Title: Is pre-operation social connectedness associated with weight loss up to two years post bariatric surgery?

Abstract

Introduction: To date little attention has been paid to supportive relationships as factors contributing to weight loss from bariatric surgery.

Material and Methods: This prospective study examined whether total percentage weight loss (%TWL) at 3, 12 and 24 months post-surgery varies by distinct aspects of pre-surgery social support (received emotional and practical support and contact with friends and family) in a sample of bariatric surgery candidates (n = 182). These associations were tested with linear regression models adjusted for gender, age, ethnicity, employment status, self-esteem, mastery and time elapsed since the day of surgery.

Results: 154 participants underwent a bariatric procedure, and all but seven provided weight loss data at least at one occasion. Emotional support and contact with friends were positively associated with %TWL at 3, 12 and 24 months and the magnitude of these associations was large. For instance, in the fully-adjusted models, %TWL at 24 months increased by 2.36% (SE 1.17, p = 0.048) with each increase of one standard deviation in emotional support and was higher by 9.23% (SE 4.31, p = 0.035) for participants who reported seeing 1-5 friends per month compared with those who saw none. There was some evidence for a positive association between practical support and %TWL at 3 and 12 months post-surgery.

Conclusion: Supportive relationships are important contributors to weight loss from bariatric surgery. If replicated in future studies, these findings could inform clinical care and interventions aimed at improving support systems of bariatric surgery candidates.

Keywords: Close relationships; social support; gastric bypass; gastric sleeve; metabolic surgery; obesity; weight management

Introduction

Bariatric surgery is a surgical treatment of severe obesity and is currently considered the most effective weight loss solution [1,2]. Despite the overall effectiveness of bariatric surgery, there is a significant variability in weight loss achieved [3,4]. Typically, post-operation weight loss is rapid in the first few months and slows down around five to twelve months post-surgery [3,5]. In the longer term, weight tends to stabilise and may also be regained [6]. Understanding factors which contribute to successful weight loss over time is therefore of paramount importance to health care providers and individuals who undergo bariatric surgery.

The role of social networks in the development of obesity has been studied for over a decade [7,8] and evidence shows the health benefits of supportive relationships in the general population [9,10], including links between social support and health promoting behaviours [11,12] as well as, more recently, obesity risk itself [13–15]. While the possible importance of social support for post-operative weight loss in the bariatric population is recognised in key training texts [16]**,** empirical evidence is scarce. It is conceivable that supportive close relationships in this population may aid the adjustment to post-surgery required lifestyle changes and follow-up clinical appointments, through positive encouragement and tangible assistance. Based on this, it is plausible that one's social support system could play an important role in short and long term weight loss.

Social support is often used to describe both the more objective characteristics of one's support network such as frequency of social contact (structural social support) as well as caring interactions between individuals such as emotional or practical support exchanges (functional social support) [17]. However, social support from close, interpersonal relationships rather than bariatric support groups has hardly been a primary focus of prospective, quantitative studies investigating weight loss from bariatric surgery. A few previous studies offer inconclusive results. For instance, emotional social support was positively associated with weight loss in a prospective study [18], however other prospective [19] and retrospective studies [20,21] did not find this association. Studies of structural

50 support, such as intensity of social contact have been rare and find little or no evidence of an
51 association with post-operative weight loss [21,22]. Some of the inconsistencies found in previous
52 studies could be explained by their multiple limitations such as retrospective study designs in which
53 social support reports suffer from recall bias [20,21], small sample sizes of fewer than 45 participants
54 [19,20], and varying weight loss outcome measures, including the use of widely criticised percentage
55 excess weight loss (%EWL) [23,24]. Since previous studies have rarely intended to examine
56 supportive social relationships specifically, they have not examined distinct aspects of social support
57 and rarely used validated social support instruments. For instance, to the best of authors'
58 knowledge, no previous quantitative studies have examined received practical support despite
59 qualitative studies reporting its relevance for weight loss from bariatric surgery [25,26].

