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Structural and functional measures of social relationships and quality of life among older adults: does chronic disease status matter?

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Abstract
Purpose To evaluate the relative importance of structural and functional social relationships for quality of life (QoL) and the extent to which diagnosed chronic disease modifies these associations.
Methods Multivariate linear regression was used to investigate time-lagged associations between structural and functional measures of social relationships and QoL assessed 5 years apart by CASP-19, in 5925 Whitehall II participants (mean age 61, SD 6.0). Chronic disease was clinically verified coronary heart disease, stroke, diabetes or cancer.
Results Social relationships–QoL associations were consistent across disease status (*P*-values for interaction: 0.15–0.99). Larger friend network (β = 1.9, 95 % CI 1.5–2.3), having a partner (β = 1.2, 95 % CI 0.5–1.7), higher confiding support (β = 2.2, 95 % CI 1.8–2.7) and lower negative aspects of close relationships (β = 3.3, 95 % CI 2.8–3.8) were independently related to improved QoL in old age. The estimated difference in QoL due to social relationships was equivalent to up to 0.5 SD of the CASP-19 score and was stronger than the effect of chronic disease (coronary heart disease β = 2.0, 95 % CI 1.4–2.6).
Conclusions We found that beneficial aspects of social relationships in relation to QoL were, in order of importance: avoiding negative aspects of close relationships, having confiding support, having a wide network of friends and having a partner. These associations were not modified by chronic disease. Thus, despite inevitable physical deterioration, we may be able to enhance a satisfying late life by optimizing our social relationships.

Keywords Quality of life · Social relationships · Chronic disease · Ageing

Introduction

Along with investigations about prolonging life expectancy and compressing morbidity [1], research interest has grown in measuring and enhancing quality of life (QoL) in old age. Being distinct from ill health, CASP offers a direct measure of QoL [2–4]. Based on the theory of needs satisfaction [5, 6], CASP captures the fulfilment of four higher-ranked needs: control (i.e. the ability to change one's life and environment), autonomy (i.e. self-determination and an absence of unwanted interference from others), pleasure (i.e. hedonic and enjoyable aspects of well-being) and self-realization (i.e. life satisfaction and fulfilment of self) [4]. This measure and modified versions [7, 8] have been widely adopted in many national ageing cohorts [7, 9–11].

Social relationships, denoted by either structural or functional aspects [12, 13], have been identified as key determinates of QoL using CASP measures [2, 14, 15]. Structural social relationships refer to how embedded an individual is within a network, where a large network [16], especially a greater number of close ties [2, 14, 16–18], and frequent social contacts [15, 16] particularly with friends [18] are positively associated with QoL. On the other hand, functional social relationships assess types of support transacted and evaluate supportive role fulfilment [19, 20]; as such, high confiding support from close relationships may raise QoL substantially [2, 14, 17, 21]. Yet, it has been

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highlighted that received support could also challenge QoL [22, 23]; for example, practical support receiving may invade autonomy of older adults with multi-morbidity [24]. Although the importance of quality of social relationships for QoL has been reported [2, 15, 18], few studies have directly evaluated the adverse effect elicited due to negative social exchanges [25, 26].

There are several limitations in the current evidence. First, cross-sectional findings render unclear temporality. Second, lack of detail in assessments of structural and functional social relationships obscures the specific association between different aspects of social relationships and QoL. Given the distinct well-being effects of friend network and relative network [18], an overall quantitative assessment of social network may weaken the effect of structural social relationships on QoL [27]. Further, it is unclear how different functional aspects of social relationships, namely confiding support, practical support and negative aspects of social relationships, work together to influence QoL. Investigating the extent to which specific aspects of social relationships make independent contributions to QoL would facilitate well-targeted intervention.

Third, the role of diagnosed chronic disease in the social relationships–QoL association is unknown. The need and perception of social relationships may be contingent upon disease status [28–31], which also influences QoL adversely [16, 32, 33]. Under the stress-buffering model [34, 35], supportive social relationships could modify stressful experience by reducing the likelihood of life event occurrence, intervening stress appraisal and alleviating the impact of stress response [20]. Thus, older adults with abundant psychosocial resources may better buffer the negative effects of physiological declines as they age [36]. Little QoL literature [37–39] hitherto has considered objective health measures. Instead, most controlled for self-reported health status, which may produce spurious associations biased by residual confounders [37]. It is worthwhile to assess whether the effect of social relationships on QoL differs in the presence and absence of clinically verified chronic disease.

