

Original Research

## Differential Effects of Social Network on Health in Later Life and the Moderating Role of Depression

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**Academic Editor:** Ray Marks

**Special Issue:** [Depression and Aging: Role of Social Support](#)

*OBM Geriatrics*

2019, volume 3, issue 3

doi:10.21926/obm.geriatr.1903067

**Received:** March 23, 2019

**Accepted:** August 01, 2019

**Published:** August 12, 2019

### Abstract

**Background:** Differential effects of the characteristics of social network on limitations with activities (LWA) and the quality of life (QOL) among older adults, and the moderating role of depression were studied.

**Methods:** The data obtained from two consecutive waves of the Survey of Health, Aging, and Retirement in Europe (SHARE) was examined.

**Results:** Emotional closeness, satisfaction with the social network, and contact frequency were able to predict the QOL and not LWA. Moreover, depression was observed to moderate the effects of network characteristics on these health outcomes, in a way that the effect of emotional closeness on QOL was significant among the low-depressed individuals in comparison to its effect on the highly depressed individuals; similar outcomes were observed for the effect of contact frequency and satisfaction with the social network on LWA. In addition, greater geographic distance was able to predict lower LWA when the levels of depression were high compared to when the levels of depression were low.

**Conclusions:** The findings of the present study highlighted the importance of recognizing the differential effects of different characteristics of social network on health outcomes, and, in addition, considered the role of depression levels in predicting these outcomes among the



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older adults. The theoretical and practical implications of these findings have also been discussed in the present report.

### **Keywords**

Social networks; social relations; depression; quality of life; health outcomes

## **1. Introduction**

Theories of social support argue that social relations, particularly the social networks in which individuals are embedded, impact health in various ways [1, 2]. Social networks comprise the interpersonal connections that people maintain and from which they probably obtain a range of resources and supports [3]. However, social networks are not singular entities, and as a result, their characteristics vary along with a range of factors [4].

In this context, a key division differentiates between the objective structural and interactional aspects of the network on one hand and the subjective relational aspects of the network on the other hand [5]. The objective structural and interactional aspects constitute the main architecture of a social network and underscore its dynamic nature [6, 7]. The examples of the structural aspects of a social network include the size of the network and the geographical proximity to or distance from the respective social connections [8, 9]. An example of the interactional aspect of a social network is the frequency or intensity of contact with one's social connections [10, 11]. In contrast, subjective relational aspects of the network refer to its content, specifically the perceived support that the network is said to provide [12, 13], the examples of which include the extent of emotional closeness that one feels toward the members of the network [14, 15] and the degree of satisfaction that one feels with one's social connections [16, 17].

Different network factors affect health outcomes in different ways and through different means. The structural and interactional characteristics of the network might affect one's health status, for example, by allowing access to and opportunities for interactions, increasing awareness regarding the requirements and resources, providing functional assistance, and encouraging adaptive health behaviors through social influence [18, 19]. These effects may be direct (the main effect model), or indirect as by buffering stress that could have otherwise subsequently compromised one's health [20]. In comparison, the subjective relational characteristics of the network work on the more affective elements of health. For instance, emotionally close relations may generate a feeling of being respected; such relations may also provide positive feedback regarding behaviors and attitudes [21], and such positive appraisals are important aspects of mental health. In addition, positive relationships are able to moderate stressors, and as a consequence, reduce mental distress [22].

Understanding the effect of social network on health gets further complicated due to the different aspects of health that are believed to be affected by the respective components of social connections. This is because health status is also not a singular entity, and rather represents a range of outcomes. Two different health outcomes of particular interest while studying older adults are functional health, such as physical activity limitation [23, 24], and mental health, which is measured, for example, in terms of the perceived quality of life [25].

