social support was statistically significant a4b4= 0.12 [a4b4 = 0.12, SE = 0.037, CI (0.05, 0.20)]. The total indirect effect of social network and social support is observed as 0.12, [a3b3+a4b4 = 0.12, SE = 0.03 CI (0.054, 0.20)].

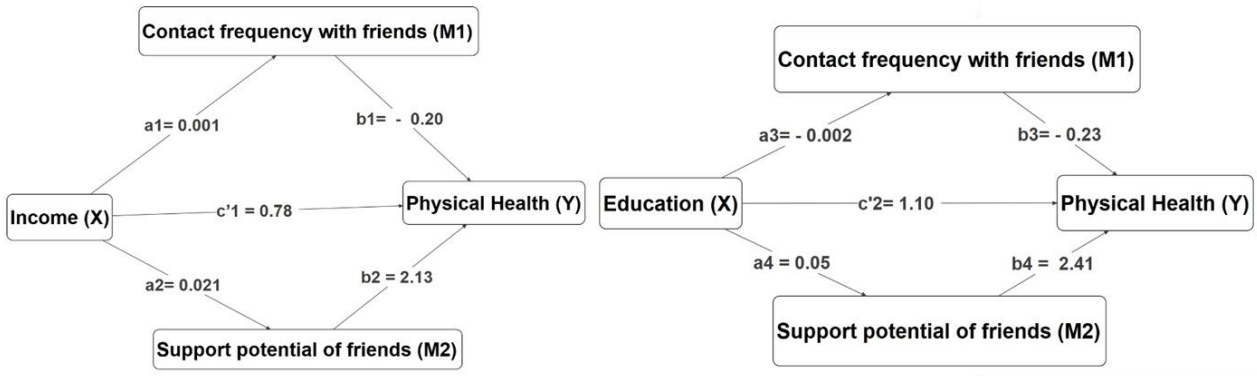

Figure 1 Multiple Mediator Model Education and Income with Network Structure, Social support and Health Status pathways (Unstandardized Direct, Indirect and Total Effect)

Discussion and summary

This paper aimed to understand the social network's role in the relationship between socioeconomic position and health status. The theory of fundamental cause and Berkman's social integration model to health were used to explain the relationship between SEP, social network, and health. The theory of fundamental cause is used to explain the relationship between SEP and health outcomes. According to this theory, peoples' socioeconomic position is the root cause of health inequality. SEP affects health outcomes as it affects various intervening mechanisms such

as a social network. As per the theory in this study, SEP is a significant predictor of health outcomes among older adults in Norway. It shows the higher the level of education and income of older adults, results in a better health status. Furthermore, it was expected that relationships between SEP and health would be mediated by the older adults' social network, mainly through social support and person-to-person contact as described in Berkman's social integration model to health.

Berkman's social integration to health argues that the social network is embedded in a broader socioeconomic context as upstream factors. Berkman and colleagues further describe that these broader social contexts influence structure and function and influences on behavior through the provision of support, social influence, social engagement, and access to resources (Berkman et al., 2000) to impact health either positively or negatively. In this paper, the SEP was considered a broader social context that influences social networks. Berkman and colleagues' argument is well supported by this paper's findings that the upstream factors, i.e., level of income and education of older adults, positively influences the support they received from their social network. This is also supported by other research (Krause & Borawski-Clark, 1995) where older adults with higher education and income have more contact with friends, get more support**,** and satisfaction with the support they receive.

This paper had mixed finding regarding the relationship between SEP and contact frequency with friends, where it is observed that the level of education has a negative influence on the contact frequency with friends, and income has a positive influence on the contact frequency with friends. This paper does not explore why education has a negative influence on contact frequency with friends. Sharifian and colleagues mention in their paper that emotional closeness with friends tends to decrease when young adults move from high school to colleges (Sharifian et al., 2020). This might also be true for older adults. When the network structure was evaluated, i.e., contact frequency with friends and the support potentials of friends (emotional, instrumental, and appraisal) and its influences on health, the results showed that peoples' SEP has a significant influence on the support potential of friends, which in turn impacts the health outcomes of older adults. Meta-analysis results have also shown that social support plays a more vital role than the social contact level (Holt-Lunstad et al., 2010; Shor et al., 2015). For example, social contacts

were beneficial; however, social support is more significant in reducing the risk of death (Shor et al., 2015). In this paper, there is observed a similar pattern where social support has a positive and significant relationship with health outcomes; however, contact with friends has a negative association with health without any statistical significance.

This paper highlights that the achieved social relationships (i.e., friendships) is a significant predictor of later life's health status. Other research also support this finding; for example, Golden and colleagues' studies showed that support from elective social relationships rather than the social support from family is crucial to promote health and wellbeing during later life (Golden et al., 2009). This might be because during late life friends are a more significant source of immediate joys and provide a greater sense of companionships through informal social activities than family, as Sharifian and colleagues argued (Sharifian et al., 2020). However, social support, particularly family support, is essential to promote physical health status during later life where social safety nets are weak (Williams et al., 2017). For example, The China Family Panel studies present being married as an indicator of the family that shows social connectedness, and reports that those who were married have better physical health compared to those who became widowed, or than those who had never been married among people aged 50 and over (Williams et al., 2017). This paper presented China as a country with a weaker social safety net (Williams et al., 2017). From the examples mentioned earlier, the role of social relationships (i.e., achieved social relationships) differs according to the social context, which needs further exploration.

From the results, it can be concluded that the social network, especially social support, is an essential resource that older adults can use to protect against adverse health outcomes and promote health. The data shows a clear association between income and education respectively regarding health status, as well it shows a mediating effect of social network on health status, though it also reveals that not all social network aspects are a substantial predictor of health outcomes among older adults in Norway. Overall, this paper provides essential evidence that social support is an essential mechanism through which SEP influences older adults' health. Social support is a critical factor in maintaining health; therefore, concerned authorities could consider developing potential interventions utilizing various supports people receive from their network in order to reduce health inequality among older adults in Norway. Furthermore, the socioeconomic position is crucial since

it produces variation in health outcome; thus, policymakers should consider SEP a vital component of the interventions that aim to reduce health inequalities.

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Title Page

Health inequalities in older Norwegians and the mediating role of social networks

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Abstract

This study aims to understand how social networks serve as an intervening pathway leading to socioeconomic health inequality among older adults in Norway. Longitudinal survey data and annual national register data from the second and the third waves of the Norwegian Life Course, Ageing, and Generation Study were used in this paper. The NorLAG second wave (NorLAG2) encompasses the nationwide gross sample of 9238 respondents aged between 40 and 80 during the interview. Similarly, Altogether, 6099 respondents aged between 50 and 95 during the interview participated in the third wave of NorLAG (NorLAG3). Hayes PROCESS was used to estimate the mediating effect of contact frequency and support potential of friends on the impact of socioeconomic position (SEP) at wave two on the health outcomes at wave three. The total indirect effect of income on physical health was observed as 0.04, meaning that those with a higher contact frequency with friends and higher support potential of friends, on average, report 0.04 units higher on the physical health score than those with lower contact frequency with friends and lower support potential of friends. The total indirect effect of the highest attained education level on physical health score is observed as 0.12, meaning that those with a higher contact frequency with friends and higher support potential of friends report on average 0.12 units higher on their physical health scores than those with lower contact frequency with friends and lower support potential of friends. The results showed a socioeconomic gradient in health among older adults in Norway, where the social network is a crucial pathway via which SEP influences peoples' health. Evidence highlights that contact frequency with friends does not influence the relationship between SEP and health status among older Norwegian adults.

