TITLE: Structural and functional aspects of social support as predictors of mental and physical health trajectories: Whitehall II cohort study

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Background: Social support is associated with better health. However, only limited number of studies has examined the association of social support with health from the adult life course perspective and whether this association is bidirectional.

Methods: Participants (n=6797; 30% women; age range from 40 to 77 years) who were followed from 1989 (phase 2) to 2006 (phase 8) were selected from the ongoing Whitehall II Study. Structural and functional social support was measured at follow-up phases 2, 5, and 7. Mental and physical health was measured at five consecutive follow-up phases (3 to 8).

Results: Social support predicted better mental health, and certain functional aspects of social support, such as higher practical support and higher levels of negative aspects in social relationships, predicted poorer physical health. The association between negative aspects of close relationships and physical health was found to strengthen over the adult life course. In women, the association between marital status and mental health weakened until to the age of approximately 60 years. Better mental and physical health was associated with higher future social support.

Conclusion: The strength of the association between social support and health may vary over the adult life course. The association with health seems to be bidirectional.

Keywords: Social support; mental health; physical health; life course; longitudinal

INTODUCTION

Higher levels of social support have been associated with better health [1–4]. Prospective longitudinal studies have demonstrated that both structural aspects (e.g., large social network size and cohesion) and functional aspects (e.g., high perceived emotional support) of social support are associated with better self-reported health [5,6], and lower levels of depression [7], coronary heart disease [8], and mortality [9–11]. Thus, there is clear evidence supporting an overall positive influence of social support on health.

There have, however, been relatively few studies that have examined the association of social support with mental and physical health by considering the adult life course. To date, most studies have relied on the analysis of two measurement points and have not taken into account of possible changes in the association between social support and health with age. The size of social networks and the amount of received social support tend to vary over life course [12], although it remains unclear whether the association between social support and health strengthens, remains stable, or decreases through the life course [13]. This issue is of importance in the context of aging as changes in social network are common in later life. There is, for example, some evidence to suggest that growth of social network is associated with better self-reported health in older adults [14], but few systematic investigations on this issue are currently available.

It is also possible that the association between social support and health is bidirectional; that is, as well as social support may affect health, health may have an impact on access to social support (e.g. restrictions on mobility) or it may affect possibilities to benefit from social support (e.g. cognitive decline). Bidirectional associations could lead to vicious cycle where poor health contributes to the loss of social support over time. Lastly, few studies have examined whether structural and functional aspects of social support are associated with health equally strongly and whether structural support shapes the effect of functional support. A better

understanding of directionality and major aspects of social support in terms of health would contribute to designing of health promoting interventions.

In the current study we examined associations between structural and functional aspects of social support and future mental and physical health from an adult life course perspective using data from the Whitehall II Study [15,16]. To examine possible bidirectional effects we determined whether self-rated mental and physical health was associated with future structural and functional aspects of social support. As previous studies have shown that social support is at least partially socioeconomically patterned [9], we controlled for the effect of socioeconomic status.

METHODS

Study sample

Participants were from the ongoing Whitehall II Study [15,16], which originally included 10,308 London-based civil servants from 20 civil service departments who were 35–55 years of age at study baseline (Phase 1: 1985-1988). Data from baseline and seven follow-up phases (phases 2–8, collected in 1989–1990, 1991–1993, 1995–1996, 1997–1999, 2001, 2003–2004 and 2006, respectively) were used in the current study. All participants who provided data at the baseline and at the first follow-up phase 2 (n=7578), and at any subsequent follow-up phases 3 to 8 (n=6797; 4788 men, 2009 women) were included. From phases 3, 4, 5, 6, 7 and 8, data were available for 6783, 6094, 5614, 5359, 5330, and 5353 participants respectively. Ethical approval for the Whitehall II study was obtained from the University College London Medical School Committee on the ethics of human research. Informed consent was obtained from the study participants.

Measures

Structural measures of social support

Self-reported social network, which was available from phases 2, 5 and 7, and marital status were used as structural measures of social support. Social network score was obtained from questions 1) on the monthly frequency of contacts with relatives, friends, and colleagues and the frequency of participation in social or religious activities and 2) on the total number of relatives or friends seen once a month or more. The scaled responses were then summed together. Marital status was dichotomized as 1=married/cohabiting; 0=never married, separated, divorced, or widowed.