Research has not yet determined whether the effect of different factors associated with social networks on health is dependent on the extent of congruency between the network characteristic in question and the health outcome being considered. This question has never been examined directly, to the best of our knowledge. However, it might be that the structural and interactional characteristics of the network affect the functional health outcomes primarily, while the subjective relational characteristics of the network primarily affect the mental health outcomes. This question would be explored in the present analysis.

Another complication in the task of disentangling the social network–health nexus is the presence of additional potentially-intervening variables. One such key variable that requires research and attention is depression or a depressive state. This is because depression has been reported to affect health antecedents, such as health behaviors and immunity, in a negative way [26-28]. Given that social networks operate on the same mechanisms which affect health, i.e., through the prevention of risk behaviors via social influence or producing positive psychological states, or through a decrease in the negative effect of stress on health [29], depression may obstruct the adaptive effects of social network on health. Moreover, depression might potentially moderate the degree to which individuals interpret and react to the health-related and social aspects of their lives, i.e., the presence of depressive symptoms in an individual may attenuate the translation of cognitions into behavioral outcomes. Previous studies have suggested that negatively biased cognitions and motivations, which are characteristic of depressed individuals, affect their behaviors and further perceptions [30, 31]. It has been reported, for example, that depression molds and shapes an individual's perception of their social interaction, thereby moderating the effect of this interaction on loneliness [32]. In addition, depression hinders the translation of health beliefs into health-protective behaviors [33].

In this context, the present study was aimed to consider the differential effect of selected social network factors on health. Specifically, the first aim of the present study was to examine [longitudinally] the relative effects of the structural/interactional characteristics of the network in comparison to the effects of the subjective relational characteristics of the network in relation to functional and mental health. It was expected that the structural/interactional characteristics of the network would be associated with lower levels of the reported functional health limitations, while the subjective relational characteristics of the network would be associated with higher levels of mental health. Therefore, it was hypothesized that:

**H1:** Functional health would be predicted more strongly by the structural/interactional characteristics rather than by the subjective relational characteristics of the network.

**H2:** Mental health would be predicted more strongly by the subjective relational characteristics of the network rather than by its structural/interactional characteristics.

The second aim of the present study was to clarify whether the effects of social network characteristics on health-related outcomes were moderated by depression. It was hypothesized that:

**H3:** The effects exerted by the characteristics of social network on health-related outcomes would be positive when the levels of depression were low, and no positive effects would be observed when the levels of depression were high.

## **2. Methods**

### **2.1 Participants**

The sample consisted of adults of age 50 years and older, who had participated in the Survey of Health, Ageing, and Retirement in Europe (SHARE) [34]. SHARE was a cross-national panel database commenced in 2004; it includes a wide range of data regarding the participants' health, social relations, and economics. Ethical approval for conducting the SHARE was originally granted by the institutional review board of the University of Mannheim, Germany. The present study which was performed as an analytical effort focused on the respondents who had participated in both of the two consecutive waves of data collection, namely Wave 4 (2011) and Wave 5 (2013). The resultant sample comprised a total of 38,192 people.

### **2.2 Measures**

#### **2.2.1 Social Network Variables**

The social network at the baseline was derived using a name-generating inventory based on the following probe: Most people discuss with others, the good things or the bad things that happen to them, problems that they are encountering, or the important concerns that they might be having. Reflecting on the past 12 months, identify the people with whom you have discussed the important things most often. These people might be your family members, friends, neighbors, or acquaintances. The variable 'network size' was measured by counting the number of people that the participant referred to in response to the above probe. This variable was used in the present analysis as a control variable, in a manner that the network characteristics that were described next were related, to varying degrees, to the network size (see the section on Statistical Analyses for the delineation of all the confounding variables that were controlled in the analysis).

The number of independent social network variables used in the analysis was four. The network structure was considered by the geographical distance of the respondent from his or her network. The variable was calculated as the average of the scores calculated on the basis of participant's answers regarding each named member of their network to the question, "Where does [the named network member] live?" The response option scores ranged from 1, which corresponded to the option of 'in the same household', to 8, which corresponded to the option of 'greater than 500 kilometers away'. Higher scores indicated greater geographical distance.