60 To address these limitations and answer calls for prospective studies of supportive relationships in
61 bariatric surgery [21,27], this prospective study examined the pre-surgery functional and structural
62 aspects of social support of bariatric surgery candidates using validated instruments and post-
63 surgery weight loss using total percentage weight loss (%TWL). Using a single-centre cohort of
64 bariatric surgery candidates this study investigated whether %TWL at 3, 12 and 24 months post-
65 surgery varied according to functional social support (received emotional and practical support) and
66 structural social support (number of friends and relatives seen on a monthly basis).

67 Methods

68 Study design and population

69 This study was designed as a prospective cohort study and was nested in a larger research project
70 which received ethical approval from Health Research Authority. Bariatric surgery candidates aged
71 over 18 years of age, proficient in English and due to undergo Roux-en-Y gastric bypass or sleeve
72 gastrectomy were recruited from a bariatric clinic in a teaching hospital in the South East of England.
73 The clinic follows National Institute of Clinical Excellence (2014) bariatric surgery eligibility guidelines
74 and offers the service to patients with body mass index (BMI) of ≥40 kg/m^2, BMI of ≥35 kg/m^2 if

obesity-related co-morbidity is present, or BMI <35 kg/m^2 if type 2 diabetes has been diagnosed within the last 10 years. Between November 2014 and June 2015, patients aged over 18 years who attended the clinic's pre-assessment appointment were invited to participate in the study and to complete a baseline questionnaire measuring social support, sociodemographic and psychological covariates. Of 201 invited to take part, 182 consented to take part and completed a baseline questionnaire, 158 had surgery and 154 were included in the main analyses (after excluding participants who became pregnant or had missing questionnaire data). Of 154 participants, 50 had Roux-en-Y gastric bypass and 104 had sleeve gastrectomy (see [3] for procedures description). All except seven participants returned for at least one post-surgery follow-up clinic appointment. One hundred thirty three participants had 3 month follow-up data, 130 had 12 month follow-up data and 101 had 24 month follow-up data. Due to clinic's capacity and patients' cancellations the post-surgery follow-up clinic appointments did not always take place at exactly 3, 12 and 24 months, hence for the analyses the dates were centred at 84, 365 and 730 days respectively. Twenty four participants were refused the surgery, had to undergo further tests to confirm eligibility substantially delaying the surgery date, or decided not to pursue the surgery. The characteristics of participants who underwent the bariatric surgery and those who did not as well as those who attended and missed their post-surgery follow-up appointments are reported in the Supplementary Material (Tables S1 and S2).

Measures

Outcome

Weight in kilograms was measured using a Walkthrough Platform by a trained health professional during all pre- and post-surgery clinic appointments as well as on the day of surgery. Height in centimetres was measured using a stadiometer. Total percentage weight loss (%TWL) was calculated by subtracting weight at each post-surgery follow-up appointment (3, 12, and 24 months) from the

weight on the day of surgery and expressing the differences as percentage of the weight on the day of surgery.

Social support

In order to capture both emotional and practical dimensions of social support received in a close relationship, the Close Persons Questionnaire [28], a validated scale previously included in some large-scale British cohort studies (e.g. the Whitehall II study and the National Survey of Health and Development) was used. The Close Persons Questionnaire asks about support received from up to four closest persons in the last 12 months, however the score of social support received from the closest person is predominantly examined [13,29] and was used here. Emotional support is assessed with 7 items (e.g. 'how much in the last 12 months did you confide in this person?' or 'how much in the last 12 months did you share interests, hobbies and fun with this person?'). Practical support is assessed with 3 items (e.g. 'how much in the last 12 months did this person give you practical help with major things?'). Each item is rated on a 4-point Likert scale, with higher scores indicating greater received emotional and practical support and ranges of 0-21 and 0-9 respectively. Both support subscales displayed high to moderate internal validity in a non-clinical sample [28] as well as here – received emotional support (Cronbach Alpha α=0.84) and received practical support (Cronbach Alpha α=0.78). In previous large-scale studies of a non-clinical sample, mean scores for emotional support ranged between 13.1 to 15.8 and between 3.7 to 5.9 for practical support [30,31]. Social contact was assessed with two items: number of friends and acquaintances seen once a month and number of relatives seen once a month, both rated on a scale: "none", "1-2", "3-5", "6-10", "More than 10".