Functional measures of social support

The following three functional measures of social support were assessed at phases 2, 5 and 7 using the Close Persons Questionnaire [17]: confiding support, practical support, and negative aspects of close relationships. Confiding support (7 items) measures included wanting to confide, confiding, sharing interests, boosting self-esteem, and reciprocity. Practical support (4 items) included measures of practical help received, whereas negative aspects of close relationships (4 items) measured adverse exchanges and conflicts in relationships. Items were rated on a 4-point Likert scale, with higher scores indicating greater negative or positive support.

Self-reported mental and physical health

Mental health and physical health were assessed using the self-administered Short Form Medical Outcomes Survey (SF-36) questionnaires [18,19]. Two subscales, mental health and physical functioning, which represent the main SF-36 subscales for mental and physical health were used [18]. The mental health subscale includes 5 items assessing aspects of mental well-being (e.g., feeling happy, feeling nervous), and the physical health subscale includes 10 items assessing the ability to carry out daily activities (e.g., difficulties in carrying groceries, difficulties in walking long distances). Cubic transformation was used to transform the negatively skewed mental and physical health scales, and both scales were then transformed into t-scores (the overall mean score

across participants and follow-up phases was 50 (SD =10) and higher scores indicated better

health).

Covariates

Age, ethnicity (0=white; 1=non-white), and socioeconomic status measured as employment grade

(1=low; 2=intermediate; 3=high) were reported at the study baseline and were used as covariates in

all analyses. Employment grade was based on the participants self-reported civil service grade title

[16,20], which was then grouped into three grade categories using the civil service employment

grade classification. Employment grade has been shown to be a broad marker of socioeconomic

status as it has been associated with salary, educational level, and the level of responsibility at work

[16,21].

Statistical analysis

All analyses were conducted separately for men and women. The association between social

support with mental health and physical health trajectories was examined using longitudinal

multilevel regression analyses with random intercept [22,23]. Repeated measurements were

arranged into a multilevel format in which measurements were nested within participants, i.e., the

same participants contributed more than one observation in the dataset. Previous studies using the

Whitehall II study data have shown that both mental and physical health have a non-linear

relationship with age [24,25]. Thus, a restricted cubic spline function with five knots was used to

model the relationship between mental and physical health with age. To examine whether the

association between social support and health strengthened or weakened with age, an interaction

term between social support and the first spline age variable was introduced.

Three separate analyses were used to examine the association between measures of

social support with mental and physical health. First, measures of social support from phase 2 were

used to predict mental and physical health in phases 3 to 8. Second, to further examine the longitudinal associations, social support as a time-dependent exposure from phases 2, 5, and 7 was used to predict mental and physical health in phases 3, 6, and 8. This enabled the examination of variation with time in the association of social support with health. Last, to examine potential bidirectional effects, mental and physical health as time-dependent exposures from phases 4 and 6 were used to predict social support at phases 5 and 7. We repeated the longitudinal regression analyses between measures social of support with mental and physical health using within-individual analysis to minimize potential confounding arising from unmeasured stable confounders. In addition to covariates, i.e., age, ethnicity, and employment grade, all analyses were adjusted for the effect of measurement period, i.e., study phase. All statistical analyses were performed using Stata 13.1 (StataCorp LP, College Station, TX).

RESULTS

Descriptive of the study sample are shown in **Table 1**. When compared to the original sample, participants included in the study sample were more likely to be white ($p < 0.001$), women ($p < 0.001$), slightly younger (mean age in years: 57.0 vs. 56.8, $p = 0.006$) and from a higher employment position ($p < 0.001$). In addition, individuals who responded at phase 5 had higher social network score ($p < 0.001$), were more likely to be married or cohabiting ($p < 0.001$), and had higher levels of emotional support ($p = 0.02$) and practical support ($p < 0.001$) than those who dropped out from the study. Expect for emotional support, similar patterns were also observed between those who responded at phase 7 versus those who dropped out from the study.

Associations between measures of social support at phase 2 with mental and physical health trajectories are shown in **Table 2**. Higher social network score, being married or cohabiting, and higher levels of emotional support were associated with better mental health in both sexes. Higher levels of negative aspects in close relationships were in turn associated with poorer mental

health. In addition, higher levels of practical support was associated with a better mental health in men. Higher levels of negative aspects in close relationships was associated with poorer physical health in both sexes, whereas higher levels of emotional support was associated with better physical health among men and higher levels of practical support was associated with poorer physical health among women.

To examine whether the association between social support and health strengthens, remains stable, or decreases through the life course, we ran interaction analyses (for results see: **Supplemental Tables 1 and 2**). In men, interaction between age and practical support suggested that the association between practical support and mental health weakened with age, whereas the association between practical support and physical health strengthened with age. In women, the association between emotional support and mental health was found to weaken with age. No other interaction effects between social support with mental and physical health were found.