In the present study, we used data from the Whitehall II prospective cohort to examine the time-lagged associations between structural and functional aspects of social relationships and QoL measured by CASP-19, taking into account diagnosed chronic disease status. We used the assessments of social relationships and CASP 5 years apart to provide a clear temporal order and minimize reporting bias. We differentiated between friend network and relative network, and assessed several functions of close relationships that provide the most reliable [28] and emotionally rewarding support [2, 16] not least as people age [40]. Our study addresses two research questions: (1) what are the beneficial aspects of social relationships in relation to QoL and (2) does chronic disease status modify these social relationships–QoL associations?

Methods

Study population

The Whitehall II cohort recruited 10,308 participants (66 % male, aged 35–55) from 20 London-based civil service departments in 1985–1988. At study baseline, all participants underwent clinical health check-ups and completed self-administrated questionnaires. Subsequent data collection alternated between postal questionnaires alone and postal questionnaires accompanied by clinic check-ups [41]. Current analysis used data from phase 7 (2002–2004) and phase 9 (2007–2009). CASP-19 measures were administrated at phase 9 when participants aged 55–79 years. The proportions in each 5-year age group were 55–59: 18 %, 60–64: 31 %, 65–69: 22 %, 70–74: 20 % and 75+: 9 %.

QoL at phase 9

QoL was measured by a self-completion questionnaire, CASP-19, an index based on 19 Likert-scaled items spanning four theoretically derived dimensions of QoL: control, autonomy, self-realization and pleasure [3]. Answers are often, sometimes, not often and never, which was numerically coded so that the most positive response was scored as 3 and the most negative response as 0. We reversely coded 13 positively worded items so that all item responses were in the same direction. CASP-19 score was the arithmetic sum of the scores for all of 19 items (range 0–57). To exclude the potential overlapping item with social relationships (i.e. Item 13: 'I enjoy being in the company of others'), we additionally used a summary score of CASP-12, a validated shortened version of CASP-19 [7].

Social relationships at phase 7

Structural social relationships were measured by marital status, friend network and relative network [42]. Marital status was coded as married/cohabiting, single, divorced and widowed. The friend network (two items, Cronbach's $\alpha = 0.65$) and the relative network (two items, Cronbach's $\alpha = 0.67$) were derived from questions on (1) *frequency of contacts* with friends or relatives and (2) *total number* of friends or relatives seen once a month or more. The five-point Likert-scaled response was summed and divided into three groups based on tertile cut-points.

Functional social relationships were measured by the close persons questionnaire [43]. Factor analysis identified

three subscales [43]: confiding support, practical support and negative aspects of close relationships. Confiding support (seven items, Cronbach's $\alpha = 0.86$) included wanting to confide, sharing interests, boosting self-esteem and reciprocity. Practical support (three items, Cronbach's $\alpha = 0.80$) reflected tangible help received. Negative aspects of close relationships (four items, Cronbach's $\alpha = 0.65$) captured adverse interactions (giving worries, problems and stress) and lack of adequate support (need for more help). Each item was rated on a four-point Likert scale, with higher scores indicating higher support or greater negative aspects. The sum for each support subscale was grouped into tertiles.

Covariates

Several covariates were considered as indicated by the literature [14, 15].

Sociodemographic variables at phase 7 were age, gender and ethnicity (white vs. non-white), the British civil services grades of employment [i.e. clerical or support grades (low), professional or executive grades (medium) and administrative grades (high)] and retirement status. A single item of optimism was used as a proxy measure of personality ('when you have difficulties in important aspects of your life, do you feel you will succeed in overcoming them?').