Covariates

Demographic data (age, ethnicity and gender) were obtained from the patient's clinical records. The clinical records specified ethnic groups as "White British", "White Other", "White/Black Asian", "Mixed background", "Indian", "Other Asian", "Caribbean", "African", "Other Black background",

"Other" and "Not stated". Due to low numbers in ethnic minority groups, ethnicity was coded for the analyses as: "White British and other White ethnicities", "Non-White ethnicities" and "Not stated". Paid employment status (currently in paid employment: yes vs. no) was asked in the baseline questionnaire administered to patients. Self-esteem was measured with the widely-used the Rosenberg scale of global self-esteem [32], with 10 items rated on a 4-point scale and scores ranging from 0-30 (Cronbach Alpha α=0.88). Mastery of one's life, a concept related to self-efficacy, was measured with the Pearlin Mastery Scale [33], which consists of 7 items rated on a 4-point scale and scores ranging from 7-28 (Cronbach Alpha α=0.79).

Statistical Analysis

A series of linear regression models were used to examine the associations between social support at baseline and %TWL at 3, 12 and 24 months. Each social support variable was analysed separately in a series of models adjusted for days since surgery centred at 3 months (84 days) and 12 months (365 days) and 24 months (740 days) (Model 1) as well as fully-adjusted models adjusting additionally for age and gender, ethnicity and employment, self-esteem and mastery (Model 2).

Results

The progressive weight loss since day of surgery is reported in Table 1. Mean %TWL steadily increased over the first 12 months post-surgery, following which it stabilised. Mean %TWL at 3, 12 and 24 months was: 14.7% (SD 4.1), 25.6% (SD 7.8), 25.2% (SD 10.2) respectively. Participants' baseline characteristics can be found in Table 2. Participants who did not proceed with the bariatric surgery reported less emotional and practical support compared with those who had one of the two procedures (Supplementary Material, Table S1). Missing any post-surgery follow-up appointment was associated with younger age and missing the 24 months post-surgery follow-up appointment was associated with lower practical support (Supplementary Material, Table S2).

Reporting higher received emotional support and seeing more friends on a monthly basis prior to surgery were associated with increased weight loss at 3, 12 and 24 months post-surgery (Table 3). In the fully-adjusted models, with each additional point on the emotional support scale, %TWL increased by 0.16% ($p = 0.08$), 0.37% ($p = 0.042$) and 0.60% ($p = 0.048$) at, respectively, 3, 12 and 24 months post-surgery. Compared with participants who reported seeing no friends on a monthly basis, those who reported seeing 1-5 friends and 6 or more friends experienced, respectively, 2.96% ($p = 0.032$) and 3.33% ($p = 0.020$) higher %TWL at 3 months post-surgery, and 9.23% ($p = 0.035$) and 7.90% ($p = 0.08$) higher %TWL at 24 months post-surgery, in the fully-adjusted models. Received practical support showed a borderline positive association with %TWL at 3 months ($\beta = 0.26$, SE 0.14, $p = 0.054$) and 12 months post-surgery ($\beta = 0.47$, SE 0.28, $p = 0.09$) in the fully-adjusted models. No associations between %TWL and number of relatives seen per month were found.

Conclusion

These results add to the wider literature on the role of social support in weight loss interventions [34] and extend it by demonstrating that supportive relationships are associated with increased weight loss from bariatric surgery. The findings that received emotional support is positively associated with %TWL is consistent with a prospective quantitative study of social support and weight loss [18] and disagrees with prospective [19] and retrospective studies [20,21] which found no association. Qualitative studies suggest that emotional support from close others takes various forms such as positive encouragement for maintaining required post-surgery lifestyle changes and empathy for one's struggles which together contribute to feelings of closeness in relationships and weight loss success [26,35]. Previous quantitative studies however have failed to measure social support with a validated instrument capturing the key emotional dimension of support [18,19] or separating it from practical aspects of support [20,21], thus making direct comparisons with present study challenging. Received emotional support appeared to be important throughout the whole bariatric surgery journey, as the participants who did not proceed to bariatric surgery reported lower levels of emotional support compared to the counterparts who had the surgery.