The interactional aspect of the network was assessed in terms of contact frequency, which was measured as the average of the scores calculated on the basis of participant's answers, regarding each member of the network, to the question: During the past twelve months, how often did you contact [the network member], personally, by phone, or via mail? The scores for the response categories ranged from 1, which corresponded to the response of 'Daily', to 6, which corresponded to the response option of 'Less than once a month or never'. The score was reverse coded in a manner that higher scores indicated a greater contact frequency.

The subjective relational aspect of the network was measured using two indicators. The first indicator was the variable of 'emotional closeness', measured as the average of the scores calculated on the basis of participant's answers, regarding each member of the network, to the question, "How close do you feel to [the network member]?" The response options were: not very close (score 1), somewhat close (2), very close (3), and extremely close (4). Higher scores indicated

greater emotional closeness. The second variable was 'satisfaction with the network', which was measured by a single item, a response to the question, "Overall, how satisfied are you with the relationships that you have with the persons we have just talked about?" The individuals who reported no members in their social network were asked the following question instead: You indicated that there is no one with whom you could discuss matters and no one who is important to you for certain reasons. How satisfied are you with this situation? Both the questions had response options with scores ranging from 1 to 10. Higher scores represented higher satisfaction.

#### 2.2.2 Dependent Variables: Measured at T<sub>2</sub> (Wave 5)

Functional health was measured using the single global indicator – limitations with activities (LWA). The respondents were asked the following question: For the past six months at least, to what extent have you been limited, because of a health problem, in activities people usually perform? The response options were as follows: 'not limited', 'limited but not severely', and 'severely limited'. The responses were dichotomized as 'not limited' (coded 0) or 'limited' (coded 1).

Mental health was assessed using the CASP scale (Control, Autonomy, Self-realization, and Pleasure) for quality of life (QOL) [35]. The original CASP instrument was a self-reporting questionnaire consisting of 19 agreement items, scored on a Likert scale, which corresponded to the following four domains of QOL: control (C), autonomy (A), self-realization (S), and pleasure (P). This variable was developed and tested specifically in the context of aging, while a shorter 12-item version of this scale, named CASP–12, was employed by the Survey of Health, Ageing, and Retirement in Europe (SHARE) [36]. On the basis of a 4-point response scale, the scores ranged from 12 to 48. Negatively phrased items were reverse coded, such that a higher score on the scale indicated a better quality of life.

#### 2.2.3 Moderating Variable: Measured at T<sub>1</sub> (Wave 4)

The moderating variable of depressive symptoms was assessed using the EURO-D scale, which was originally developed and validated in order to enable comparisons across the different European countries [37, 38]. Participants were asked to indicate whether they experienced any of the following 12 symptoms: depressed mood, pessimism, suicidal tendency, guilt, troubled sleep, loss of pursuing interests, irritability, loss of appetite, fatigue, loss of concentration, lack of enjoyment, and tearfulness. The scores of individual responses were added together to produce a final score ranging from 0 to 12. Higher scores represented higher levels of depressive symptoms.

#### 2.2.4 Statistical Analyses

It is noteworthy that a number of potential confounders were controlled in the present study. The control variables associated with the socio-demographic background from Wave 4 included gender, age, income level, and marital status. The variable of income level was measured in terms of the degree to which the household was able to make ends meet at baseline (T<sub>1</sub>), the responses to which were as follows: 'With great difficulty', 'With some difficulty', 'Fairly easily', or 'Easily'. The marital status variable was dichotomized, with the responses of living with a spouse or not. Background health confounders were reflected by two indicators: smoking and physical activity at the baseline. The smoking indicator was measured by a no/yes response. Vigorous physical activity indicator was

measured using the item, “How often do you engage in physical activity, such as sports, heavy household work, or a job that involves physical labor?” on a scale ranging from 1 [More than once a week] to 4 [Hardly ever or never]. The scale was reverse coded while generating the final scores for the analyses. Finally, as described earlier, the network size variable was also controlled.

