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Social support and trajectories of body mass index and waist-to-hip ratio from mid-adulthood to old age

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Abstract

Background: Although social networks' influence on obesity has been increasingly recognised, it remains unclear if different dimensions of social support, for example emotional or practical support, received from one's closest relationship are associated with weight outcomes over midlife and old age.

Methods: Using linear mixed models we examined whether person-level body mass index (BMI) and waist-to-hip (WHR) trajectories vary according to levels of emotional, practical and negative aspects of social support in a large UK-based cohort of healthy civil servant workers (n=5,460) with objectively measured anthropometry data on five occasions over two decades (1989-1990 to 2012-2013).

Results: We found that gender modified the associations, with more consistent patterns found in men. In men, high negative aspects of support compared with low were consistently associated with steeper increase in BMI (0.024, 95% CI 0.001 to 0.047 kg/m^2) and WHR (0.00020, 95% CI −0.00001 to 0.00040) after adjustment for demographic and socioeconomic covariates, mental

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Contributions

Study design and critical input into manuscript: MS, UT, MK, RB. Data analyses: UT, MS. Manuscript preparation: UT.

Competing interests

None to declare

health, health behaviours and longstanding illness. We found that low emotional support, compared with high, was associated with steeper BMI gain in men (0.024, 95% CI 0.0001 to 0.047 kg/m^2).

Conclusions: Low levels of negative aspects of the relationships with the closest person and high levels of emotional support may be protective against weight gain over time, particularly in men. If replicated in other studies, these results would suggest that the quality of social support in close relationships has been an overlooked risk factor for weight gain in an ageing population.

INTRODUCTION

Recent estimates show that more than 1 in 3 adults aged 60y and over in England and Scotland are obese (Body mass index or BMI, >30 kg/m^2) [1], and similar rates have been found for other European countries and the US [2,3]. On average, body weight increases steadily from mid-adulthood to the age of 65–70y [4-6], accompanied by ageing-related changes in body composition, such as decrease in muscle mass and increase in metabolically active visceral fat [4,6], which contribute to growing rates of obesity in older adults. Obesity as well as substantial weight changes in later life are associated with adiposity-related comorbidities, functional decline and earlier mortality [6-8], whilst trajectories of steadily increasing body weight are linked with better survival rates in older adults [6,8]. Body weight trajectories therefore provide valuable, health-relevant information in older adulthood. Understanding factors associated with them over middle and older age presents an opportunity to prevent obesity and promote healthy ageing.

Over a decade ago it was suggested that obesity may be “socially contagious” and spread in one’s social network [9], however the evidence and theoretical framework explaining the role of social relationships in the aetiology and prevention of obesity remains inconclusive [10,11]. Social support is an important component of close relationships which constitute one’s social network and has been identified as a key process through which social networks influence weight and weight-impacting behaviours in the most comprehensive review to date [10]. Despite evidence linking supportive relationships to health promoting behaviours and psychological wellbeing [12-15], few large-scale, prospective studies have investigated it in relation to weight outcomes over the life course. These studies suggest that positive aspects of social support, notably emotional support, are protective against increases in adiposity [16,17]; whilst negative aspects of social support contribute to weight gain over time [16,18]. However, not all studies find these associations [12] and there is some evidence of gender difference in these associations [17,19], albeit inconsistent [12,16,18].

The majority of previous longitudinal studies have measured body weight at two time points [17-19] and thus are not able to model individual body weight trajectories. They have also mostly relied on BMI as measure of adiposity, however its accuracy as a proxy of body composition changes with age, for instance in older adults abdominal adiposity can increase together with a decrease in BMI [4]. Waist-to-hip ratio (WHR) has been suggested as a superior measure of visceral fat and total fat levels in ageing populations compared with BMI [20] but change in WHR has rarely been investigated and in relation to social support.

This study explores person-level BMI and WHR trajectories from mid-adulthood to older age using a large UK-based occupational cohort with objectively measured height, weight, waist and hip circumference at five occasions over two decades of follow up. It tests whether trajectories vary according to levels of social support from the closest person. We hypothesised that higher levels of emotional and practical support and lower levels of negative aspects of the closest relationship would be associated with less steep BMI and WHR increase over time. As gender has been shown to affect weight gain in middle and old age [5,21] as well as social support levels [22,23], we test whether gender modifies these associations. We further test the contribution of health behaviours and psychological wellbeing in explaining associations.