Seeing more friends on a monthly basis was associated with greater %TWL, and the magnitude of these associations was substantial. For instance, seeing 1-5 friends per month compared with none was associated with 9.23% or 0.88 standard deviation higher %TWL at 24 months post-surgery. Differences of such magnitude are also clinically significant, as a previous study reports a 7% increase in the odds of type 2 diabetes remission for every 1% weight loss [36]. This finding is in partial agreement with a prospective study which reported a borderline positive association between number of confidants and %EWL [22]. This is in contrast to a retrospective study which did not find an association between the number of friends and %EWL [21]. Meeting with a greater number of friends could indicate higher chances of meeting one's emotional and practical support needs post-surgery. No evidence for an association between seeing relatives on a monthly basis and weight loss was found. This may be because, in addition to providing support, family can be a common source of weight stigma and negative interactions for obese individuals, often contributing to strategies of eating to cope [37,38].

The results indicated a positive association between received practical support and %TWL in the fully-adjusted models. The surgery begins a difficult process during which individuals face challenges of new food tolerance, old cravings and adherence to new life style regimen [26,35]. Learning to place one's health needs as a priority is crucial in order to maintain weight loss in the long run [35]. Practical help during this time such as assistance with everyday tasks and reminders about post-surgery requirements may facilitate this learning process and therefore contribute to bariatric surgery success. Interestingly, participants who received less practical support were less likely to proceed to bariatric surgery in the first place and to return to the 24 months post-surgery follow-up appointment.

The strengths of this study include its prospective design, the use of validated social relationship scales and commonly accepted %TWL instead of widely criticised %EWL which dominated the previous studies. A few limitations should be acknowledged. Though comparable in size to previous

related studies, statistical power was moderate and some differences %TWL of clinical significance attained only borderline statistical significance. Despite a low attrition rate (only 7 out of 154 participants did not return to any post-surgery follow-up appointment), participants who missed all or some follow-up appointments could introduce bias due to their younger age, potentially lower practical support levels and other unobserved factors. Questionnaire item non-response was observed for only four participants and was handled with listwise deletion, which was considered unlikely to significantly bias the results. Furthermore, participants who proceeded to surgery reported higher emotional and practical support potentially leading to overestimation of the associations. Social support was measured at baseline, though qualitative studies indicate changes to patient's social networks following surgery that may be important for weight loss. For example, prioritising friendships which accommodate patient's post-surgery lifestyles by changing socialising from food-centred to activity-based pursuits [26]. A recent large-scale, quantitative study has also reported frequent changes to marital relationships status following bariatric surgery including both dissolution of existing relationships and entering new ones, which could have implications for availability and levels of received social support [39]. Lastly, due to small sample size and incomplete clinical records, the measure of ethnicity used here was crude and precluded analyses in specific ethnic groups.

This study addressed a significant gap in bariatric literature by reporting pre-surgery supportive relationships and their prospective relationship with %TWL at 3, 12 and 24 months post-surgery. The findings indicate that emotional support and contact with friends are important factors substantially contributing to weight loss over time. If these results are replicated in future studies, they would suggest that bariatric surgery candidates should be supported in cultivating their close relationships in order to improve their post-surgery weight loss prognosis.

221 Table 1 Pre-surgery weight and post-surgery weight loss levels at each post-surgery time point, max

222 n=152, 2014-2017, UK.