Health measures included depressive symptoms and chronic disease status. Depressive symptoms were defined as General Health Questionnaire score $\geq$4 or use of antidepressant medicine [44]. Chronic disease was diagnosed coronary heart disease, stroke, diabetes or cancer. Coronary heart disease prevalence was ascertained according to clinically verified events, including myocardial infarction and definite angina [45]. Stroke cases were confirmed from participants' general practitioners, information extracted from hospital medical records or data from the National Health Hospital Episode Statistics databases [46]. Diabetes was assessed based on the WHO diagnostic criteria: having fasting glucose $\geq$7.0 (126 mg/dl) or 2-hour plasma glucose $\geq$11.1 mmol/l (200 mg/dl), reported physician-diagnosed diabetes or use of diabetes medication [47]. Physician-diagnosed cancer was identified via Cancer registry and National Health Service-Wide Clearing Service notifications [41]. We distinguished prevalent chronic disease at phase 7 (defined as long-term chronic disease) from incident chronic disease between phases 7 and 9 (defined as newly developed chronic disease).

Statistical analysis

Characteristics of participants across different chronic disease status were assessed by Chi-square test for categorical variables and analysis for variance (ANOVA) for continuous variables. Multiple linear regressions were used to investigate the associations between social relationships and CASP-19. We first examined gender differences in those associations. Non-significant gender interactions led us to combine men and women in all analyses ($P = 0.15$–0.83). Next, we investigated whether chronic disease status modified the association of social relationships and CASP-19, via fitting interaction terms between social relationships and chronic disease status.

The main associations between each measure of social relationships and CASP-19 were examined via subsequently adjusting for demographic variables (age, age-squared, gender and ethnicity), personality (Model 1); employment grade and retirement status (Model 2); and depressive symptoms and disease status (Model 3). To assess the independent contribution of measures of social relationships on CASP, we simultaneously included all measures of social relationships into Model 3. This final analysis was repeated using CASP-12 [7] to verify that results would not be substantially altered upon scale version [48]. The attenuation of social relationships–CASP-19 associations due to extra covariates was calculated via formula: $(\beta_{\text{model with fewer covariates}} - \beta_{\text{model with extra covairates}})/\beta_{\text{model with fewer covariates}} \times 100\,\%$

Considering possible changes in social relationships during 5-year follow-up, we conducted sensitivity analysis among participants whose rating on social relationships maintained in the same categories between occasions (note: measures of friend and relative network were not available at phase 9; few participants' marital status changed between phases 7 and 9, i.e. 96 % participants remained married/cohabiting).

To characterize effect sizes of social relationships–QoL associations, we compared them with the effects of chronic disease status and specific chronic disease on QoL. All estimated effect sizes were obtained from the fully adjusted Model 3. Here, we only included social relationships measures that were independently related to CASP.

Results

Of the 10,308 participants at Whitehall II inception (1985/1988), 584 had died and 2142 had withdrawn by phase 7. Among 7582 remaining participants, 6546 answered CASP questionnaire and 6931 had measure of social relationships. Current analysis was based on 5925 participants who provided data on CASP-19, social relationships, disease status and other covariates; and who were more likely to be white male, have higher employment grade and have lower prevalence of chronic disease than those not included.

Table 1 Baseline characteristics (phase 7: 2002/04) of the study sample by chronic disease status ($n = 5925$)

Characteristics	*n* (%)	No chronic disease $n = 4079$ (69 %)	Long-term chronic disease $n = 1139$ (19 %)	Newly developed chronic disease $n = 707$ (12 %)	*P* value
Age, y, mean (SD)	5925	60.1 (5.7)	63.3 (6.0)	62.1 (5.9)	<0.0001
Male	4248 (71.7)	71.2	70.1	77.2	0.002
Non-white	413 (6.9)	5.3	12.1	8.2	<0.0001
Personality (optimistic)	5679 (95.9)	96.2	95.6	94.3	0.07
Low employment grade	586 (9.9)	8.6	14.3	10.2	<0.0001
Retirement status	2933 (49.5)	44.4	64.3	55.5	<0.0001
Depressive symptoms	1181 (19.9)	19.8	20.9	19.1	0.60
High friend network[a]	1827 (31.1)	29.8	33.9	34.2	0.002
High relative network[a]	1559 (27.2)	25.9	30.5	29.0	0.01
Married/cohabiting	4522 (76.4)	76.3	76.4	77.5	0.01
High confiding support[a]	1869 (32.2)	32.2	32.9	30.6	0.55
High practical support[a]	1904 (32.8)	31.8	34.9	35.2	0.15
Low negative aspects of social relationships[a]	2601 (44.8)	45.4	43.6	43.3	0.35