METHODS

Study Population

The Whitehall II study was started in 1985-8 and recruited 10,308 (74% response rate) middle-aged men and women working in the offices of 20 Whitehall departments in London [24]. From 10,308 initially recruited, the total number of participants who participated at the subsequent data collection phases was: 8,132 at phase 2 (1989-1990, ages 37-60), 8,815 at phase 3 (1991-1994), 7,870 at phase 5 (1997-1999), 6,967 at phase 7 (2002-2004), 6,761 at phase 9 (2007-2009) and 6,318 at phase 11 (2012-2013, ages 59-83). This analysis examined social support data from phase 2 and BMI and WHR data from phases: 3, 5, 7, 9 and 11.

Outcome Measures

Height was measured using a stadiometer with the head in the Frankfort plane and weight was measured using a portable digital scale (Tanita, Middlesex, UK). WC was measured in the standing position and unclothed, using a fiberglass tape measure at 600g tension. The smallest circumference was taken at or below the costal margin [25]. Hip circumference was measured at the level of the greater trochanter. All measurements were taken by a trained nurse. WHR was measured by dividing waist circumference measurement (at smallest point) in cm by hip circumference measurement in cm. BMI was calculated as weight in kilograms divided by height in meters squared.

Social Support Measures

Social support was examined using the Close Persons Questionnaire [26] which measures support received from the person nominated as the closest in the last 12 months. Emotional support is measured with seven items (e.g. “how much did you confide in this person?”); practical support is measured with three items (e.g. “how much did this person give you practical help with major things?”); and negative aspects of support is measured with four items (e.g. “how much did talking to this person make things worse?”). Each item is rated on a 4-point Likert scale (0=“Not at all”, 1=“A little”, 2=“Quite a lot”, 3=“A great deal”), with higher scores indicating greater emotional and practical support and higher negative aspects of support. Responses on each item are summed separately for emotional support (0-21), practical support (0-9) and negative aspects (0-12).

Covariates

Analyses were adjusted for demographic and socioeconomic covariates including: age; gender; ethnicity (White, South Asian, Black African and Caribbean and Other); current or last civil service employment grade (highest, comprising administrative grades, middle, comprising professional grades, and lowest, comprising clerical/support grades); and marital status (married, single, divorced or separated and widowed). Health behaviours and psychological wellbeing were theorised as potential explanatory mechanisms linking social support to BMI and WHR trajectories. Health behaviour covariates included: smoking (current smokers, ex-smokers and never-smokers); frequency of fruit and vegetable consumption (rated as daily or less than daily); number of units of alcohol consumed in the last week (categorised as high weekly consumption exceeding 14 units in women and 21 units in men vs. low [27]); and frequency of various mildly, moderately and vigorously energetic sports and physical activities (three times a week or more, once or twice a week, about once to three times a month, seldom [28]). Presence of any longstanding illness, disability or infirmity was recorded with a binary (Yes/No) variable. Psychological wellbeing was assessed using the 30-item version of Goldberg's General Health Questionnaire with scores of ≥5 considered to be cases as in previous research [29]. All covariates except ethnicity (measured at phase 5) were obtained from phase 2.

Statistical Analyses

Social support measures were highly skewed and in line with previous analyses [23,30], were divided into tertiles for analyses. Person-level trajectories of BMI and WHR were estimated using separate multilevel growth models with measurement occasion nested within participant. This approach makes statistically efficient use of repeat measures and enabled us to investigate the correlates of initial body weight and its rate of change over time. Time was measured as follow-up time (time elapsed since baseline phase 2). The basic growth model included fixed terms for: intercept (capturing baseline BMI or WHR), time (capturing the linear increase in BMI or WHR each year of follow-up), and time squared (capturing nonlinear increase in BMI and WHR). Random estimates were included for the intercept and the linear slope, which allow each individual to have their own baseline body size and linear change in body size. In order to test if BMI and WHR trajectories vary by the level of social support, a term for social support (capturing differences in baseline BMI or WHR by social support tertile) as well as interaction terms for social support by time and social support by time squared (in BMI models only) were additionally included in the basic growth model (Model 1). Model 1 also included baseline age (centred at mean age 47y) and gender. We additionally adjusted for demographic and socioeconomic factors as well as longstanding illness (Model 2) and tested for the contribution of health behaviours and psychological wellbeing to explaining these associations (Model 3). Results from fully-adjusted Model 3 are presented in the main text, results from Models 1 and 2, which did not vary substantially, are presented in supplementary material. As a sensitivity analysis, to capture participant's wider social support network, we adjusted the analyses for the self-reported number of close persons (Supplementary Tables S1 and S2, Model 4).