		Weight in kg	**%TWL**	**BMI (kg/m^2)**	**Days since surgery**
	N	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Day of surgery	152	126.6 (27.9)	----------	45.0 (7.2)	----------
3 months post-surgery	133	107.3 (25.4)	14.7 (4.1)	38.2 (6.5)	97.2 (13.0)
12 months post-surgery	130	92.8 (22.4)	25.6 (7.8)	33.1 (6.1)	369.7 (52.7)
24 months post-surgery	101	92.6 (23.3)	25.2 (10.2)	33.2 (6.1)	709.7 (80.8)

223 Abbreviation: %TWL, percentage of weight loss relative to day of surgery weight; BMI, body mass

224 index.

225 Table 2 Descriptive characteristics of participants who had bariatric surgery, n=154, 2014-2017, UK.

Variables included the analyses	Mean (SD) or N (%)
Demographic and socioeconomic covariates	
Gender	
Women	112 (72.7%)
Men	42 (27.3%)
Age on the day of surgery	45.8 (11.9)
Ethnicity	
White ethnicities	115 (74.7%)
Non-White ethnicities	25 (16.2%)
Not stated	14 (9.1%)
Employed	
Yes	90 (58.4%)
No	64 (41.6%)
Psychological covariates	
Rosenberg's self-esteem scale (0-30)	19.4 (5.9)
Pearlin's mastery scale (7-28)	20.8 (3.5)
Functional social support	
Received emotional support (0-21)	16.8 (3.9)
Received practical support (0-9)	6.3 (2.6)
Structural social support	
Number of friends seen per month	
None	9 (5.8%)
1-5 friends	80 (52.0%)
6+ friends	65 (42.2%)
Number of relatives seen per month	
None	11 (7.1%)
1-5 relatives	77 (50.0%)
6+ relatives	66 (42.9%)

226

Table 3 Associations between pre-surgery social support levels and post-surgery weight loss derived from linear regression models, 2014-2017, UK.

	3 months %TWL (*n* = 133)		**12 months %TWL (*n* = 130)**		**24 months %TWL (*n* = 101)**	
	β (SE)	**p**	**β (SE)**	**p**	**β (SE)**	**p**
M1: Received emotional support	**0.18 (0.08)**	**0.031**	**0.37 (0.17)**	**0.030**	**0.55 (0.29)**	**0.050**
M2: Received emotional support	0.16 (0.09)	0.08	**0.37 (0.18)**	**0.042**	**0.60 (0.30)**	**0.048**
M1: Received practical support	0.14 (0.13)	0.30	0.33 (0.27)	0.23	0.72 (0.43)	0.10
M2: Received practical support	**0.26 (0.14)**	**0.054**	0.47 (0.28)	0.09	0.72 (0.44)	0.10
M1: Number of friends seen per month *(ref none)*						
1-5 friends	**3.44 (1.32)**	**0.010**	4.99 (3.12)	0.11	**8.60 (4.32)**	**0.049**
6+ friends	**4.13 (1.35)**	**0.003**	5.44 (3.15)	0.09	6.84 (4.40)	0.12
M2: Number of friends seen per month *(ref none)*						
1-5 friends	**2.96 (1.36)**	**0.032**	5.01 (3.14)	0.11	**9.23 (4.31)**	**0.035**
6+ friends	**3.33 (1.41)**	**0.020**	5.08 (3.20)	0.11	7.90 (4.42)	0.08
M1: Number of relatives seen per month *(ref none)*						
1-5 relatives	0.67 (1.26)	0.59	0.34 (2.97)	0.91	-0.50 (3.70)	0.89
6+ relatives	0.54 (1.28)	0.67	0.54 (3.00)	0.86	-3.20 (3.73)	0.39
M2: Number of relatives seen per month *(ref none)*						
1-5 relatives	0.43 (1.28)	0.74	-1.21 (3.02)	0.69	-3.28 (3.75)	0.39
6+ relatives	0.32 (1.29)	0.81	-0.70 (3.03)	0.82	-5.41 (3.76)	0.15

M1: Model 1 crude model adjusting only for days since surgery at each time point.

M2: Model 2 fully-adjusted model adjusting for: Model 1 + gender, age, ethnicity, employment, self-esteem and mastery.