Long-term chronic diseases were defined as those that had been diagnosed of any chronic diseases at study baseline (phase 7), and those that developed any chronic diseases between phase 7 to phase 9 were grouped as newly developed chronic disease. Chronic disease was diagnosed coronary heart disease, stroke, diabetes or cancer

Numbers are percentage unless specified

[a] All measures of social relationships were summed and grouped into tertiles (low, medium and high). Cut-off points for low versus medium and medium versus high were friend network: 4.0, 5.0; relative network: 2.0, 4.0; confiding support: 12.0, 15.2; practical support: 3.0, 5.0; negative aspects of close relationships: 1.3, 4.0

Study sample characteristics by disease status are presented in Table 1. There were 1139 participants who had been diagnosed with chronic disease by phase 7, and 707 developed chronic disease during 5-year follow-up. Participants with long-term chronic disease were older, were from ethnic minority, had low employment grade and were retired. They were also more likely to report frequent contacts with friends and relatives. No significant association was found between chronic disease status and functional social relationships. Further analysis indicated that chronic disease status did not modify the effects of social relationships on CASP (P for interaction = 0.15–0.99, Appendix), leading us to conduct analysis without stratification for chronic disease status.

Table 2 shows associations between CASP-19 and measures of social relationships, entered one at a time. All measures of social relationships showed statistically significant associations with CASP-19. Specifically, compared to reference groups (i.e. low tertile), large friend ($\beta = 2.4$, 95 % CI (confidence interval):1.9, 2.8) and relative network ($\beta = 1.1$, 95 % CI 0.6, 1.6), high confiding support ($\beta = 3.1$, 95 % CI 2.7, 3.6) and practical support ($\beta = 0.8$, 95 % CI 0.4, 1.3) were related higher CASP-19 scores, whereas being single (vs. married/cohabiting) ($\beta = -1.7$, 95 % CI −2.3, −1.1) and high negative aspects of close relationships ($\beta = -4.0$, 95 % CI −4.6, −3.5) were associated with lower CASP-19 scores. Employment grade, retirement status, depressive symptoms and diseases status (Model 3 vs. Model 1) together attenuated social relationships–CASP-19 associations by 11.1–24.5 % whilst significant associations maintained.

Table 3 presents mutually adjusted social relationships–CASP associations. The positive relationships in relation to high friend network or confiding support were attenuated by 22 and 29 %, whereas the pernicious effects associated with negative aspects of close relationships or singlehood were reduced by 18 and 29 %. After taking into account of all measures of social relationships, relative network was not significantly associated with CASP scores, and the positive effect of practical support was replaced by a marginally significant adverse effect ($\beta = -0.7$, $P = 0.01$). Table 3 also demonstrates that social relationships–CASP associations were invariant to measurement scale (i.e. CASP-19 or CASP-12); further precluding, these observed associations were driven by potential overlapping measurement item. Sensitive analysis indicates that significant social relationships–CASP associations were even stronger among those reported similar levels of functional social relationships during follow-up ($n = 3329$). For example, compared with those who always reported low

Table 2 Associations between phase 7 (2002/04) measures of social relationships and phase 9 (2007/09) CASP-19