Participants who provided baseline social support and covariate data, and minimum 2 measures of BMI and WHR (n=5,460) were included in the analysis. Missing observations

in baseline covariates were considered to be missing at random and imputed by imputation by chained equations [31] with 10 cycles. The imputation model included all outcomes, exposures and covariates as recommended in the literature [31]. Analyses based on data including imputed values for missing covariate data did not materially change the results, hence analyses on complete cases were reported. Compared with those included in the complete case analyses, participants with missing outcome data were older, more likely to be women, South Asian and Black African or Black Caribbean, current smokers, in lower civil service employment grades as well as reported lower consumption of fruits and vegetables, lower alcohol intake and less frequent mild, moderate and vigorous physical activity and higher emotional support.

RESULTS

The participants included in the analyses were predominantly male (72.3%) and aged 46.8y at baseline (Table 1). Over 74% of participants reported their spouse or partners as the closest person, with men being more likely to report their spouses and partners as their closest person compared with women (81.7% vs. 56.3%, Table 1). Amongst married and cohabiting participants, 94.46% of men and 83.2% of women reported their spouse or partner as the closest person (data available from the authors).

Maximum time of follow-up was 25.0y and the data were consistent with nonlinear change in BMI and WHR over time. Mean BMI increased between phases 3 and 9 and was higher by approximately 1.6 kg/m^2 at phase 11 compared with phase 3 (Table 2). Mean WHR increased from 0.895 at phase 3 to 0.953 at phase 11 among men and from 0.761 at phase 3 to 0.834 at phase 11 among women. BMI and WHR increased linearly by respectively 0.222 (SE 0.005) kg/m^2 and 0.0047 (SE 0.0001) per year but a negative coefficient for the quadratic term indicated that the weight gain slowed and became negative at later follow-up. Gender modified the associations between social support and BMI/WHR trajectories (see Supplementary Material Tables S3 and S4), thus results are presented separately for men and women.

When examining BMI, emotional support was not associated with baseline BMI but was associated with less steep BMI gain in men (Table 3). Men in the low tertile of emotional support had a steeper linear slope by 0.024 (SE 0.012 kg/m^2, p=0.049) compared to those in the high tertile. Practical support was not associated with BMI trajectories. High negative aspects of support were associated with steeper BMI gain in men only. Men in the high tertile of negative aspects of support had a steeper BMI gain by −0.024 (SE 0.012 kg/m^2, p=0.038) compared to those in the low tertile.

Emotional and practical support were not associated with WHR trajectories, with two exceptions. Men in the middle tertile of practical support had less steep WHR gain than those in the high tertile (−0.00034, SE 0.00011, p=0.002) (Table 4). Compared to women in the high tertile, those in the medium tertile of emotional support had lower baseline WHR (−0.0111, SE 0.0046, p=0.016) and steeper WHR gain (0.0005, SE 0.0002, p=0.021). Negative aspects of support were positively associated with WHR increase in both men and women, though less consistently in women. In men, being in the high tertile was associated

with a steeper linear WHR increase (−0.00020, SE 0.00011, p=0.066) compared to being in the low tertile. Women in the middle tertile of negative aspects had steeper WHR gain compared with those in the low tertile (0.0004, SE 0.0002, p=0.047). In both BMI and WHR models, we found no evidence of health behaviours and psychological wellbeing explaining the associations between social support and weight gain. Adjusting for participant's wider social support network did not alter the associations (Supplementary Tables S1 and S2, Model 4).