Means, standard deviations, paired-sample t-tests, and regression analyses were performed using STATA statistical software version 13. A logistic regression analysis was performed in order to predict limitations with activities (LWA), and a hierarchical linear regression analysis was performed to predict the quality of life (QOL). In both the analyses, the variables were entered in three different steps to separately examine the respective effects of these social network variables as well as their interaction with depression. The first step regressed the outcome, at the baseline variable, of the dependent variable (i.e., LWA/QOL at  $T_1$ ) and the background control variables (i.e. the socio-demographic variables, background health variables, and network size). The second step added the depression score as well as the social network characteristics (geographical distance, contact frequency, emotional closeness, and satisfaction with the network). The third step entered the variables for the interaction of depression with each of the characteristic variables of the social network. Significant interactions were further probed using simple slopes analysis [39].

### **3. Results**

#### **3.1 The Sample**

The initial description of the sample indicated that 57% of the respondents were female, and the mean age in the sample was 65.7 years ( $SD = 9.7$ ). Most of the participants were married (67%) or widowed (14%). Thirty-five percent of the participants reported that they were able to manage the financial needs of their households with a little or great difficulty, while 65% of them reported that it was convenient or fairly convenient for them to manage the financial needs of their households.

#### **3.2 Descriptive Statistics of the Study Variables**

Table 1 presents the means and standard deviations for the independent and moderating variables in the present study. As it may be observed in the table, participants reported relatively low levels of depression (the moderator), although with sufficient variance among them. In addition, they reported relatively high levels of emotional closeness, contact frequency, and satisfaction with the members of their network, while only a moderate degree of geographical distance was reported.

No difference was in limitations with activities (LWA) from the baseline to the follow-up on a group level ( $\chi^2 = 2.11$ ;  $p = 0.15$ ). However, when examining the differences at the individual level, it was observed that 52% of the participants reported having no limitation at  $T_1$ , while the same respondents reported having limitations at  $T_2$ . In comparison, 13% of the respondents who had reported having limitations at  $T_1$ , reported having no such limitations at  $T_2$  (i.e., their situation had improved).

In addition, the results indicated that the quality of life increased significantly from  $T_1$  ( $M = 37.77$ ;  $SD = 6.21$ ) to  $T_2$  ( $M = 37.88$ ;  $SD = 6.30$ ) at the group level ( $t_{(34,453)} = 3.89$ ;  $p < 0.001$ ; Cohen's  $d = 0.02$ ). Moreover, when examining the differences at the individual level, it was observed that

from T<sub>1</sub> to T<sub>2</sub>, 44% of the respondents exhibited a decrease in their QOL assessments, 47% exhibited an increase in their assessments, and 9% did not exhibit any change in their assessments.

**Table 1** Ranges, means, and standard deviations of the study variables.

	Range	M	SD
Depression	0–12	2.45	2.20
Distance	1–8	3.26	1.61
EC	1–4	3.23	0.63
CF	1–7	6.07	0.97
Satisfaction	0–10	8.80	1.41

Note: EC=emotional closeness, CF=contact frequency

### 3.3 Associations among the Study Variables

Table 2 presents the bivariate associations among the study variables. Apparently, all these associations, with the exception of only one, were statistically significant, although to different degrees. The two health outcomes (LWA and QOL) were observed to be negatively associated with each other, while the respective associations of these outcomes with the social network characteristics were weak. Depressive symptoms were observed to be associated with poor physical health (LWA) and negatively associated with mental health (QOL). Satisfaction with the social network was observed to be most strongly associated with emotional closeness to the network members, and, to a lesser degree, with more frequent contact. In addition, the greater the geographical distance reported, the less frequent and emotionally close the contacts were. Finally, a positive association was observed between contact frequency and emotional closeness.