	CASP -19						
	CASP score[a]	Model 1		Model 2		Model 3	
		β[b]	95 % CI	β[b]	95 % CI	β[b]	95 % CI
Structural social relationships							
Friend network							
Low	41.8	ref.		ref.		ref.	
Medium	43.9	2.0***	[1.5, 2.6]	2.0***	[1.4, 2.5]	1.7***	[1.2, 2.2]
High	44.9	2.9***	[2.4, 3.3]	2.9***	[2.4, 3.3]	2.4***	[1.9, 2.8]
P for trend		<0.0001		<0.0001		<0.0001	
Relative network							
Low	42.5	ref.		ref.		ref.	
Medium	43.2	0.7**	[0.2, 1.2]	0.6**	[0.2, 1.1]	0.5*	[0.1, 1.0]
High	43.9	1.3***	[0.8, 1.9]	1.4***	[0.9, 1.9]	1.1***	[0.6, 1.6]
P for trend		<0.0001		<0.0001		<0.0001	
Marital status							
Married/cohabiting	43.6	ref.		ref.		ref.	
Single	41.1	−2.2***	[−2.8, −1.6]	−1.8***	[−2.5,− 1.2]	−1.7***	[-2.3, −1.1]
Divorced	42.0	−1.2**	[−1.9, −0.4]	−1.0**	[−1.8, −0.3]	−0.7	[−1.4, 0.0]
Widowed	42.9	−0.4	[−1.4 ,0.7]	0.0	[−1.1, 1.0]	0.7	[−0.3, 1.7]
P for trend		<0.0001		<0.0001		<0.0001	
Functional social relationships							
Confiding support							
Low	41.4	ref.		ref.		ref.	
Medium	43.6	2.2***	[1.7, 2.6]	2.1***	[1.6, 2.6]	1.8***	[1.3, 2.2]
High	45.1	3.6***	[3.1, 4.1]	3.5***	[3.1, 4.0]	3.1***	[2.7, 3.6]
P for trend		<0.0001		<0.0001		<0.0001	
Practical support							
Low	42.6	ref.		ref.		ref.	
Medium	43.2	0.4	[−0.1, 0.9]	0.3	[−0.2, 0.8]	0.3	[−0.2, 0.8]
High	43.7	0.9***	[0.4, 1.4]	0.8**	[0.3, 1.3]	0.8***	[0.4, 1.3]
P for trend		0.002		0.005		0.001	
Negative aspects of close relationships							
Low	45.3	ref.		ref.		ref.	
Medium	43.7	−2.5***	[−2.9, −2.0]	−2.6***	[−3.0, −2.1]	−2.0***	[−2.4, −1.6]
High	39.5	−5.3***	[−5.9, −4.8]	−5.4***	[−5.9, −4.9]	−4.0***	[−4.6, −3.5]
P for trend		<0.0001		<0.0001		<0.0001	

Each measure of social relationships was analysed separately

Model 1: age, age-squared, gender, ethnicity and personality

Model 2: Model 1 + employment grade + retirement status

Model 3: Model 2 + depressive symptoms + chronic health status at phase 7

CI confidence interval

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Age-adjusted CASP-19 score (mean 43.2, SD 8.0)

[b] Regression coefficient (β) indicates differences in mean CASP-19 score relative to reference category (ref = 0.0)

negative aspects of social support, participants who perceived high levels at both occasions showed substantially lower CASP-19 scores (β = −6.3, CI −7.0, −5.6) (results not shown).

Figure 1 illustrates the differences in CASP-19 scores due to social relationships, compared with chronic disease, demonstrating comparable effects of social relationships and chronic disease on QoL. For example, the largest effect

Table 3 Associations between phase 7 (2002/04) measures of social relationships (mutually adjusted) and phase 9 (2007/09) CASP-19 and CASP-12

	CASP-19[a]			CASP-12[a]		
	β[b]	Standardized β	*P* value	β[b]	Standardized β	*P* value
Structural social relationships						
Friend network						
Low	ref.	ref.		ref.	ref.	
Medium	1.45	0.07	<0.0001	0.86	0.06	<0.0001
High	1.88	0.11	<0.0001	1.20	0.10	<0.0001
P for trend			<0.0001			<0.0001
Relative network						
Low	ref.	ref.		ref.	ref.	
Medium	0.08	0.01	0.70	0.02	0.00	0.87
High	0.19	0.01	0.44	0.15	0.01	0.37
P for trend			0.74			0.63
Marital status						
Married/cohabiting	ref.	ref.		ref.	ref.	
Single	−1.15	−0.05	<0.001	−0.86	−0.05	<0.001
Divorced	−0.59	−0.02	0.12	−0.65	−0.03	0.01
Widowed	0.44	0.01	0.36	0.02	0.00	0.95
P for trend			0.001			0.0002
Functional social relationships						
Confiding support						
Low	ref.	ref.		ref.	ref.	
Medium	1.55	0.09	<0.0001	0.99	0.08	<0.0001
High	2.24	0.13	<0.0001	1.45	0.12	<0.0001
P for trend			<0.0001			<0.0001
Practical support						
Low	ref.	ref.		ref.	ref.	
Medium	−0.43	−0.03	0.08	−0.28	−0.02	0.09
High	−0.72	−0.04	0.01	−0.43	−0.04	0.02
P for trend			0.02			0.06
Negative aspects of close relationships						
Low	ref.	ref.		ref.	ref.	
Medium	−1.72	−0.10	<0.0001	−1.27	−0.11	<0.0001
High	−3.29	−0.17	<0.0001	−2.29	−0.17	<0.0001
P for trend			<0.0001			<0.0001