Prospective longitudinal associations between repeated measures of social support and mental and physical health are shown in **Table 3**. Higher social network score, higher levels of emotional and practical support, and lower levels of negative aspects in close relationships predicted better mental health in both sexes. Being married or cohabiting predicted better mental health only among men. Lower practical support and lower levels of negative aspects in close relationships were associated with better physical health in both sexes. However, only the associations between emotional support, practical support, and negative aspects in close relationships with mental health in men and the association between practical support and physical health remained statistically significant in within-individual analyses.

Interactions between age and social support predicting mental and physical health are shown in **Supplemental Tables 3** and **4**. In women, the significant interaction between age and marital status predicting mental health indicated that the association between marital status and mental health weakened over the adult life course. There was also some indication that mental

health in married women begun to decline after the age of 60 years, while no such effect was found for single women. Interactions were also observed in both sexes in the association between negative aspects of close relationships and physical health; these associations strengthened over the adult life course. Interactions are illustrated in **Figure 1**.

Interaction analyses between structural and functional support in predicting mental and physical health are shown in **Supplement Tables 5-8**. Out of the 24 interactions analyses, there was some evidence that high social network size buffered the effect of emotional support and negative aspects of close relationships on mental health for men. No other consistent interaction effects were found.

Result of the possible bidirectional effects, i.e., associations of mental and physical health with future structural and functional aspects of social support, are shown in **Table 4**. Better mental health predicted higher social network score, higher levels of emotional and practical support, and lower levels of negative aspects in close relationships in both sexes. Better physical health, in turn, predicted lower practical support and lower levels of negative aspects in social relationships in both sexes. In addition, better physical health predicted higher emotional support in men. However, only the associations between marital status and physical health remained significant in the within-individual analysis.

DISCUSSION

Current study results demonstrate that there is a bidirectional association between social support and health, and that the strength of this association can vary over the adult life course. These findings, which are based on British occupational cohort, highlight the importance of examining the role of social support over the adult life course life course.

Current results are in line with previous studies showing that social support is important for mental and physical health. The role of social support in mental health has been

highlighted [26], and whereas functional support was only associated with physical health, both aspects of social support clearly contributed to mental health over the adult life course. Whereas positive effects of marriage have been demonstrated in numerous studies [27,28], here, being married or cohabiting was associated only with mental, but not with physical, health. Although being married or cohabiting was somewhat stronger predictor in men than in women, these results were, however, partly explained by the finding that the effect of marriage or cohabiting varied across life course in women, but not in men. In addition, we found evidence that for men some effects of functional support were buffered by structural support, indicating that structural support could shape the effect of functional support on mental health.

Our finding that higher levels of practical support was associated with poorer physical health, is likely explained by the fact that people need more practical support when they become sick (e.g., assistance in transportation to health care). Practical support can also have a preventive effect on physical disease, as help with every-day functions may promote healthier lifestyles protective of physical disease. Negative aspects of social relationships were more strongly associated with both physical and mental health than positive social support. These results are in accordance with some previous studies showing that negative, but not positive, aspects of social support are associated with health [29–31]. Negative aspects of social relationships could be especially harmful as they can be a source of stress, and thus lead to chronic strain [32].

A novel finding of the current study is that the strength of social support in health can differ across the adult life course. Whereas the association between marital status and mental health in women was found to weaken with age, the role of negative aspects of close relationships in physical health strengthened gradually over the adult life course. The role of social support over the whole life course has also been emphasized previously [13], although most of these studies have focused on specific stages of the life course. For example, higher social support has been shown to predict better mental health in adolescence [33], in middle age [5], and in older adulthood [34].

However, social support might be of more importance among those who are more vulnerable to loss of health, such as older adults. There is also some evidence that low social support predicts faster cognitive decline [35], and as cognitive functioning is strongly linked to ability to maintain independence this might explain the amplifying effect of functional support at older ages.

We obtained evidence of bidirectional association between social support and mental health; both functional and structural aspects of social support were associated with future mental health and vice versa. Similar bidirectional association was observed also between measures of social support and physical health, although the founded effect sizes were considerable smaller. It has been previously noted that there is a lack of studies that have examined potential bidirectional effects between social support and health [36]. However, it is likely that the association from health to social support is considerably weaker than the association from social support to health. This is also supported by numerous studies showing the predictive strength of social support on health [4,26]. However, our findings are of importance as they demonstrate that reverse causality, for example health may have an impact on availability of social support, should be taken into account in the studies of social support and health.