**Table 2** Bivariate associations among the study variables.

		1	2	3	4	5	6
1	Depression	1					
2	Distance	.07***	1				
3	EC	-.10***	-.23***	1			
4	CF	-.03***	-.65***	.34***	1		
5	Satisfaction	-.12***	-.04***	.35***	.17***	1	
6	LWA	.16***	.003	-.01**	.01*	-.01*	1
7	QOL	-.13***	.02***	.03***	-.03***	.03***	-.26***

\*\*\* p<0.001, \*\* p<0.01, \* p<0.05

Note: EC=emotional closeness, CF=contact frequency, QOL=quality of life, LWA=limitations with activities

### 3.4 Multivariate Results

The results for predicting limitation with activities (LWA) are presented in Table 3 in terms of the effects according to the steps in which the variables were entered into the regression model. The first step was significant ( $\chi^2(9) = 6,019.79; p < 0.001$ ), such that a greater risk of having limitations with activities could be predicted by factors such as a higher baseline risk of activity limitation, older age, lower-income, and education, engaging in less vigorous physical activities,

and smoking. The second step, which included the addition of depressive symptoms and the social network characteristics to the regression model, was also significant ( $\chi^2(5) = 396.23; p < 0.001$ ) and indicated that a greater risk of having limitations with activities could be predicted by factors such as higher levels of depression, while it could not be predicted by any of the social network variables as main effects. Finally, the third step, which added the variables of interaction between the depressive symptoms and each of the social network variables, was also significant ( $\chi^2(4) = 13.39; p = 0.01$ ). The three interaction variables that were observed to predict limitations were depression  $\times$  geographical distance, depression  $\times$  contact frequency, and depression  $\times$  satisfaction.

**Table 3** Logistic regression analysis for predicting limitations with activities (LWA) by background variables, depression, social network variables, and their interactions.

	Step 1		Step 2		Step 3	
	B	Exp (B)	B	Exp (B)	B	Exp (B)
<b>Block 1: Background variables</b>						
LWA T <sub>1</sub>	1.86***	6.45	1.74***	5.68	1.74***	5.68
Gender (1=female)	.09**	1.09	-.01	.99	-.01	.99
Age	.03***	1.03	.04***	1.04	.04***	1.04
Income	-.20***	.81	-.15***	.86	-.15***	.86
Education	-.04**	.96	-.02*	.97	-.02*	.98
Spouse (1=yes)	-.05	.95	-.03	.97	-.03	.97
Physical activity	-.13***	1.14	-.11***	1.12	-.11***	1.12
Smoking	.03**	.97	.03**	.97	.03**	.97
Size of network	-.01	.99	-.003	.99	-.004	.99
<b>Block 2: Affective and social network variables</b>						
Depression			.34***	1.41	.35***	1.42
Distance			-.002	.99	-.003	.99
EC			.02	1.02	.02	1.02
CF			.03	1.03	.03	1.03
Satisfaction			-.02	.97	-.03	.97
<b>Block 3: Interaction terms</b>						
Depression * Distance					-.06*	.94
Depression * EC					.02	1.02
Depression * CF					-.05*	.95
Depression * Satisfaction					.04*	1.04

Note. N=22,799.

LWA - limitations with activities, EC=emotional closeness, CF=contact frequency

\*p<0.05 \*\*p<0.01 \*\*\*p<0.001

Simple slopes analysis indicated that lower contact frequency and greater satisfaction could predict a lower risk of having limitation with activities only when the levels of depression were low ( $B = 0.08, SE = 0.03, t = 2.58, p = 0.01$  and  $B = -0.07, SE = 0.03, t = 2.40, p = 0.01$ , respectively) and not when the levels of depression were high ( $B = -0.02, SE = 0.03, t = 0.72, p = 0.47$  and  $B = 0.01, SE = 0.02, t = 0.48, p = 0.63$ , respectively). In case of geographical distance, greater distance could [marginally] predict a lower risk of having limitation with activities only when the levels of

depression were high ( $B = -0.06, SE = 0.03, t = 1.88, p = 0.06$ ) and not when the levels of depression were low ( $B = 0.05, SE = 0.03, t = 1.74, p = 0.08$ ).