Keywords: Older adults, network structure, social support, health inequality, achieved roles

Health inequalities in older Norwegians and the mediating role of social networks

Introduction

Health inequalities are defined as, "the systematic, avoidable and unfair differences in health outcomes that can be observed between populations, between social groups within the same population or as a gradient across a population ranked by social position" (McCartney, Popham, McMaster, & Cumbers, 2019). This difference in health is a public health threat as it has a broader socioeconomic implication and affects every member of society (Woodward & Kawachi, 2000). For example, the AIDS epidemic has largely appeared in the context of poverty, and not only does this phenomenon affect or is confined to the people or groups where it has emerged, but this also affects everyone else within the society. As a result, reducing inequality will bring benefits to everyone. Research shows that health inequality does not emerge solely as a result of individual health choices, rather it is shaped by the broader social, political, and economic conditions (Arcaya, Arcaya, & Subramanian, 2015). The existence of health inequality implies that individuals and groups are not enjoying their rights to attaining the highest standard of physical and mental health available (Woodward & Kawachi, 2000). Further, the health inequalities across populations or specific groups are easily avoidable, thus posing significant implications for social justice (Marchand, Wikler, & Landesman, 1998; Woodward & Kawachi, 2000).

Norway is a social-democratic welfare state characterized as a highly egalitarian society that aims to provide equity of the highest standards for all citizens (Huijts & Eikemo, 2009). Furthermore, the Norwegian welfare state is based on the principle of universalism (Bergqvist, Yngwe, & Lundberg, 2013), where income, education, and health services are more equally distributed among the citizens compared with other European countries (Brekke, Grunfeld, & Kverndokk, 2011). Despite this, Norway has not succeeded in reducing health inequality. For

example, socioeconomic inequality in the morbidity and mortality rates in Norway is not significantly different from other European countries (Mackenbach et al., 2003; Mackenbach et al., 2008). People aged 65 or above with a higher level of education live 4 years longer compared with people who have a lower level of education in Norway **(**NIPH, 2016 **).** These inequalities are paradoxical since Norway is expected to have low inequality owing to its status as an egalitarian society. Therefore, this paper argues that a better understanding of health inequality will contribute positively to policies aimed at reducing this phenomenon.

It is a well-established fact that people with a higher socioeconomic position (SEP) have better health status compared with people that have a lower SEP. This is because people with a low SEP are more likely to live and work in an unhealthy physical environment, are less likely to have access to quality health care, and more likely to adopt risky health behaviors. The housing and living conditions survey by Statistics Norway showed that people with lower income live in poorer housing conditions compared to people with higher income (SSB, 2018). In Norway, cigarette consumption and cigarette dependency are higher among people from low SEP compared to their high socioeconomic counterparts (Lund, 2015).

Various studies have documented the income and education gradient of health in Norway. The risks of mortality are lower among people with high incomes. The odds of mortality among people in low-income groups is 1.034 times the odds of mortality among people in a high-income group (Dahl, Elstad, Hofoss, & Martin-Mollard, 2006). A study that evaluated the association between mortality and income inequality in 35 Norwegian regions using registered mortality data between 1994 and 2003 indicated that regional mortality was significantly higher in regions with larger income disparities (Elstad, 2011). In a Norwegian study conducted between 1984 and 2008, the socioeconomic inequalities in health care utilization showed that people with a higher education level have a greater utilization of general practitioner services compared with people of a lower education level (Vikum, Krokstad, & Westin, 2012). This is

similar to Iverson and colleagues' findings that people with a higher education level utilize more specialized services and have better access to general health care services (Iversen & Kopperud, 2005). In Norway, people with a higher education level who are diagnosed with cancer live longer compared with those with a lower level of education (Kravdal, 1999; Strand et al., 2014). There is also a significant economic gradient in overall mortality rates in Norway, and this is more prevalent for avoidable mortality such as mortality from Ischemic heart disease and other preventable deaths (Espen, Hofoss, & Elstad, 2007). Dhal and colleagues argued that the mortality related education gradient is because people with less education have fewer resources that can help them to adhere to medical advice and treatment regimens (Espen et al., 2007).

Various scholars have purposed different perspectives to explain the reason for health inequality. I utilize the fundamental cause theory (FCT) as a possible explanation for why health inequality exists in Norway. This is because FCT argues that an individual's social factors, particularly their SEP, is the root cause of health inequality. This is because SEPs are associated with numerous resources that can be used to avoid various health risks and minimize the consequences when disease occurs. Health inequality exists as long as the general socioeconomic structure giving access to these resources remains stable. Norway has reduced inequalities in access to material and immaterial resources, however, these are not yet completely eliminated (Mackenbach, 2012). Therefore, people being from different SEPs has an impact on their ability to access a wide range of serviceable resources such as money, knowledge, prestige, power, and beneficial social connections that can be used to one's health advantage (Link & Phelan, 1995; Phelan, Link, Diez-Roux, Kawachi, & Levin, 2004).

Socioeconomic stratification being linked to a person's social network implies that those with the most disadvantaged SEP experience the most impoverished network function and structure (Campbell, Marsden, & Hurlbert, 1986; Lin, 2000). A German study focusing on

disadvantageous SEP levels showed that older adults aged between 45 and 74 reported having poorer network structure and lower social support levels compared to people from advantageous SEP (Weyers et al., 2008). Krause and colleagues' study on the social class difference on social networks showed similar results, where older adults with higher income and higher education reported having a higher frequency of contact with friends and higher social support compared to older adults with lower income and lower education (Krause & Borawski-Clark, 1995). Furthermore, Letki and colleagues suggested that people with a higher level of education and higher income tend to have larger networks spread over a wider geographical area, and further that the support they receive tends to be of a better quality than people of a lower level of education and income (2015). This is because people in higher SEPs are able to use their economic resources to form better social relationships (Letki & Mieriņa, 2015).

Among the various utilizable resources, Link & Phelan identify social networks as a major resource that can be used to avoid or minimize health risks and prolong life (Phelan, Link, & Tehranifar, 2010). Social networks refer to the web of social relationships and their characteristics around which an individual is surrounded. Various theories and empirical findings reveal the influence of social networks on physical and mental health (Agadjanian, 2002; McLaughlin, Horwitz Allan, & Raskin White, 2002; Pescosolido Bernice & Levy Judith, 2002). Social relations and their characteristics are complex in nature, where they are able to operate in different ways to influence health (Fiori, Antonucci, & Cortina, 2006; Windsor, Rioseco, Fiori, Curtis, & Booth, 2016).

Scholars have commonly differentiated the nature of the social network according to network structure and function (Avlund et al., 2004; Berkman, Glass, Brissette, & Seeman, 2000; Due, Holstein, Lund, Modvig, & Avlund, 1999; O'Reilly, 1988). The structural aspect of social networks represents the number of social relations that people have, the frequency of seeing

other people, the diversity of social relations, and the reciprocity of social relations; whereas the qualitative and behavioral aspects of the social relations such as social support, social anchorage, and relational strain is represented in the network function (Avlund et al., 2004; Berkman et al., 2000; Due et al., 1999; O'Reilly, 1988). A longitudinal study by Ellwardt, and colleagues among older adults in The Netherlands showed that the structural characteristics of the network (number of social contacts and number of social roles) improves the chance of survival among older adults (Ellwardt, van Tilburg, Aartsen, Wittek, & Steverink, 2015). This is similar to findings from a meta-analytical review across 148 studies (308,849 participants) conducted by Holt-Lunstad, and colleagues that showed the chance of survival increases by 50% among participants with stronger social relationships (Holt-Lunstad, Smith, & Layton, 2010). Weaker social ties as represented by limited social contact and social isolation have a negative influence on health and survival. A population-based cohort study among 21,604 participants in Denmark has shown that social isolation increases the chance of mortality by 60 to 70 % (Laugesen et al., 2018).