DISCUSSION

We found that high levels of negative aspects of the relationship with the closest person, such as worries and insufficient confiding, were associated with steeper linear increase in BMI and WHR in men. These results agree partially with previous studies which found positive associations between negative aspects of support and general as well as central adiposity in both genders [16,18]. Here we further found that negative aspects of support were more consistently associated with WHR gain compared to other aspects of support, in line with another study [16]. Poor quality social support has been hypothesised to constitute chronic psychosocial stress previously linked with central fat accumulation in early reviews [32,33] and more recently with a modest increase in adiposity in a meta-analysis of longitudinal studies [34]. Psychosocial stress could also affect coping and health behaviours, for instance it has been suggested that stress-induced eating can be a quick means of emotional soothing which does not address the cause of the emotional distress and could indicate a poor emotional closeness of relationships [35]. Negative, but not positive aspects of social support have also been associated with prevalent and incident physical inactivity [12]. We also found that high emotional support from the closest person was associated with less steep BMI increase in men in accordance with previous studies [16,17]. Previous research suggests that emotional dimension of support is central to benefits of support [36]; in this study emotional support emerged as an important contributing factor to the increase in BMI over time, among men.

Contrary to our hypotheses, in general we found no consistent associations between practical support and BMI or WHR gain. We found that men in middle tertile of practical support had higher baseline WHR and less steep WHR gain compared with those in the high tertile. These results may suggest reverse causation, namely, poor health resulting in greater need for social support in those who report high received practical support [37]. Previous analyses of the Whitehall II study data found better self-reported health in women in the low tertile of practical support compared to those in the high tertile [23]. More broadly, possible reverse direction may extend to the association between social support and body weight, as evidence suggests that obese individuals might receive less emotional support and suffer more conflict in their relationships with family [38].

We found that gender modified observed associations, in contrast to findings from some previous studies [12,16,18]. The associations between emotional support and WHR trajectories were found for women, not men, though were not linear. Low levels of negative aspects of close relationships showed a protective association with BMI and WHR trajectories in men, but not in women. A previous study reported that a lack of emotional

support was associated with weight gain in men, but not women, however did not examine gender differences in negative aspects of support [17]. Further research is needed to investigate whether different elements and sources of social support are relevant for weight gain in men and women. For instance, social support from additional sources other than the closest person has been suggested as a more gender-fair measure, however it did not explain the associations of social support with self-reported physical health or psychological morbidity in previous research [23] and adjustment for number of close persons did not affect observed associations in our study.

The strengths of this study include a large sample size, long follow-up, use of statistically efficient linear mixed models and objectively measured anthropometry data. There are also few limitations. The occupational cohort might not be representative of the general population. Those with missing observations were more likely to report higher emotional support thus could bias the results, likely leading to underestimation of the association. However, conclusions were largely unchanged when analyses were conducted following imputation for missing data. Social support and covariates were measured at the beginning of the study, thus change in them over the follow-up time was not accounted for. In this cohort, social support was predominantly provided by spouses and romantic partners and changes in relationship status over the follow-up time occurred in only 30% of participants, which may have minimised changes in social support levels. Finally, it is important to acknowledge that types of social support distinguished in research, can co-occur in close relationships in real life.

In conclusion, this study confirms and extends previous findings that emotional and negative aspects of support are associated with BMI and WHR gain, demonstrating that these associations appear more consistent in men. These results would suggest that close social relationships should not be overlooked as potential risk factors for weight gain in middle and old age and that early prevention aimed at improving the quality of social support in close relationships (such as managing conflict and increasing emotional closeness) may be beneficial.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Manuscript

What is already known on this subject?

Over a decade of research shows that people's social networks can influence their health behaviours and risk of obesity. Close relationships which constitute one's social networks are also a source of social support. A wealth of observational evidence links social support to various health outcomes, yet few studies tested the associations with weight outcomes, particularly in an ageing population.

What this study adds?

We examine the associations between social support from the closest person and weight gain using longitudinal data capturing individual trajectories of body size. We find that low emotional and high negative aspects of support are associated with central and general adiposity increase over midlife and older age, particularly in men. If replicated in other samples, these results would suggest that individual risk profiles for weight gain should incorporate close relationships and that early prevention aimed at improving the quality of social support in close relationships may be beneficial.