The results for the quality of life (QOL) are presented in Table 4, according to the steps in which the variables were entered into the regression model. The results revealed that the background variables explained 46.9% of the total variance in QOL ( $F(9,21120) = 20,69.73; p < 0.001$ ), such that the same background predictors were significant, although in the opposite direction, which was consistent with the previously obtained results for LWA. This implied that better QOL was associated with a higher baseline QOL, being female, younger age, higher income, and education, engaging in more vigorous physical activities, and not smoking. The addition of depressive symptoms and social network characteristics into the regression model in step two added 0.8% to the variance ( $F_{change}(5,21115) = 71.51; p < 0.001$ ), such that QOL was associated with lower levels of depression, with more emotional closeness, lesser contact frequency, and greater satisfaction with the social network. Finally, the third step, in which the variables of interaction between the depression and the network variables were added to the regression model, added 0.1% to the explained variance ( $F_{change}(4,21111) = 3.07; p = 0.01$ ). In this analysis, depression  $\times$  emotional closeness interaction variable emerged as the only predictor of QOL.

**Table 4** Regression analysis for predicting QOL by background variables, depression, social network variables, and their interactions.

	Step 1 <i>B</i>	Step 2 <i>B</i>	Step 3 <i>B</i>
<b>Block 1: Background variables</b>			
QOL at T <sub>1</sub>	.57***	.52***	.52***
Gender (1 = female)	.002	.01*	.01*
Age	-.07***	-.08***	-.08***
Income	.12***	.12***	.12***
Education	.05***	.05***	.05***
Spouse (1 = yes)	.003	.004	.004
Physical activity	.06***	.05***	.05***
Smoking	-.03***	-.04***	-.04***
Size of network	.01	.002	.001
<b>Block 2: Affective and social network variables</b>			
Depression		-.10***	-.10***
Distance		.002	.002
EC		.03***	.03***
CF		-.04***	-.04***
Satisfaction		.03***	.03***
<b>Block 3: Interaction terms</b>			
Depression $\times$ Distance			-.01
Depression $\times$ EC			-.02*
Depression $\times$ CI			.01
Depression $\times$ Satisfaction			.01

Note. N=21,130. R<sup>2</sup>=46.9% for the first step ( $p < .001$ ); R<sup>2</sup><sub>change</sub>= 0.8% for the second step ( $p < .001$ ); R<sup>2</sup><sub>change</sub>= 0.1% for the third step ( $p = .01$ )

QOL=quality of life, EC=emotional closeness, CF=contact frequency

\* $p < 0.05$  \*\* $p < 0.01$  \*\*\* $p < 0.001$

The simple slopes analysis indicated that higher emotional closeness could predict better QOL when the levels of depression were low ( $B = 0.24$ ,  $SE = 0.04$ ,  $t = 5.40$ ,  $p < 0.001$ ) and not when the levels of depression were high ( $B = 0.07$ ,  $SE = 0.04$ ,  $t = 1.57$ ,  $p = 0.11$ ).

#### **4. Discussion**

In the present study, two main aims were pursued. The first one was to longitudinally examine the differential effects of the objective structural and interactional aspects of a social network on the one hand and those of the subjective relational aspects of the network, on the other hand, on two different health outcomes. The second aim of the present study was to examine the moderating role of depression on these associations. Overall, the findings of the present study indicated that the importance of the different characteristics of social network changes as a function of the health outcome that is being predicted. Specifically, it was observed that emotional closeness, satisfaction with the social network, and contact frequency were able to predict the quality of life – a mental health outcome, while none of the network characteristics could directly predict limitations with activities – a measure of functional health. Previous studies have also reported the differential effects of the different social network characteristics in relation to health outcomes [40, 41].