Scholars have identified various pathways and processes through which a social network influences physical health. Berkman's causal pathway model showed the mediating role of a social network in the relationship between macro-social determinants of health (i.e., SEP and poverty) and micro social determinants of health (i.e., social support), which in turn influence various health outcomes. Berkman elucidated that the social, cultural and political contexts determine the extent, size, and nature of the social network. In turn, these offer people the opportunities to receive social support; social engagement and attachments; access to resources and material goods; and social influences (Berkman et al., 2000). Overall, these resources influence health outcomes through their influence on health behaviors; the chance to have exposure to various infections and disease agents; the physiological stress responses;

psychological states; and characteristics such as self-esteem and security (Berkman et al., 2000).

Current social network related research commonly differentiates between the structural and functional dimensions of the social network as having a potential to influence pathways to health (Berkman et al., 2000; House, Umberson, & Landis, 1988). Network structure positively affects physical health by providing opportunities to access various resources that determine health behaviors and emotional response (Berkman et al., 2000; House et al., 1988). For example, having a larger and more extensive social network increases the availability of information that individuals can use for health advancement (House et al., 1988). Furthermore, social integration is associated with a sense of physical and emotional security as well as self-esteem, which is associated with positive health outcomes. On the other hand, the functional dimensions of the network prevent stress from occurring by providing various kinds of support such as emotional and instrumental, and this has a positive influence on physical health (Due et al., 1999; Faber Ashley & Wasserman, 2002; Uchino, 2004a, p. 114).

Various health inequality related studies have indicated that the social network's role can influence socioeconomic inequalities in health. For example, Vonneilich and colleagues evaluated the mediating effect of social networks on the relationship between SEP and subjective health among people aged between 45 and 75. The structural aspect was indicated by the Social Integration Index (SII) and the functional aspect was measured by social support (i.e., emotional support and instrumental support). The study revealed that the structural aspects of a social network reduced the relationship between education and income by 15 percent. At the same time, emotional and instrumental support reduced the association between education and subjective health by 6 percent and 2 percent respectively (Vonneilich et al., 2012).

On the contrary, a different study showed no mediating effect of a social network on the socioeconomic differences according to the onset of mobility related disability among older Danes (Nilsson, Avlund, & Lund, 2010). A US study found similar results, where psychosocial factors such as negative emotions did not meditate the SEP according to self-rated health (Barger, 2006). Further, Aartsen and colleagues' study on the mediating role of the social network in relation between SEP and health among people aged between 40 and 81 in Norway concluded that not all dimensions of the social network are important. This study showed that network structure does not meditate the relationship between SEP and Health, whereas the functional aspect does act as a meditator (Aartsen, Veenstra, & Hansen, 2017). These research findings show a mixed role of key social network dimensions on the relation between SEP and health. Social network research explains that structural aspects (i.e. size and contact frequency) can influence various network functions (i.e. emotion, informational, or instrumental supports) (Seeman & Berkman, 1988). The interconnectedness between network structure and function might explain this ambiguous result.

This paper posits that this ambiguity in results may be because of the differing roles present in a social network, where the roles are a set of norms and expectations applied to the incumbent of a particular position. For example, some attributes of the social network are based on ascription, where roles are assigned based on characteristics over which the person has no control, i.e. they require no effort to form, such as family and kinship (Banton, 1966, p. 29). This in contrast to social roles that form as a result of choice, individual effort, and competition; thus, being considered a form of achieved roles, i.e. friendships (Banton, 1966, pp. 30-31).

Furthermore, achieved roles such as friendships are considered important for maintaining cognitive functioning and physical health in old age (Holt-Lunstad et al., 2010). The positive aspects of friendship provide meaning to older adults' lives, which is crucial for their health and wellbeing. The mechanism for the positive effect on health can be attributed to friends

offering emotional and instrumental support, as well as companionship (Felmlee & Muraco, 2009). Furthermore, this alleviates loneliness among older adults (Chen & Feeley, 2013).

Despite such importance of achieved relationships, very limited research has been conducted to explore how friendships the functional and structural aspects of influence the health status of older adults in Norway. More specifically, this paper focuses on the structural and functional role of friendships in order to illuminate its mediating role between SEP and health. A deeper understanding of the network structure and function may better inform policy makers and aid in the development of effective health interventions that in turn may better address health inequality. Therefore, this study aims to contribute to the understanding of how structural and functional dimensions of friendships in the social network may serve as an intervening pathway between socioeconomic position and in physical health among older adults in Norway.

Hypothesis

Following the discussion above, this study expects to find the following associations between various indicators of SEP, the social network with and physical health;

H1: Older Norwegians adults with a higher level of income and education have higher physical health score

H2a: A higher income is associated with more frequent contacts with friends, which in turn is related to a higher physical health score

H2b: A higher income is associated with more support potential of friends, which in turn is related to a higher physical health score

H3a: A higher level of education is associated with more frequent contacts with friends, which in turn is related to a higher physical health score

H3b: A higher level of education is associated with more support potential of friends, which in turn is related to a higher physical health score

Method

This paper is based on longitudinal survey data and annual national registered data from the second and the third wave of the Norwegian Life Course, Ageing, and Generation Study (NorLAG). The NorLAG is the nationwide population study that gathers information on four major aspects of life; (i) Health and Care (ii) Family and generation (ii) work and retirement, and (iv) Mastery and quality of life (Veenstra et al., 2021). Data are planned to be collected in five waves, so far three waves of data collection were completed in the year 2002-2003, 2007-2008, and 2017 respectively.

The NorLAG second wave (NorLAG2) encompasses the nationwide gross sample of 9238 respondents aged between 40 and 80 during the time of the interview (Veenstra et al., 2021). NorLAG2, constituted by the gross sample of NorLAG1, younger birth cohorts 1962–1966 and refreshment sample from birth cohort 1922–1961. The refreshment samples from birth cohort 1922–1961 were added to compensate for the dropout rate. The attrition rate from the first wave to the second wave was recorded at 28.4 % (Slagsvold et al., 2012). Altogether, 6099 respondents aged between 50 and 95 during the time of the interview participated in the third wave of NorLAG (NorLAG3). All the people who participated in NorLAG3 were born between 1922 and 1966 and also participated in the first and second waves of NorLAG (Veenstra et al., 2021). Among 9338 people who participated in NorLAG2, 5711 responded in NorLAG3 accounting attrition rate of 38 %. Similarly, loss to follow-up due to mortality in between NorLAG2 and NorLAG3 was recorded as 11% (Veenstra et al., 2021).

The second and third wave of NorLAG adopted a stratified sampling design where the sample was stratified according to gender, age, geographical region, and centrality of a residential

municipality (most central to least central), resulting in 78 strata. Statistics Norway collected data through a combination of computer-assisted telephone interviews (CATI) followed by postal questionnaires with a supplementary question in both NorLAG2 and NorLAG3. Moreover, In NorLAG3 participants have the option to choose between a web-based and a postal questionnaire. In NorLAG2 and NorLAG3, the overall response rate for both CATI postal questionnaires was 61 % and 68 % respectively (Veenstra et al., 2021). About 70 % responded to CATI, whereas the response rate for post postal questionnaires was 79 % in NorLAG2. Similarly, the response rate for CATI accounted for 73 % in NorLAG3, however, this rate was higher in web-based self-administrative questions i.e. 81 %. Written approval from Norwegian Social Science Data Services (NSD) was taken to use this datasheet.