230 Supplementary material

231 Table 4 Characteristics of participants who underwent bariatric surgery (n=154) and those who did not (n=24),

232 2014-2017, UK.

	Participant underwent bariatric surgery		
Total	**Yes** (*n* = 154) N (%) or mean (SD)	**No** (*n* = 24) N (%) or mean (SD)	**P**
Gender: Women	112 (72.7)	13 (54.2)	0.06
Age on the pre-surgery assessment visit	45.6 (11.9)	49.4 (11.4)	0.15
Ethnicity			
White British & other White	115 (74.7)	15 (62.5)	0.21
Non-White ethnicities	25 (16.2)	4 (16.7)	
Not stated ethnicity	14 (9.1)	5 (20.8)	
Employed: Yes vs. No	90 (58.4)	14 (58.3)	0.99
Rosenberg's self-esteem scale (0-30)	19.4 (5.9)	19.3 (5.9)	0.93
Pearlin's mastery scale (7-28)	20.3 (3.4)	20.8 (3.5)	0.55
Received emotional support (0-21)	**16.8 (3.9)**	**14.5 (4.8)**	**<0.01**
Received practical support (0-9)	**6.3 (2.6)**	**4.9 (3.1)**	**0.02**
Number of friends seen per month			
None	9 (5.8)	1 (4.2)	0.33
1-5	80 (52.0)	9 (37.5)	
6+	65 (42.2)	14 (58.3)	
Number of relatives seen per month			
None	11 (7.1)	4 (16.7)	0.23
1-5	77 (50.0)	9 (37.5)	
6+	66 (42.9)	11 (45.8)	

233

234 Table 5 Characteristics of participants who missed a follow-up appointment and those who stayed in the study, 2014-2017, UK.

	Missed 3 months follow-up		Missed 12 months follow-up		Missed 24 months follow-up	
Total	**Yes** (*n* = 21)	**No** (*n* = 133)	**Yes** (*n* = 24)	**No** (*n* = 130)	**Yes** (*n* = 53)	**No** (*n* = 101)
	N (%) / mean (SD)		N (%) / mean (SD)		N (%) / mean (SD)	
Gender: Women	17 (81.0%)	95 (71.4%)	16 (66.7%)	96 (73.9%)	35 (66.0%)	77 (76.2%)
Age on the day of surgery	**38.9 (12.6)**	**46.9 (11.5)*** **	**38.8 (11.1)**	**47.1 (11.6)*** **	**43.6 (11.8)**	**47.0 (11.9)***
Ethnicity						
White British & other White	17 (81.0%)	98 (73.7%)	19 (79.2%)	96 (73.8%)	39 (73.6%)	76 (75.3%)
Non-White ethnicities	3 (14.3%)	22 (16.5%)	5 (20.8%)	20 (15.4%)	7 (13.2%	18 (17.8%)
Not stated ethnicity	1 (4.7%)	13 (9.8%)	0	14 (10.8%)	7 (13.2%)	7 (6.9%)
Employed: Yes vs. No	13 (61.9%)	77 (57.9%)	15 (62.5%)	75 (57.7%)	34 (64.2%)	56 (55.5%)
Rosenberg's self-esteem scale (0-30)	20.2 (6.3)	19.3 (5.9)	19.6 (19.4)	19.4 (5.9)	19.6 (5.7)	19.3 (6.1)
Pearlin's mastery scale (0-28)	21.2 (2.8)	20.7 (3.6)	20.9 (3.7)	20.8 (3.4)	20.6 (3.4)	20.9 (3.5)
Received emotional support (0-21)	17.5 (3.2)	16.7 (4.0)	17.3 (3.3)	16.7 (4.0)	16.5 (4.5)	17.0 (3.6)
Received practical support (0-9)	6.2 (3.3)	6.3 (2.5)	6.2 (3.0)	6.3 (2.5)	**5.7 (2.9)**	**6.5 (2.4)***
Number of friends seen per month						
None	0	9 (6.8%)	2 (8.3%)	7 (5.4%)	3 (5.6%)	6 (5.9%)
1-5	10 (47.6%)	70 (52.6%)	12 (50.0%)	68 (52.3%)	25 (47.2%)	55 (54.5%)
6+	11 (52.4%)	54 (40.6%)	10 (41.7%)	55 (42.3%)	25 (47.2%)	40 (39.6%)
Number of relatives seen per month						
None	0	11 (8.3%)	3 (12.5%)	8 (6.2%)	2 (3.8%)	9 (8.9%)
1-5	12 (57.1%)	65 (49.9%)	12 (50.0%)	65 (50.0%)	28 (52.8%)	49 (48.5%)
6+	9 (42.9%)	57 (42.8%)	9 (37.5%)	57 (43.8%)	23 (43.4%)	43 (42.6%)