The prediction of mental health by the emotional closeness and network satisfaction variables observed in the present study is consistent with the hypothesis established at the beginning of the study. Therefore, the things represented by these two particular network variables, i.e., the ability to rely emotionally on others, feeling socially connected, and to have access to the required emotional support indeed predicted QOL better. Unexpectedly, the contact frequency also predicted QOL, although in a negative manner, which could be understood by the fact that contact frequency often correlates with a worsening health condition. That is, there is more frequent contact from the members of the social network because greater support is required as a result of increasing health requirements [4]. This may negatively affect, in turn, one's QOL.

Furthermore, it was observed that the positive effect of emotional closeness was significant only when levels of depression were low and not when they were high. This finding supported the notion that the negatively biased cognitions and motivation characteristics of depressed individuals could moderate the degree to which they interpreted and reacted to the health-related and social aspects of their lives [32, 42], and extended it into the realm of social networks. In this case, the highly depressed respondents apparently did not benefit from the emotional closeness to others, and did not interpret it as a part of the quality of their lives.

In regard to functional health, which was measured in terms of limitations with activities, the findings were less straightforward. Contrary to the expectations, neither the structural nor the interactional network characteristics could predict limitations with activities, both in simple correlation analysis and multivariate regression analysis. One possible explanation for this lack of association could be that the limitations with activities indicator represented 'too organic' an outcome, one that is relatively closer in association to the physical predictors such as fractures/injuries, and diseases such as diabetes, osteoporosis, etc. [43], compared to the social elements. This interpretation is, however, less probable, given the moderating effects of depression observed in this case. These effects provided support for the predicted differential effects of the social network characteristics as well as an explanation of the null effects that were

observed. Specifically, depression was observed to moderate the associations between limitations with activities and all the social network characteristics, with the only exception of the emotional closeness variable.

Consistent with the rationale of depression being able to prevent the use of the adaptive qualities of the social network characteristics, satisfaction with the social network was observed to be associated with a lower risk of limitations, although only among the individuals with low levels of depression, who might benefit more from it. Although it was hypothesized that the strength of satisfaction in predicting limitations with activities would be relatively low given its emotional character, the same variable might have been understood by the respondents in terms of its instrumental nature as well (e.g., satisfaction with the assistance provided by the members of the social network, etc.). Nevertheless, in this case, as well, the highly depressed individuals were not observed to use these advantages in their perceptions of the limitations.

In summary, while emotional closeness could predict only QOL and not the limitations with activities, which was expected, the satisfaction with the social network variable predicted both QOL and limitations with activities. This might have happened because satisfaction with the social network may involve both emotional and instrumental aspects. However, the highly depressed respondents in the study sample appeared to encounter difficulty in translating the benefits of emotional closeness into their QOL perceptions. These respondents also encountered difficulty, apparently, in transferring the benefits of being satisfied with the social network into their perceptions of the limitations.

The fact that the depressive symptoms were able to moderate only the association between satisfaction and activity limitation and not the association between satisfaction and QOL may be explained on the basis of the nature of the association. Specifically, it is possible that the highly depressed individuals find it difficult to translate the benefits of social network characteristics, in this case, satisfaction with the network, into health outcomes, especially when these associations are not straightforward. According to this speculation, even if the depressed individuals perceive satisfaction in an instrumental way (e.g., satisfaction with the assistance provided by the members of the social network, etc.), as suggested above, its relation to the physical outcomes is less obvious than to the subjective perceptions regarding life. This interpretation, however, warrants further investigation.

It was also observed that lower contact frequency was associated with a lower risk of experiencing limitations, although only among the individuals with low levels of depression. This implies that the abovementioned interpretation, that contact frequency may be correlated with a health condition, is true only for the less depressed individuals when assessing a functional health outcome, and not for the highly depressed ones. Among the latter, there was no association between the health condition and the perceived frequency of contact with the social connections, as was indicated by the null correlation between these variables as well.