Measures

Physical Health

The dependent variable physical health is assessed with PCS-12, this is the physical health component of the short-form generic measure of health SF-12 (Ware, Kosinski, & Keller, 1998, p. 11). The PCS -12 scale measures physical functioning, role limitation due to the physical health problem, bodily pain, and general health aspects to evaluate individual physical health status (Ware et al., 1998, p. 19). The value of the physical health component (PCS-12) of SF-12 survey ranges from 0 to 100, where a lower value corresponds to a lower level of physical health (Ware et al., 1998).

Social-economic position (SEP)

In line with several other studies, the focus of this study is on education and income as the two most relevant aspects of SEP (Galobardes, Shaw, Lawlor, Lynch, & Davey Smith, 2006). In NorLAG, the respondents' level of education is obtained from register data that is recorded using the International Standard Classification of Education (ISCED-97) and represented in the

following five categories: (1) No education and primary education (2) Basic education and higher education (3) Supplementary higher education and higher secondary (4) University and college education, lower level (5) University and college education, higher level and doctorate.

A respondent registered gross income (in Norwegian Kroner, NOK) after tax from 2007 is used to reflect the persons' income. A Gross annual income less than 50,000 NOK is considered an inadequate reflection of the financial situation of people living in Norway, as it is far below the level needed for an independent life (Aartsen et al., 2017). Hence, all entries less than 50,000 were recoded as system missing. Furthermore, the level of income was categorized in deciles to reduce the skewness of the income variable the deciles are as follows: gross income 50,000-140,000 =1; 140,000 - 180,000=2; 180,000- 210,000=3; 210,000-230,000=4; 230,000 - 250,000=5; 250,000-270,000=6; 270,000 -300,000=7; 300000 - 350,000=8; 350,000 - 430000 =9, and above 430,000 = 10

Network structure

Contact frequency with friends is used a proxy measure for network structure, and this has been assessed using the question "how often do you meet with your friends"?. The responses were coded in the following categories; 0 = does not have (friends) /is not alive (friends passed away); 1= Never; 2=Less often 3 = sometimes; 4= Every month, but not daily; 5= Every week but not daily; 6 = Daily.

Network function

In this paper, the network function is assessed through social support. Social support is chosen to assess network function since various scholars have shown that social support from social networks is a strong predictor of health outcomes. Berkman categorizes social support as emotional, informational, appraisal, and instrumental assistance. Accordingly, a scale measure for social support is developed by using the following questions (i) Have friends standing up

for you in crisis; (ii) Have someone whom you can appreciate as a friend (iii) been on holiday with friends (iv) Celebrated your birthday with friends. Thus, the new variable' support potential of friends' is created using aforementioned variables in line with Beekman's' categories. A respondent had to categorize their response that he/she made about each statement, answering as 0 = No or 1 = Yes. The reliability of the social support scale was calculated by using the Cronbach Alpha coefficient. The reliability measurement for social support was $0.69 \approx 0.70$, which is considered an acceptable level of internal consistency among questions (Tavakol & Dennick, 2011).

Older Adults: In line with several other physical health studies on older adults (Geerlings, Beekman, Deeg, & Van Tilburg, 2000; Petry, 2002), people aged 55 or older were considered as older adults for this study. Thus, only those people aged 55 and above were selected during the data analysis process.

Covariate:

Some demographic factors such as gender and marital status can produce a spurious association in the relationship between SEP and health (Wongpakaran et al., 2016). For example, studies have shown that married people are healthier than unmarried people (Williams & Umberson, 2004), since marriage provides social support and social control for health behaviors (Ross, Mirowsky, & Goldsteen, 1990). Health outcomes differ among males and females even if they are exposed to an equal amount of risk to disease (Manandhar, Hawkes, Buse, Nosrati, & Magar, 2018). For example, women who smoke tobacco develop more severe chronic obstructive pulmonary disease compared to men who smoke the same amount of tobacco (CDC, 2014). Therefore, gender and marital status were statistically controlled for during analysis.

Analytical Strategy

Basic data screening and normality test of the variable's physical health score, income, education, contact frequency with friends, support potential of friends was performed before conducting any statistical analysis to ensure the accuracy and legibility of data. Only participating older adults aged 55 and above during the third waves (N= 2856) were used for the analysis to prevent the effect of attrition and loss to follow up. Two separate parallel multiple mediation models as shown in figures 1 and 2 were used to evaluate whether the association between SEP and physical health status is mediated by the social network, so that no mediator causally influences the other. The first model shows social networks (i.e., contact frequency with friends and the support potential of friends) as a mediating pathway between income and physical health. The second model shows the mediating role of the social network between education and health status. A multiple mediation model is used because it allows for a test of the combined effects (i.e. the total indirect effect) of all proposed mediators, and further allows examining and reporting of the individual effects of each mediator while controlling for the others (Hayes & Rockwood, 2017). Moreover, various covariates can be included in the model.

Hayes PROCESS macro-regression analysis (Hayes & Little, 2018) developed by Andrew F. Hayes is used to predict the direct effect of SEP (X) on physical health (Y), and also the indirect effects of contact frequency with friends (M1) and support potential of friends' (M2) on the relationship between SEP (X) and physical health (Y). Accordingly, the pathway leading from SEP to physical health without passing through social networks is called the direct effect of SEP on physical health. Likewise, the indirect effect shows how physical health is influenced by SEP through a causal sequence in which SEP influences social networks, which in turn influences physical health.

In the first mediation models, a1 and a2 represent the amount of variation in M1, and M2 caused by a one-unit change on X. b1 estimates the amount of variation in Y caused by one-unit change on M1, while holding M2 and X's effects on physical health constant (Hayes & Little, 2018, pp. 149-161). Similarly, b2 estimates the amount of variation in Y caused by one-unit change on M2, while holding M1 and X's effects on physical health constant. Finally, c′1 represents the direct effect, this is the variation in Y for one-unit change in X, while holding the effects of M1 and M2 constant.

The specific indirect effect of X on Y through M1 is a1b1, while the specific indirect effect through M2 is a2b2. The total indirect effect of X on Y is represented by a1b1 + a2b2, while c1 represents the total effect.

Similarly, in the second mediation model a3, a4 represents the amount of variation in M1 and M2 caused by a one-unit change on X.b3 estimates the amount of variation in Y caused by one-unit change in M1 while holding M2 and X's effects on physical health constant. Similarly, b4 estimates the amount of variation in Y caused by one-unit change on M2, while holding M1 and X's effects on physical health constant. Finally, c′2 represents the direct effect, this is the variation in Y for one-unit change in X, while holding the effects of M1 and M2 constant. The specific indirect effect of X on Y through M1 is a3b3, while the specific indirect effect through M2 is a4b4. The total indirect effect of X on Y is represented by a3b3 + a4b4, while c2 represents the total effect. A bootstrap confidence interval approach is used to make an inference. A total of 50000 bootstrap samples was used to estimate at a 95% confidence interval (CI) for direct effects, indirect effects, and specific indirect effects.