All measures of social relationships were entered simultaneously into the model, adjusted for age, age-squared, gender, ethnicity and personality, employment grade, retirement status, depressive symptoms and chronic health status measured at phase 7

[a] Both CASP-19 (mean 43.2, SD 8.0) and CASP-12 (mean 26.8, SD 5.5) were used to verify whether obtained results would vary upon different scale versions. CASP-12 does not include Item 13: 'I enjoy being in company with others'

[b] Regression coefficient (β) indicates differences in mean CASP score relative to reference category (ref = 0.0)

was observed regarding negative aspects of close relationships (β = 3.5, 95 % CI 3.0, 4.0), estimated nearly 0.5 SD of CASP-19 scores and 1.8 times higher than the effect of coronary heart disease (β = 2.0, 95 % CI 1.4, 2.6). Similarly, the effect of having a partner (β = 1.3, 95 % CI 0.7, 1.9) was comparable with newly developed chronic disease (β = 0.9, 95 % CI 0.3, 1.5).

Discussion

Our study examined several indicators of social relationships in relation to QoL measured 5 years apart. In order of importance, the beneficial aspects of social relationships in relation to QoL were: low negative aspects of close relationships, high confiding support, having a wide network of

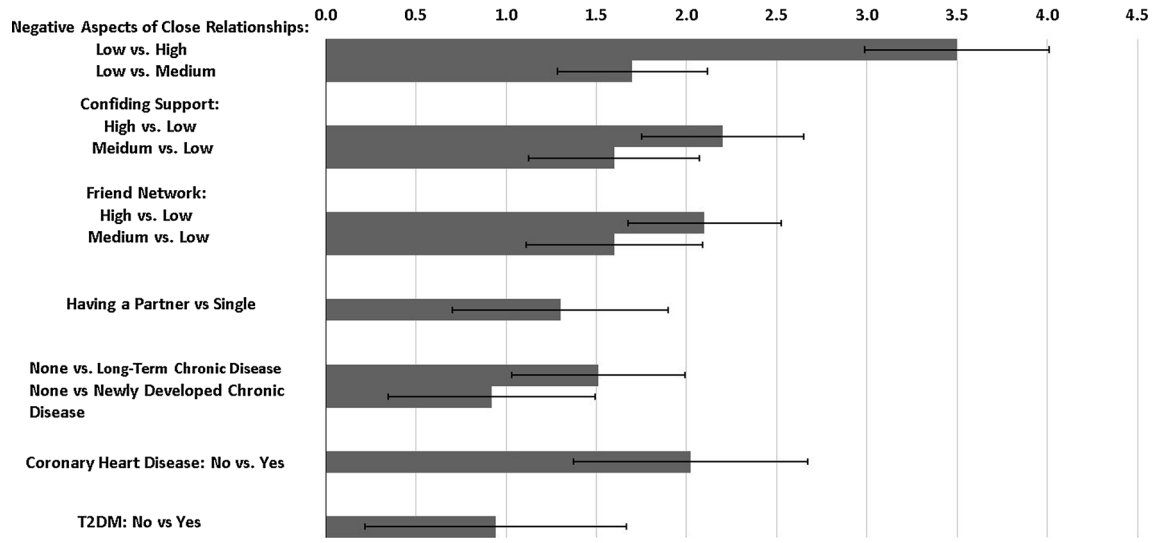

Fig. 1 Comparison of differences in CASP-19 scores due to social relationships and chronic disease status, Whitehall II study ($N = 5929$). The effect sizes were estimated from model with age (age-squared), gender, ethnicity and personality, employment grade, retirement status, depressive symptoms, all measures of social relationships and chronic health status (chronic health status and specific chronic disease were entered into the model separately)

friends and having a partner. These associations were not modified by chronic disease status, and their effect sizes were comparable with or larger than that of chronic disease.