Only the associations between functional support and mental health, practical support and health, and marital status with mental health were not confounded by unmeasured variables. This indicates that the discovered associations reflect mostly associations between individuals. It is possible, for example, that individuals with high social support may have better mental health across measurement times, but mental health of each person might not change as the person's social support changes from one measurement time to another.

A number of mechanisms, not directly measured here, are likely to explain the observed associations [36]. A number of psychosocial mechanisms such as social comparison (i.e., individuals are likely to compare their attitudes, beliefs, and behaviors to those around them, and typically adjusting their own norms to others) are likely to explain why functional aspects of social

support lead to better health [37]. Social support has also been shown to buffer against stressful life-events [38], indicating that some beneficial effects of social support are likely resulted from better coping with difficult situations. With regard to biological mechanisms, neuroendocrine changes triggered by poor social support have been supported in studies using humans as well as animals [39], and social support has been also associated with changes in the immune systems [40].

This study has some notable strengths. Longitudinal data from over 20 years with repeated measures made it possible to examine mental and physical health trajectories. We were able to examine both structural and functional aspects of social support and potential bidirectional effects. When interpreting current findings, some limitations need to be taken into account. All measurements were based on self-reported data, which can create bias due to common method variance [41]. For example, it is possible individuals with poor mental health assess their level of social support differently from individuals with better mental health. Another potential limitation is that the measures of social support were only available from three phases, which could increase statistical error. As current study participants are mainly London-based white-collar civil servants, results may not be representative of general British population. In addition, most women in the Whitehall II Study were from the lower occupational grades, thus the results for women might not be generalizable to the general population of working women. Also, in a previous study using Whitehall II study data higher probability of attrition has been associated with poorer mental health and poorer physical health [25]. In our analyses, individuals who continued at the study had more structural and functional support than those who dropped out from the study. This can – if anything – both inflate or attenuate observed associations.

To conclude, this study demonstrates that there is a bidirectional association between social support with mental and physical health, and that the association between social support and health may change over the adult life course. Future studies should address the mechanisms explaining the varying association of social support with health over the life course.

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Table 1. Descriptive statistics of the study sample, phase 2-3

	Men (n=4788)		Women (n=2009)	
	N (%)	Mean (SD)	N (%)	Mean (SD)
Age		49.89 (6.03)		50.66 (6.1)
Employment grade				
Clerical/office support (low)	1961 (41%)		270 (13%)	
Professionals (intermediate)	2517 (53%)		898 (45%)	
Administrators (high)	310 (6%)		841 (42%)	
Ethnicity				
White	4487 (94%)		1796 (89%)	
Non-white	301 (6%)		213 (11%)	
Marital status				
Not married/cohabiting	771 (16%)		726 (36%)	
Married/cohabiting	4017 (84%)		1283 (64%)	
Social network score		10 (4.11)		9.66 (3.86)
Emotional support		14.66 (4.39)		15.08 (4.17)
Practical support		5.55 (2.69)		4.78 (2.8)
Negative aspects of close relationships		2.84 (2.29)		2.8 (2.4)
Mental health		51.55 (8.26)		50.37 (9.28)
Physical health		53.04 (6.07)		49.86 (8.78)

Table 2. Structural and functional aspects of social support at baseline (study phase 2) predicting mean levels of mental and physical health from study phase 3 to phase 8

	Mental health		Physical health	
Men	b	95 % CI	b	95 % CI
Social network	0.23	0.19 to 0.28	-0.02	-0.05 to 0.02
Marital status	2.16	1.63 to 2.70	-0.06	-0.51 to 0.38
Emotional support	0.18	0.14 to 0.23	0.03	0.00 to 0.07
Practical support	0.19	0.11 to 0.26	-0.04	-0.10 to 0.02
Negative aspects of close relationships	-0.83	-0.91 to -0.75	-0.17	-0.24 to -0.10
Women				
Social network	0.21	0.13 to 0.30	-0.04	-0.13 to 0.05
Marital status	1.05	0.37 to 1.73	0.63	-0.10 to 1.36
Emotional support	0.21	0.13 to 0.29	-0.06	-0.14 to 0.02
Practical support	0.11	-0.01 to 0.23	-0.30	-0.42 to -0.17
Negative aspects of close relationships	-0.91	-1.04 to -0.78	-0.33	-0.47 to -0.18

Note. Values are regression coefficients. Adjusted for age. period, ethnicity, and employment grade.