Hayes PROCESS macro-regression is used for mediation analysis because it considered superior and more powerful than Sobel's test and Baron and Kenny's causal steps method. For example, in Sobel's test the product of two normally distributed coefficients may not follow a

normal distribution (Hayes & Preacher, 2014) , thus it can lead to wrong conclusions (Hayes, Montoya, & Rockwood, 2017). Similarly, Baron and Kenny's method has low statical power (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). These weaknesses are overcome in Hayes PROCESS macro-regression analysis by generating a confidence interval with thousands of empirical samplings (Bootstrapping) (Hayes et al., 2017).

Graphical Representation

Figure 1 Multiple Mediation Model Income, Social Network, and Physical Health

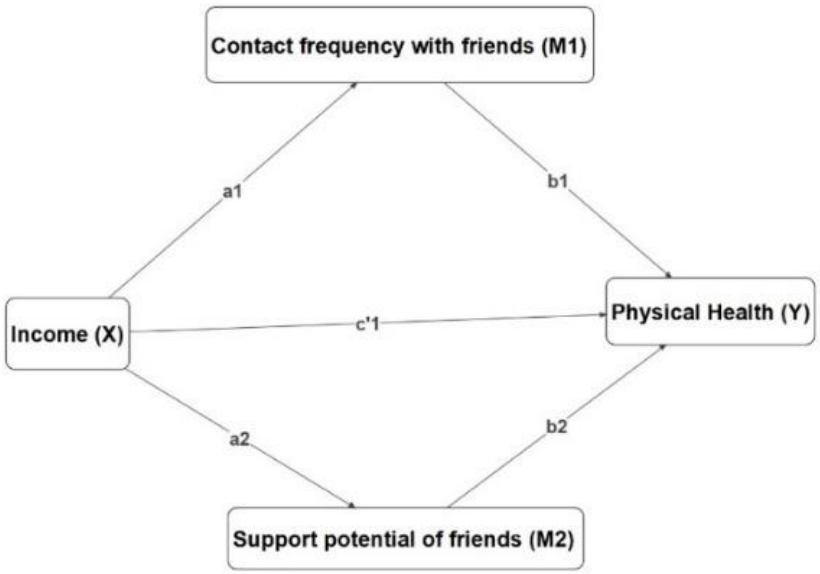
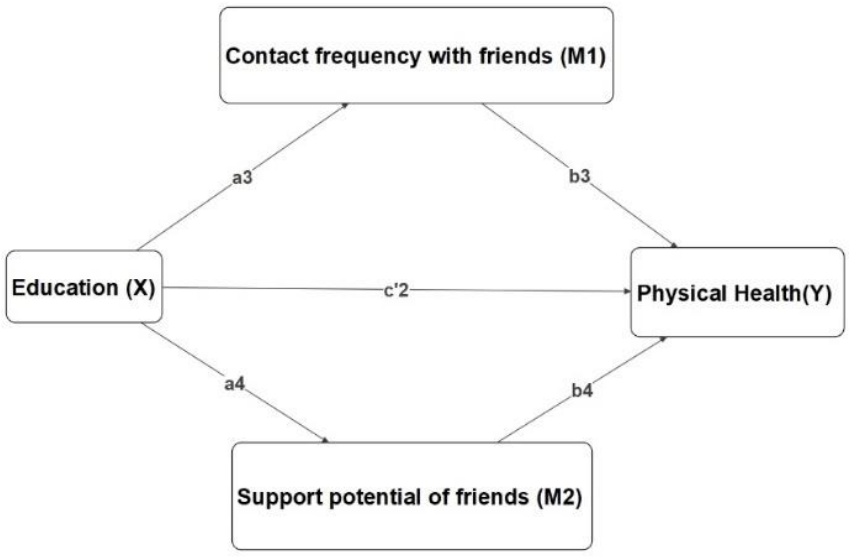


Figure 2 Multiple Mediation Model Education, Social Network, and Physical Health



Results

Table 1 Socio-demographic characteristics of the study population

	Male				Female			
	N	**%**	**Mean**	**SD**	**N**	**%**	**Mean**	**SD**
Age	1412	-	63.46	6.42	1444	-	63.68	6.63
Health status	N= 1383	-	48.07	9.64	N=1411	-	45.82	10.97
Marital status	N=1412				N=1444			
Without Partner	316	22.4			568	38.9		
With partner	1096	77.6			882	61.1		
Education	**N=1409**				**N=1444**			
Primary education and no education	202	14.3			267	18.5		
Higher education, basic education	378	26.8			479	33.2		
Higher secondary and supplementary higher education	344	24.4			196	13.6		
University and college education, lower level	293	20.8			428	29.6		
University and college education, higher level and doctorate	192	13.6			74	5.1		
Income Deciles	**N=1395**				**N= 1417**			
1st	54	3.9	340465	282823	262	18.5	232194	105372
2nd	100	7.2			201	14.2		
3rd	130	9.3			199	14.0		
4th	115	8.2			150	10.6		
5th	120	8.6			127	9.0		
6th	132	9.5			109	7.7		
7th	152	10.9			126	8.9		
8th	196	14.1			126	8.9		
9th	170	12.2			66	4.7		
10th	226	16.2			51	3.6		

Table 1 presents the descriptive statistics of various demographic characteristics of the study populations. All together 2856 older adults were included in the analysis of which 49.4 % are men and 50.6 % are women. The mean age of the study population was 63.57 (SD= 6.57) where the minimum age was 55 years and the maximum age was 85 years. The mean age for men was 63.46 (SD =6.42) and 63.68 (SD=6.63) for women. The mean PCS-12 physical health

status score was 46.93 (SD =10.39). The mean PCS-12 physical health score is higher for males 48.07 (SD = 9.64) compared to their female counterparts 45.82 (SD = 10.97). The average annual gross income of older adults was 285906 NOK (SD=219526). The male older adults have a higher average gross income (M= 340465, SD= 282823) than women (M=231194, SD=10532). 16 % of older men fall in 10th income deciles while only 3.6 % of female older adults were in the corresponding income group. More than three- fourth (77.6 %) of male older adults and 61.1% of female older adults were with partners. The majority of male and female older adults having at least basic higher education accounting for 26.8 % and 33.2 % respectively. The percentage of male older adults having higher university education was higher compared with their female counterparts with 13.6 % and 5.1 % respectively**.**

Figure 3 Multiple Mediator Model Income, Contact frequency with friends, Support potential of friends, and Physical Health (Unstandardized Direct and Indirect Effects)