Structural and functional social relationships in relation to QoL

Of the structural and functional measures of social relationships considered, our findings suggest a substantial adverse effect of negative aspects of close relationships on QoL. The beneficial effects of confiding support and friend network were similar and were stronger than the effect of having a partner. Our study extends the existing evidence of quality of social relationships in relation to QoL [15, 18], by simultaneously evaluating positive and negative aspects of social relationships and revealing the detrimental effects of negative aspects of the closest relationship on QoL. Negative aspects of close relationships may create feelings of dependency and incompetency and hence go right against the needs of autonomy and control [23, 49, 50] which are the core tenets of CASP. Threatened autonomy and self-competency may also explain the reversed associations of practical support and CASP-19 once taking into account other aspects of social relationships. Our findings also indicate that friend network and relative network were positively related to QoL, but when both were present, the friend network appeared to confer more well-being benefit than the relative network. These results confirm that voluntary friendships are in general superior to obligatory family relationships as sources of psychological well-being [51, 52], yet acknowledge the importance of relative relationships for QoL [21, 27, 53].

The estimated difference in QoL due to negative aspects of close relationships (highest third vs. lowest third) was close to half a standard deviation of the CASP-19 score. This large contrast may suggest a clinically meaningful difference in perceived QoL [54]. In view of the substantial effect of negative aspects of social relationships on well-being and other health outcomes [55–57], our findings underscore the value of high-quality social relationships [58, 59]. Social relationship interventions that maintain older people's autonomy and self-esteem [24] and improve their ability to minimize social conflicts [60] are most likely to improve older people's QoL. Meanwhile, having a large number of friends with frequent contacts may promote positive social exchanges and maintain social connections [61, 62], which are essential to self-realization in older people [63, 64].

Social relationships, QoL and chronic disease status

We found no evidence that disease status modified social relationship–QoL associations. Instead, our findings indicate robust and consistent associations between social relationships and CASP-19 scores across chronic disease status. Having chronic disease was associated with larger network size and more frequent contacts with friends and relatives, possibly implying mobilization of social resources in response to health-related needs [24]. On the other hand, chronic disease status did not significantly affect the

perceived levels of support from close social partners, which may reflect the nature of close relationships as the main and reliable sources of emotional and practical support [65, 66]. Differences in QoL scores between those who had long-term or newly developed chronic disease and their healthy counterparts were estimated to be 1.5 and 0.9, respectively, responding to less than 0.2 SD of the CASP-19 score. This moderate effect of chronic disease on QoL is in line with the finding based on the Survey on Health, Ageing and Retirement in Europe (SHARE) [39], which may be ascribed to the adjusted expectations due to inevitable morbidity in late life. More importantly, chronic disease status by itself may be less sensitive an indicator of QoL than functional limitation in old populations [67]. Functional limitations, for instance cognitive and physical impairments, vision and hearing problems, could curtail social engagement [68, 69] and strain social relationships [70], which in turn compromise QoL in old age.

Previous studies suggest that social relationships may contribute more to QoL than health indicators [2, 16]. Using objective measures of health status, our study provides a direct comparison between measures of social relationships and diagnosed chronic disease. The effects of social relationships on CASP were no less than chronic disease, such that participants who had long-term chronic disease but perceived high confiding support, low negative aspects of close relationships or large friend network reported higher CASP scores than their healthy counterparts, who yet experienced low confiding support, high negative aspects of close support or had few friends. Our results echo evidence that well-being could coexist with chronic disease and poor functioning if sufficient psychosocial resources are provided [36, 71, 72].

Considering the raising functional limitations as people age [73] and their profound effects on QoL [67], our findings on the importance social relationships for QoL in the presence of chronic disease may provide a proactive solution to better anticipate and adapt to the changes of ageing [74]. Via providing adequate assistances and positive emotional exchanges, supports from significant others [75] may free the elderly from inescapable functional deteriorations, lead to more effective coping [72] and higher resilience [76] and whereby facilitate the balance between age-related physical loss with psychic culmination [77, 78].