Table 3. Longitudinal associations between structural and functional aspects of social support and mental health and physical health

	Mental health				Physical health			
	Total effects		Within-individual effects		Total effects		Within-individual effects	
Men	b	95 % CI	b	95 % CI	b	95 % CI	b	95 % CI
Social network	0.18	0.14 to 0.23	0.05	-0.01 to 0.10	0.00	-0.04 to 0.05	0.03	-0.03 to 0.09
Marital status	1.71	1.23 to 2.19	-0.06	-0.89 to 0.77	0.31	-0.17 to 0.79	0.60	-0.26 to 1.47
Emotional support	0.20	0.16 to 0.24	0.10	0.05 to 0.15	0.02	-0.01 to 0.06	0.00	-0.05 to 0.05
Practical support	0.19	0.13 to 0.25	0.10	0.03 to 0.18	-0.14	-0.20 to -0.08	-0.12	-0.20 to -0.04
Negative aspects of close relationships	-0.66	-0.73 to -0.59	-0.21	-0.30 to -0.11	-0.10	-0.18 to -0.03	0.04	-0.06 to 0.13
Women								
Social network	0.17	0.08 to 0.25	-0.03	-0.14 to 0.08	0.06	-0.03 to 0.15	0.09	-0.03 to 0.20
Marital status	0.48	-0.16 to 1.12	-1.28	-2.50 to -0.05	0.05	-0.67 to 0.78	-0.72	-1.95 to 0.52
Emotional support	0.19	0.12 to 0.25	0.05	-0.05 to 0.14	-0.04	-0.12 to 0.03	0.02	-0.08 to 0.12
Practical support	0.15	0.05 to 0.25	0.03	-0.10 to 0.17	-0.37	-0.48 to -0.25	-0.19	-0.33 to -0.05
Negative aspects of close relationships	-0.69	-0.82 to -0.57	-0.15	-0.31 to 0.01	-0.21	-0.35 to -0.08	-0.04	-0.21 to 0.14

Note. Values are regression coefficients. Adjusted for age, period, ethnicity, and employment grade.

Table 4. Mental and physical health predicting structural and functional aspects of social support

	Social network		Marital status		Emotional support		Practical support		Negative aspects of close relationships	
Men	b	95 % CI	b	95 % CI	b	95 % CI	b	95 % CI	b	95 % CI
Mental health, total effects	0.027	0.021 to 0.034	0.003	0.002 to 0.004	0.033	0.024 to 0.042	0.014	0.009 to 0.019	-0.038	-0.043 to -0.034
Mental health, within-individual effects	0.008	-0.001 to 0.018	0.002	0.001 to 0.003	-0.003	-0.016 to 0.01	0.002	-0.006 to 0.01	-0.006	-0.012 to 0.001
Physical health, total effects	0.002	-0.006 to 0.010	-0.001	-0.001 to 0.000	0.014	0.003 to 0.025	-0.012	-0.018 to -0.005	-0.010	-0.016 to -0.005
Physical health, within-individual effects	0.000	-0.012 to 0.011	-0.001	-0.002 to 0.000	0.009	-0.006 to 0.024	-0.007	-0.016 to 0.003	-0.004	-0.011 to 0.004
Women										
Mental health, total effects	0.027	0.018 to 0.035	0.003	0.002 to 0.005	0.023	0.010 to 0.035	0.009	0.001 to 0.017	-0.035	-0.042 to -0.029
Mental health, within-individual effects	0.010	-0.002 to 0.023	0.003	0.002 to 0.004	0.005	-0.013 to 0.024	0.001	-0.011 to 0.013	0.000	-0.010 to 0.010
Physical health, total effects	-0.002	-0.011 to 0.008	-0.001	-0.003 to 0.000	-0.002	-0.015 to 0.012	-0.020	-0.029 to -0.011	-0.020	-0.027 to -0.013
Physical health, within-individual effects	-0.001	-0.016 to 0.014	-0.003	-0.004 to -0.001	0.007	-0.014 to 0.029	-0.007	-0.021 to 0.008	0.000	-0.012 to 0.012

Note. Values are regression coefficients. Adjusted for age, period, ethnicity, and employment grade.

Figure 1. In the left side panel (a) are predicted mental health trajectories by marital status (single *vs* married/co-habiting) for women and in the right side panel (b) are predicted physical health functioning trajectories by negative aspects of close relationships (low =-1 S.D. below the mean *vs* high = 1 S.D. above the mean). Values are means. Gray shaded areas represent 95% confidence intervals.

What is already known on this subject?

The positive effects of social support are well known and higher social support has been associated with better mental and physical health. However, only few studies have examined the association of social support with health from the adult life course perspective.

What this study adds?

Current results show that there is a bidirectional association between social support and health. In addition, the association between social support and health was shown to vary over the life course. These findings highlight the importance of social support in public health over the adult life course.