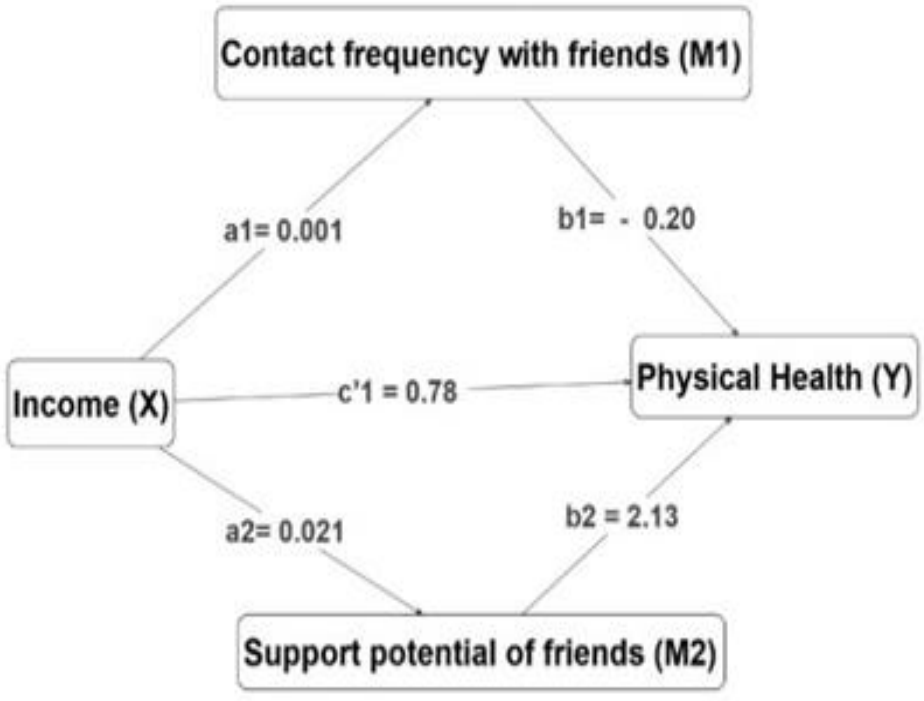


Table 2 present the total effect (c1), direct effect (c'1), indirect effects (a1b1 and a2b2), total indirect effect (a1b1+ a2b2), and other regression coefficients (a1, a2, b1 b2) from the parallel multiple mediation model of income, social network, and physical health. The total effect of income on physical health alone is observed as 0.83 [c1=0.83, SE 0.78, CI (0.67,0.98)]. The direct effect**,** c′1 = 0.78 [c'1=0.78, SE 0.79, CI (0.62,0.94)], quantifies the effect of income on physical health score independent of the effect of the proposed mediators on physical health score. Irrespective of differences between the groups in their contact frequency with friends and support potential of friends and how those mediators relate to physical health score, those with higher income have higher physical health scores (because c′1 is positive) than those with low-income level. The indirect effect of contact frequency with friend is estimated as a1b1= - 0.002 [a1b1= - 0.002, SE= 0.002, CI (-0.005, 0.005)]. This implies that a one decile increase in income is likely to decrease the physical health score by 0.002 units. This suggests that those with higher contact frequency with friends are likely to have a lower physical health score. A 95% confidence interval straddles zero**,** thus we cannot say that income influences physical health indirectly through contact frequency with friends. The indirect effect of friends` support potential is estimated as a2b2= 0.04 [a2b2 =0.04, SE= 0.01, CI (0.01,0.07)]. As a result, one decile increase on income is likely to result in a 0.04 unit increase in physical health score. This implies that those with higher support potential of friends are likely to report a higher physical health score. The bootstrap confidence intervals support the claim at the 95% confidence level, thus suggesting that income significantly influences physical health indirectly through the support potential of friends, as confidence intervals are entirely above zero.

The indirect effect of income on physical health summed across all mediators is called the total indirect effect of income on physical health, which is observed as 0.04, [a1b1+a2b2=0.04, SE 0.01, CI (0.018,0.07)]. The total indirect effect is positive, meaning that those with a higher contact frequency with friends and higher support potential of friends, on average report 0.04

units higher on the physical health score than those with lower contact frequency with friends and lower support potential of friends. This is a result of income`s effect on the mediators, which in turn influence physical health. In the mediation model, we can be 95% confident that income`s total indirect effect through both mediators simultaneously is somewhere between 0.018 and 0.07. This supports the claim that contact frequency with friends and friends` support potential collectively mediate the effect of income on physical health scores. The values of a1 and a2 are observed as [a1= 0.001, SE = 0.007, CI (-0.01, 0.01)], [a2= 0.021, SE= 0.002, CI (0.01, 0.01)]. This implies that a one decile increase in income is likely to increase the contact frequency with friends by 0.001 scale units, and friends` support potential by 0.02 scale units respectively. The b1 [b1= -0.20, SE =0.23, CI ( -0.66, 0.24)] estimates the amount by which one scale unit increase in the contact frequency with friends decreases the physical health score while holding friends` support potential and income constant. Similarly, b2 [b2=2.13, SE= 0.65, CI (0.85, 3.42)] estimates the amount by which one scale unit increase in friends` support potential increases the physical health score while holding contact frequency with friends and income constant. 2 % variance in contact frequency with friends and 5.9 % variance in friends` support potential is explained by the income [R^2= 0.021 F (3, 2306) = 17.00, p= 0.000, R^2 = 0.059, F (3,2306) =41.32, p =0.0000], whereas 6.3 % of the variance in physical health score is accounted for by both proposed mediators and income, [R^2 = 0.063 F (5, 2304) = 31.47, p=0.000].

Table 2 Model Summary Information for the Parallel Multiple Mediator Model (Income, Contact frequency with friends, Support potential of friends, and Physical Health)

		M1 (Contact frequency with friends)			95 % CI		M2 (Support potential of friends)					Y (Physical Health)			95 % CI
		B	SE	LL CI	UL CI		B	SE	LLCI	UL CI		B	SE	LL CI	UL CI
Constant		4.08	0.100	3.88	4.28		0.18	0.035	0.11	0.25		41.97	1.40	39.20	44.73
X (Income)	**a1**	0.001	0.007	-0.01	0.01	**a2**	**0.021**	0.002	0.01	0.027		0.78	0.79	0.62	.94
M1 (Network Structure)		-	-	-	-		-	-	-	-	**b1**	-0.20	0.23	-0.66	0.24
M2 (Social Support)		-	-	-	-		-	-	-	-	**b2**	**2.13**	0.65	0.85	3.42
Gender		**0.21**	0.043	0.13	0.30		0.15	**0.015**	0.12	0.18		-0.40	0.48	-1.32	0.51
Marital status		**-0.16**	0.04	-0.25	-0.07		0.011	0.016	-0.19	0.04		**1.63**	0.47	0.71	2.56
R^2		R^2= 0.021 F (3, 2306) = 17.00, p= 0.000					R^2 = 0.05 9, F (3,2306) =41.32, p =0.0000					R^2 = 0.063 F (5, 2304) = 31.47, p=0.000			

Direct, Indirect and Total Effect

Path	Effect (B)	Boot SE	Boot LL CI	Boot UL CI
Total effect (c1)	**0.83**	**0.78**	0.67	0.98
Direct Effect (c'1)	**0.78**	0.79	0.62	0.94
a1	0.001	0.007	-0.01	0.02
a2	**0.021**	0.002	0.01	0.01
b1	-0.20	0.23	-0.66	0.24
b2	**2.13**	0.65	0.85	3.42
Indirect effects				
Total indirect effects (a1b1+a2b2)	**0.04**	0.01	0.018	0.07
a1b1	-0.002	0.002	-0.005	0.005
a2b2	**0.04**	0.01	0.01	0.07

****SE: Standard Error CI: Confidence Interval LL CI Lower Limit Confidence Interval ULCI: Upper Limit Confidence Interval, Bold Values are statistically significance at significance level 0.05**

Figure 4 Mediator Model Education, Contact frequency with friends, Support potential of friends, and Physical Health (Unstandardized Direct and Indirect Effects)