Table 1.

Descriptive Table of Participants' Baseline Characteristics, n=5,460. All Variables Were Collected at Phase 2 (1989-1990) of the Whitehall II Study, United Kingdom.

	Total	**Men n=4,118**	**Women n=1,655**
Age, mean (SD)	46.8 (6.0)	46.7 (6.0)	47.2 (6.0)
Ethnicity, n(%)			
White British	5,130 (94.0)	3,750 (94.9)	1,380 (91.4)
South Asian	202 (3.7)	143 (3.6)	59 (3.9)
Black African & Caribbean	95 (1.7)	42 (1.1)	53 (3.5)
Other	33 (0.6)	15 (0.4)	18 (1.2)
Marital status, n(%)			
Married	4,279 (78.4)	3,347 (84.8)	932 (61.7)
Single	763 (14.0)	420 (10.6)	343 (22.7)
Divorced/widowed	418 (7.6)	183 (4.6)	235 (15.6)
Employment grade, n(%)			
Administrative (highest)	2,166 (39.7)	1,893 (47.9)	273 (18.1)
Professional/Executive	2,631 (48.2)	1,869 (47.3)	762 (50.5)
Clerical/support	663 (12.1)	188 (4.8)	475 (31.4)
Longstanding illness: Yes vs. No, n(%)	1,922 (35.2)	1,365 (34.6)	557 (36.9)
Smoking status, n(%)			
Current smoker	2,811 (51.5)	1,952 (49.4)	859 (56.9)
Never-smoker	1,982 (36.3)	1,565 (39.6)	417 (27.6)
Ex-smoker	667 (12.2)	433 (11.0)	234 (15.5)
Non-daily vs. daily fruit and veg intake, n(%)	2,146 (39.3)	1,646 (41.7)	500 (33.1)
Infrequent mild exercise [a], n(%)	415 (7.6)	285 (7.2)	130 (8.6)
Infrequent moderate exercise [a], n(%)	2,469 (45.2)	1,657 (42.0)	812 (53.8)
Infrequent vigorous exercise [a], n(%)	4,358 (79.8)	3,016 (76.4)	1,342 (88.8)
High alcohol intake >14/21 units [b], n(%)	938 (17.2)	749 (19.0)	189 (12.5)
GHQ score ≥ 5, n(%)	1,647 (30.2)	1,111 (28.1)	536 (35.5)
Close person, n(%)			
Partner or spouse	4,079 (74.7)	3,229 (81.7)	850 (56.3)
Relative	678 (12.4)	319 (8.1)	359 (23.8)
Friend or acquaintance	703 (12.9)	402 (10.2)	301 (19.9)
Number of close people, median (IQR)	5 (4)	5 (5)	5 (4)

SD, standard deviation; GHQ, general health questionnaire; IQR, interquartile range.

[a] 1-3 times per month or less often

[b] Recommended maximum alcohol intake per week for men: 21 units and for women: 14 units

Table 2.

Mean BMI and WHR across the five Whitehall II Study Phases (1991-1994 – 2007-2009) for Men and Women Included in the Analytical Sample (n=5,460), United Kingdom.

Phase	n	BMI Mean (95% CI)	n	WHR: men Mean (95% CI)	N	WHR: women Mean (95% CI)
3	5,180	24.92 (24.79-25.04)	3,702	0.895 (892-897)	1,418	0.761 (0.756-0.765)
5	4,217	25.85 (25.72-25.99)	2,755	0.917 (0.915-0.920)	1,085	0.788 (0.783-0.792)
7	4,827	26.41 (26.26-26.55)	3,526	0.937 (0.934-0.939)	1,305	0.809 (0.804-0.814)
9	4,666	26.47 (26.32-26.63)	3,433	0.939 (0.936-0.941)	1,234	0.816 (0.811-0.821)
11	4,249	26.49 (26.33-26.65)	3,148	0.953 (0.950-0.955)	1,101	0.834 (0.829-0.839)

BMI, body mass index; WHR, waist-to-hip ratio; 95% CI, 95% confidence interval

Table 3.