Strengths and limitations

Based on a population scale, our study provides a clear temporality of the associations between multiple and detailed measures of structural and functional social relationships and CASP, which is a specially designed measure of QoL among old adults. However, several limitations remain. First, given both social relationships and CASP are measured by self-reported questionnaires, any association between them may be susceptible to individual heterogeneity in evaluating social relationships and QoL. Our analyses address this issue by using measures from different phases, adjusting for personality and depressive symptoms, as well as excluding potential overlapping measurement item. However, we still cannot entirely rule out residual confounders. Second, despite derived from prospective panels, our findings do not imply casual relations. Given the continuity in rating QoL [18], estimates obtained from longitudinal regressions could also reflect cross-sectional associations. Third, the Whitehall II cohort is predominantly comprised of white-collar civil servants whose health conditions were better than the general population. As only one-third of the analysis sample was diagnosed with chronic disease, the power to detect the interaction between social relationships and chronic disease is low.

Conclusion

In the effort to sustain and promote high quality of life in old age, we should understand what older people value in their lives, beyond the medical perspective of ageing. Our study identified avoiding negative aspects of close relationships, having close confiding support, having a wide network of friends and having a partner as predictors of QoL in old age, irrespective of chronic disease. No one is immune to disease; yet through proactively optimizing one's social relationships, we may be able to maintain a satisfactory late life and age well.

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Compliance with Ethical Standards

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Ethical Standards The authors have no conflicts of interests to declare. Ethical approval for the Whitehall II study was obtained from the University College London Medical School Committees on the Ethics of Human Research. The study procedures are in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants were asked to give written informed consent at each phase.

Appendix

See Table 4.

Table 4 Phase 9 CASP-19 score (2007/09) by chronic disease status and phase 7 (2002/04) social relationships levels [a]

	No chronic disease		Long-term chronic disease		Newly developed chronic disease		*P* value for interaction
	Mean	SE	Mean	SE	Mean	SE	
CASP score[b]	43.6	0.1	41.7	0.2	42.5	0.3	<0.0001
Friend network							0.99
Low	42.3	0.2	40.3	0.3	40.9	0.4	
Medium	44.4	0.3	42.6	0.5	43.3	0.6	
High	45.6	0.2	43.5	0.4	44.1	0.5	
Relative network							0.21
Low	43.0	0.2	41.1	0.4	41.8	0.5	
Medium	43.8	0.2	42.2	0.4	42.1	0.5	
High	44.4	0.2	41.9	0.4	44.2	0.6	
Marital status							0.89
Married/cohabiting	44.2	0.1	42.0	0.3	42.9	0.3	
Single	41.6	0.3	39.9	0.7	40.2	0.9	
Divorced	42.5	0.5	41.2	0.9	40.6	1.2	
Widowed	43.7	0.7	40.8	1.0	42.8	1.4	
Confiding support							0.97
Low	41.9	0.2	39.8	0.4	40.6	0.5	
Medium	44.2	0.2	42.1	0.4	42.9	0.6	
High	45.6	0.2	43.5	0.4	44.8	0.5	
Practical support							0.54
Low	43.1	0.2	41.0	0.4	42.2	0.5	
Medium	43.7	0.2	41.7	0.4	43.0	0.5	
High	44.4	0.2	42.3	0.4	42.4	0.5	
Negative aspects of close relationships							0.15
Low	45.6	0.2	44.3	0.4	44.8	0.4	
Medium	43.3	0.2	40.7	0.4	42.5	0.5	
High	40.1	0.3	38.4	0.5	38.4	0.6	

SE standard error

[a] Long-term chronic diseases were defined as those that had been diagnosed of any chronic diseases by study baseline (phase 7), and those that developed any chronic diseases between phases 7 to phase 9 were grouped as newly developed chronic disease. Chronic disease was defined as diagnosed coronary heart disease, stroke, diabetes or cancer. All CASP-19 scores are age-adjusted

[b] The mean CASP-19 score of the study sample is 43.2 (SD 8.0)

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