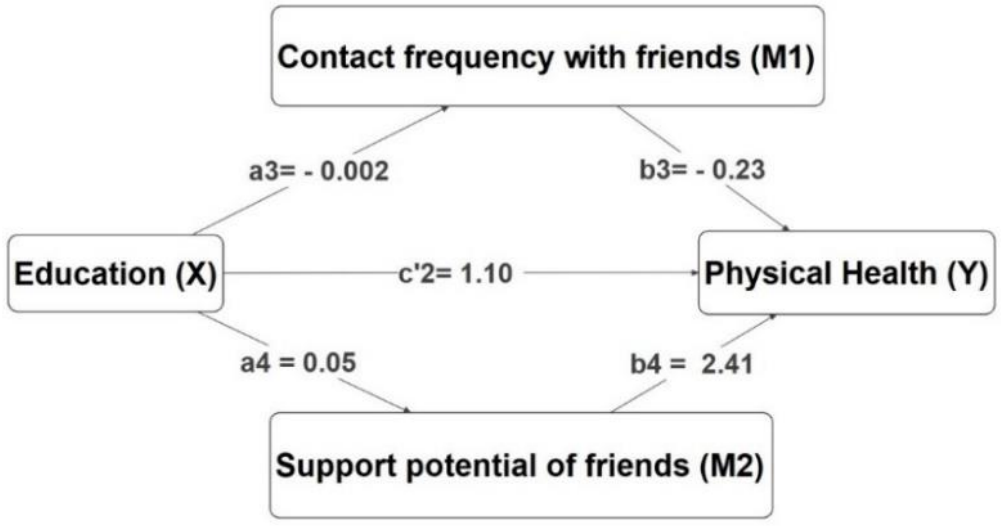


Table 3 presents the total effect (c2), the direct effect (c'2), the indirect effects (a3b3 and a4b4), the total indirect effect (a3b3+a4b4), and other regression coefficients (a3, a4, b4, and b4) from the parallel multiple mediation models of level of education attained, social networks, and physical health. The total effect of attained education level on physical health alone is observed as 1.23 [c2 =1.23, SE 0.172, CI (0.89, 1.57)]. The direct effect**,** c′2 = 1.10 [c'2 = 1.10, SE= 0.175, CI (0.76, 1.45)]. This shows the effect of attained education level on physical health score independent of the effects of the proposed mediators on physical health score. Irrespective of the differences between the groups with regard to their contact frequency with friends and their friends` support potential, as well as how those mediators relate to physical health score; those who have attained a higher education level have higher physical health scores than those with a lower attained education level. The indirect effect of contact frequency with friends is estimated as a3b4= 0.0005 [a3b3 = 0.0005, SE= 0.005, CI (-0.010, 0.12)]. This means that a one scale unit increase on attained education level is likely to cause a 0.0005 scale unit increase in the physical health score. This implies that those with a higher contact frequency with friends have a lower physical health score. The 95% confidence interval straddles zero, so we cannot say that the attained education level influences physical health indirectly through contact frequency with friends.

The indirect effect of friends` social support is estimated as a4b4= 0.12 [a4b4 = 0.12, SE = 0.037, CI (0.05, 0.20)]. This implies that a one scale unit increase in the attained education level is likely to cause a 0.12 scale unit increase in the physical health score. This suggests that those with a higher support potential of friends have a higher physical health score. The bootstrap confidence intervals support the claim at the 95% confidence level. This means that highest attained education level influences the physical health scores indirectly through friends` support potential, as implied by that confidence interval being entirely above zero.

Table 3 Model Summary Information for the Parallel Multiple Mediator Model (Model (Education, Contact frequency with friends, Support potential of friends, and Physical Health)

		M1 (Contact frequency with friends)			95 % CI		M2 (Support potential of friends)					Y (Physical Health)			95 % CI
		B	SE	LL CI	UL CI		B	SE	LLCI	UL CI		B	SE	LL CI	UL CI
Constant		4.11	0.912	3.93	4.28		0.21	0.032	0.11	0.25		45.40	1.34	42.76	48.76
X (Education)	**a3**	-0.002	0.016	-0.03	0.29	**a4**	**0.051**	0.005	0.01	0.027		1.10	0.17	0.76	1.45
M1 (Network Structure)		-	-	-	-		-	-	-	-	**b3**	-0.23	0.23	-0.69	0.22
M2 (Social Support)		-	-	-	-		-	-	-	-	**b4**	**2.41**	0.66	1.11	3.70
Gender		**0.21**	0.040	0.13	0.29		0.11	0.014	0.12	0.18		- 1.79	0.43	- 2.65	-0.93
Marital status		**-0.17**	0.044	-0.25	-0.084		0.0006	0.015	-0.19	0.04		**1.30**	0.47	0.37	2.23
R^2		R^2= 0.022 F (3, 2337) = 17.00, p= 0.000					R^2 = 0.056, F (3,2337) =46.71, p =0.0000					R^2 = 0.039 F (5, 2335) = 19.39, p=0.000			

Direct, Indirect and Total Effect

Path	Effect (B)	Boot SE	Boot LL CI	Boot UL CI
Total effect (c2)	**1.23**	0.172	0.89	1.57
Direct Effect (c'2)	**1.10**	0.175	0.76	1.45
a3	-0.002	0.016	-0.03	0.29
a4	**0.051**	0.005	0.01	0.027
b3	-0.23	0.23	-0.66	0.22
b4	**2.41**	0.66	1.11	3.70
Indirect effects				
Total indirect effects (a3b3+a4b4)	**0.12**	0.03	0.054	0.20
a3b3	0.0005	0.005	-0.010	0.12
a4b4	**0.12**	0.037	0.05	0.20

****SE: Standard Error CI: Confidence Interval LL CI Lower Limit Confidence Interval ULCI: Upper Limit Confidence Interval, Bold Values are statistically significance at significance level 0.05**

The total indirect effect of highest attained education level on physical health score is observed as 0.12, [a3b3+a4b4 = 0.12, SE = 0.03 CI (0.054, 0.20)]. The total indirect effect is positive, meaning that those with a higher contact frequency with friends and higher support potential of friend's report on average 0.12 units higher on their physical health scores than those with lower contact frequency with friends and lower support potential of friends. This is a result of the effect of attained education level on the mediators, which in turn influence physical health. According to this mediation model, we can be 95% confident that the total indirect effect of the attained education level through both mediators simultaneously is somewhere between 0.054 and 0.20. This supports the claim that contact frequency with friends and friends` support potential collectively mediate the effect of attained education level on physical health scores.

The values of a3 and a4 are observed as [a3 = - 0.002, SE = 0.016, CI (-0.03, 0.29)], [a4 = 0.051, SE = 0.005, CI (0.01 ,0.027)]. This means that a one scale unit increase in the attained education level is likely to decrease the contact frequency with friends by 0.002 units, and a one scale unit increase in the attained education level is likely to increase the support potential of friends by 0.051 respectively. The b3 is [b3 = -0.23, SE = 0.23 CI (-0.66,0.22)], this implies that a one scale unit increase in the frequency of contact with friends decreases the physical health score, while holding friends` support potential and highest attained education level constant. Further, b4 is [b4= 2.41, SE = 0.66, CI (1.11, 3.70)], implying that a one scale unit on friends` support potential is likely to increase the physical health sore, while holding contact frequency with friends and highest attained education level constant. 2.2 % variance in the contact frequency with friends and 5.6 % variance in friends` support potential is explained by the level of education [R^2= 0.022 F (3, 2337) = 17.00, p= 0.000, R^2 = 0.056, F (3,2337) =46.71, p =0.0000], whereas 3.9 % of the variance in physical health score is accounted for by both proposed mediators and highest level of education attained , [R^2 = 0.039 F (5, 2335) = 19.39, p=0.000].

Discussion

This paper confirms that the socioeconomic gradient in health exists among older adults in Norway. This implies that older adults belonging to higher income groups and higher levels of education have a greater physical health status (H1). For instance, for every decile increase in the income of older adults there is an expected increase in the physical health score by 0.89 units. Similarly, for each education level increase there is an expected increase in the physical health score by 1.1 units.