Trajectories of Body Mass Index by Social Support over the Whitehall II Study Phases 3 (1991-1994) – 11 (2012-2013), United Kingdom.

Body Mass Index						
	Men (n=3,950)			**Women (n=1,510)**		
Model	**Intercept β (SE)**	**Linear slope β (SE)**	**Nonlinear change β (SE)**	**Intercept β (SE)**	**Linear slope β (SE)**	**Nonlinear change β (SE)**
Basic growth model	24.62 (0.05)	0.212 (0.005)	−0.0054 (0.0002)	24.91 (0.13)	0.250 (0.011)	−0.0065 (0.0004)
M3: Emotional support						
Tertile 1 (low)	−0.211 (0.136)	0.024 (0.012) *	−0.0011 (0.0004) *	−0.347 (0.329)	0.027 (0.028)	−0.0004 (0.0011)
Tertile 2 (medium)	−0.222 (0.139)	0.020 (0.012)	−0.0010 (0.0004) *	−0.406 (0.325)	0.028 (0.029)	−0.0004 (0.0011)
M3: Practical support						
Tertile 1 (low)	−0.027 (0.143)	−0.005 (0.012)	−0.0001 (0.0005)	−0.515 (0.367)	−0.006 (0.030)	0.0008 (0.0011)
Tertile 2 (medium)	−0.0005 (0.1322)	0.012 (0.012)	−0.0008 (0.0004)	−0.601 (0.302)	0.018 (0.032)	−0.0002 (0.0012)
M3: Negative aspects						
Tertile 2 (medium)	−0.224 (0.129)	0.007 (0.012)	−0.0009 (0.0004)	−0.181 (0.312)	0.030 (0.027)	−0.0012 (0.0010)
Tertile 3 (high)	−0.042 (0.131)	0.024 (0.012) *	−0.0008 (0.0004)	0.196 (0.319)	−0.031 (0.027)	0.0012 (0.0010)

Reference: Tertile 3 (high emotional and practical support) and Tertile 1 (low negative aspects); SE, standard error; M2, Model 2; M3, Model 3.

Model 3 adjusts for: age at baseline, ethnicity, employment grade, longstanding illness, marital status, health behaviours and psychological wellbeing

* $P < 0.05$

** $P < 0.01$

Table 4.

Trajectories of Waist-to-Hip Ratio by Social Support over the Whitehall II Study Phases 3 (1991-1994) – 11 (2012-2013), United Kingdom.

Waist-to-hip ratio				
	Men (n=3, 950)		**Women (n=1,510)**	
Model	**Intercept β (SE)**	**Linear slope β (SE)**	**Intercept β (SE)**	**Linear slope β (SE)**
Basic growth model	0.891 (0.001)	0.0046 (0.0001)	0.756 (0.002)	0.0051 (0.0002)
M3: Emotional support				
Tertile 1 (low)	−0.0026 (0.0025)	0.00016 (0.00011)	−0.0066 (0.0045)	0.0002 (0.0002)
Tertile 2 (medium)	−0.0034 (0.0025)	−0.00005 (0.00011)	−0.0111 (0.0046) *	0.0005 (0.0002) *
M3: Practical support				
Tertile 1 (low)	−0.0008 (0.0026)	−0.00006 (0.00011)	−0.0011 (0.0050)	0.00009 (0.00021)
Tertile 2 (medium)	0.0034 (0.0024)	−0.00034 (0.00011) **	0.00036 (0.0051)	−0.00003 (0.00022)
M3: Negative aspects				
Tertile 2 (medium)	−0.0041 (0.0023)	0.00009 (0.00011)	−0.0029 (0.0043)	0.0004 (0.0002) *
Tertile 3 (high)	−0.0047 (0.0024)	0.00020 (0.00011)	0.0036 (0.0044)	0.00007 (0.00019)

Reference: Tertile 3 (high emotional and practical support) and Tertile 1 (low negative aspects); SE, standard error; M2, Model 2; M3, Model 3.

Model 3 adjusts for: age at baseline, ethnicity, employment grade, longstanding illness, marital status, health behaviours and psychological wellbeing

* $P < 0.05$

** $P < 0.01$