Finally, being geographically distant from others was observed to be associated with a lower risk of functional limitations, although only among the highly depressed respondents. One possible explanation for this finding is that, as in the case of contact frequency, the geographical distance may also indicate a health condition. That is, people with activity limitations usually live close to those who would serve as a source of functional help and support. Moreover, this might hold true mainly among the depressed individuals, who are characterized by low self-efficacy, low coping

efficacy, and hopelessness, as a result of their negative self-schemas [44, 45]. All this may possibly lead to increased dependency on others.

## **5. Implications**

The findings of the present study highlighted the importance of considering both nature of the social network characteristics and degree of depressive symptoms, while predicting the various health outcomes among older adults. Specifically, it was indicated that in order to achieve better QOL, it was important to encourage individuals with low levels of depression to maintain emotionally close relations with their significant social connections. Among the highly depressed individuals, on the other hand, an attempt to enhance emotional closeness in relations would exert less effect, as these individuals might be lacking the tools to incorporate them into their perceptions of QOL. Therefore, in this case, it would be important to initially work on strengthening the connections among them.

Furthermore, since satisfaction with social network may include both emotional and instrumental aspects, the findings of the present study indicated that it is important to trace the socially-related motivations that are embedded in the high and low depressed individuals' perceptions of satisfaction with their social network, as that might increase the QOL for both these groups. It might also decrease the probability of experiencing limitations with activities for low depressed individuals. In this case as well, efforts should be put to work with the highly depressed individuals for identifying the approaches using which satisfying social networks could assist in the more physical outcomes such as limitations with activities (e.g. by using the assistance provided by the network to move around, participate in the outside activities, etc.).

It has been suggested that older adults are inclined to be optimistic, and are generally satisfied with their social networks [46], as has been indicated by the relevant network measures presented in this study. It has also been observed that older adults tend to decrease their peripheral relations, and stay close to the well-known and emotionally close ones [47]. Nonetheless, there is sufficient variance among individuals regarding these aspects, and according to the present study, they should be addressed according to the different levels of depression. Therefore, strengthening of the existing social connections among the low depressed people (e.g., maintaining emotionally close relations) and furthering the required associations between the social network characteristics and the health outcomes among the highly depressed people is recommended.

The present study has certain limitations which should be noted. Although control was applied to prevent potential alternative explanations and a longitudinal design was used for the present study, the direction of a few of the associations determined in the study remains inconclusive. For instance, as indicated earlier, both contact frequency and geographical distance may function as the indicators of health conditions rather than as predictors. In addition, again mentioned earlier, the measure of satisfaction was defined broadly in the present study. Even though a moderate positive association was observed between satisfaction and emotional closeness, the possibility that this association arose from the instrumental aspects of the satisfaction variable could not be ruled out. Therefore, further studies are warranted in future, which differentiate satisfaction with the network in terms of its instrumental aspects from the satisfaction with the network in terms of its emotional aspects, in order to better ascertain their differential effect on the health outcomes.

In addition, due to the complex design of the present study, country-level differences could not be considered. It is possible that the observed associations may vary across different cultural contexts. Future investigation in this direction is, therefore, warranted.

Despite its limitations, the present study makes an important contribution to the literature in this domain. The present study is a pioneer in longitudinally examining the effects of different social network characteristics on two different health outcomes, considering the moderating effects of depression as well. It also draws upon a distinctive database that uniquely allows this type of investigation.

### **Author Contributions**

Shira Peleg conceived the study, executed the statistical analyses and wrote the first draft. Howard Litwin supervised the work, gave critical comments along the way and re-wrote the Introduction.

### **Funding**

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

### **Competing Interests**

The authors have declared that no competing interests exist.

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