The two separate parallel multiple mediation models as shown in figure 3 and figure 4 show the role of social networks in the relationship between SEP and the physical health status of

older adults in Norway. In the first mediation model, it was expected that a higher income level would be associated with a greater support potential of friends, which in turn would be related to a higher physical health score (H2a). Likewise, a higher income level was expected to be associated with a greater support potential of friends, which in turn would be related to a higher physical health score (H2b). These assumptions are only partly supported by the results since the 95% confidence interval does include zero for the indirect effect of contact frequency with a friend (a1b1) in the relationship between income and physical health, thus implying that the result is not statistically significant. On the other hand, the 95% confidence interval does not include zero for the indirect effect of support potential of a friend (a2b2) in the relationship between income and physical health, this implying the result is statistically significant.

The second mediation model assumes that a higher level of education is associated with more frequent contacts with friends, which in turn is related to a higher physical health score (H3a). Likewise, it is assumed that a higher level of education is associated with more support potential of friends, which in turn is related to a higher physical health score (H3b). These assumptions are only partly supported by the results since the 95% confidence interval does include zero for the indirect effect contact frequency with a friend (a3b3) in the relationship between education and physical health, thus implying that the result is not statistically significant. On the other hand, the 95% confidence interval does not include zero for the indirect effect of support potential of a friend (a4b4) in relationship between education and physical health, this implying the result is statistically significant.

In the case of each mediation model, the total indirect effect of income on physical health (a1b2+a2b2) summed across the two mediators (i.e., contact frequency and support potential of friends), and the total indirect effect of education on physical health summed across two mediators (a3b3+a4b4); both showed a positive and statistically significant association.

Therefore, from these findings it can be concluded that social networks (i.e., friends` support potential and frequency of contact with friends) mediate the relationship between SEP and health status among older adults in Norway, but only partially. The results show that a higher level of education results in greater support potential of friends, and in turn leads to better health status. Similarly, a higher income level is associated with a greater social support potential from friends, which in turn is related to better physical health. These findings are similar to other studies that show that social support is related to a lower level of mortality and protects people from illnesses. In such cases, social support (i.e. emotional and instrumental support) in turn can promote healthier lifestyles and result in protection from various diseases (Seeman & Berkman, 1988). For example, a US based longitudinal study with a nationally representative sample of older adults examined the relationship between social support and change in blood pressure measures over six years. The results showed a clear gradient in Blood Pressure (BP) measures according to the social support. This was shown by the significant difference in BP profiles of older adults with higher levels of support (Yang, Boen, & Mullan Harris, 2015). Yang et al. further highlighted that perceived social support was a prominent factor influencing blood pressure (Yang et al., 2015) but they did not provide a possible explanation. It may be that friends are an important source of perceived social support, i.e. in the form of emotional support (Larson, Mannell, & Zuzanek, 1986), which helps to reduce stress, and in turn results in a positive influence on blood pressure. Furthermore, the meta-analysis paper by Shor et.al, shows that social relationships facilitate healthy behaviors like adherence to treatment regimens and keeping healthy diets that are crucial during old age (Shor & Roelfs, 2015). In contrast to the above examples of social support, Seeman et al., and Hakulinen, C. et.al's studies show that a higher level of social support (i.e., in the form of practical support) is associated with poorer physical health (Hakulinen et al., 2016; Seeman & Berkman, 1988).

The current study's findings were according to expectations, and in agreement with the findings of Yang et al. and Larson et al., who posit that social support is associated with better physical health outcomes. However, the results were in contrast to Seeman et al.`s & Hakulinen et.al's findings, who posited that social support is negatively associated with physical health outcomes. More specifically, this negative association is likely explained by the fact that people who become sick need more practical support, for example sick persons often need assistance in order to utilize healthcare, i.e., they need help with mobility and transport. In other words, these authors posit that those who are not physically fit tend to utilize more social support (Seeman & Berkman, 1988). The current study's findings indicate the opposite, where an increased level of social support is associated with higher a higher physical health score.

There are mixed findings regarding contact frequency`s influence on physical health outcomes. Various meta-analyses results indicate that social contact is beneficial to health (Holt-Lunstad et al., 2010; Shor & Roelfs, 2015) and this effect is especially pronounced in the older population (Shor & Roelfs, 2015). Other studies show that a higher frequency (i.e. daily) of social interactions is not necessarily associated with better health outcomes (Stavrova & Ren, 2020). This paper finds that the contact frequency with a friend does not influence physical health outcomes among older adults in Norway. This might be because contact frequency is often associated with social support that older people receive, which in turn influences health. A study by Seeman et.al showed that received instrumental and received emotional support by those who are 65 year old`s and older is strongly related to the frequency of the contact with their social network (Seeman & Berkman, 1988). However, in this paper, it is assumed that the frequency of contact and friends` social support potential do not influence each other. Additionally, the data showed that the frequency of contact with the social network has a negative influence on older adult's health, though this is not statistically significant. Thus, it can be assumed that social networks, especially the contact frequency, does not always act as

a positive health predictor. The negative association between network structure and health is a result of the divergence of resources on other activities as a result of frequent social contacts, which otherwise could be used for positive health outcomes (Stavrova & Ren, 2020). Interestingly, people who actively seek solitude as a way to relax and regulate their emotions, for them the increase in frequency of contact with others interferes with such valuable moments for solitude and other dimensions of personal life (Coplan et al., 2019). Also, individuals need to maintain a particularly high frequency of social contacts because that's what they have to do, and not because that's what they want to (Uchino, 2004b). Such frequent social contact might put people in a stressful situation (Stavrova & Ren, 2020; Uchino, 2004b) and it is a well-established fact that stress is a well-known predictor of poor health (Thoits, 2010). Following the above discussions and evidences, this paper reveals mixed findings; that is, some aspects of the social network (i.e., friends` support potential) has a positive impact on physical health, while others have a negative impact (i.e., contact frequency with friends) on physical health. Therefore, health researchers also need to consider the deteriorating influence of social networks on health outcomes.

There are a number of limitations. This paper only uses a single measure of the network structure i.e., contact frequency with friends, therefore does not comprehensively identify the network structure`s influence on health. This paper assumes that social structure does not relate to social support, however, studies have also indicated that social network`s structure can influence various social support, which In turn can produce different health outcomes. Therefore, future studies could explore how various social network characteristics interact with each other and influence the relationship between SEP and health status using complex mediation models. The strength of this paper is the use of national-level longitudinal data spanning 10 years, which allows for detailed estimation of the causal association between SEP, social network, and physical health.

Conclusion

The results show a socioeconomic gradient exists in the health of the older adults in Norway. This study`s results show that the social network is an important pathway via which SEP influences people`s health status. All aspects of the achieved social network (i.e., friends) do not play a positive role not have a significant influence on health outcomes. More specifically, the evidence highlights that contact frequency with friends does not show any influence on the relationship between SEP and health status among older Norwegian adults. Nevertheless, other aspects of the social network structure and their influences on health outcomes among older adults needs further investigation, which were not included in this study owing to limited scope of this research paper. This paper shows friends` support potential is a significant pathway between SEP and health status in Norway. However, this limited operationalization of network structure is not sufficient, and motivates a more comprehensive operationalization so that a better understanding of why these effects occur can be found. It is also necessary to investigate the specific dimension of social support (i.e., emotional, instrumental, appraisal, or informational) that has the most beneficial effect on physical health outcomes in Norwegian older adults, so that policy interventions may be more well informed.

Declaration of Conflicting Interests

There are no potential conflicts of interest concerning the research.

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