235 * p<0.1; ** p<0.05; *** p<0.001

Ethical statement (blinded)

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval for this study was granted by the Health Research Authority's National Research Ethics Service Committee London - Harrow.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

All but three authors declare that they have no conflict of interest. Author 1 reports grants from Fractyl, other from Novo Nordisk, other from Orexigen, other from Medtronic, other from Ethicon, other from Nestle, outside the submitted work. Author 2 reports grants and personal fees from Olympus, grants and other from Ethicon, grants and personal fees from Gore, other from Stryker, outside the submitted work. Author 3 reports other from Johnson & Johnson, personal fees from WL Gore, personal fees and other from Olympus Keymed, outside the submitted work.

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References

1. Picot J, Jones J, Colquitt J, Gospodarevskaya E, Loveman E, Baxter L, et al. The clinical effectiveness and cost-effectiveness of bariatric (weight loss) surgery for obesity: a systematic review and economic evaluation. Health Technol Assess. 2009;13:1–190, 215–357, iii–iv.

2. Bult MJF, van Dalen T, Muller AF. Surgical treatment of obesity. Eur J Endocrinol. 2008;158:135–45.

3. Manning S, Pucci A, Carter NC, Elkalaawy M, Querci G, Magno S, et al. Early postoperative weight loss predicts maximal weight loss after sleeve gastrectomy and Roux-en-Y gastric bypass. Surg Endosc. 2015;29:1484–91.

4. de Hollanda A, Ruiz T, Jiménez A, Flores L, Lacy A, Vidal J. Patterns of Weight Loss Response Following Gastric Bypass and Sleeve Gastrectomy. Obes Surg. 2015;25:1177–83.

5. Douglas IJ, Bhaskaran K, Batterham RL, Smeeth L. Bariatric Surgery in the United Kingdom: A Cohort Study of Weight Loss and Clinical Outcomes in Routine Clinical Care. PLoS Med. 2015;12:e1001925.

6. Magro DO, Geloneze B, Delfini R, Pareja BC, Callejas F, Pareja JC. Long-term Weight Regain after Gastric Bypass: A 5-year Prospective Study. Obes Surg. 2008;18:648–51.

7. Christakis NA, Fowler JH. The spread of obesity in a large social network over 32 years. N Engl J Med. 2007;357:370–9.

8. Powell K, Wilcox J, Clonan A, Bissell P, Preston L, Peacock M, et al. The role of social networks in the development of overweight and obesity among adults: a scoping review. BMC Public Health. 2015;15:996.

9. Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. PLoS Med. 2010;7:e1000316.

10. Reblin M, Uchino BN. Social and emotional support and its implication for health. Curr Opin Psychiatry. NIH Public Access; 2008;21:201–5.

11. Thoits PA. Mechanisms Linking Social Ties and Support to Phyical and Mental Health. J Health Soc Behav. 2011;52:145–61.

12. DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. Heal Psychol. 2004;23:207–18.

13. Kouvonen A, Stafford M, De Vogli R, Shipley MJ, Marmot MG, Cox T, et al. Negative aspects of close relationships as a predictor of increased body mass index and waist circumference: the Whitehall II study. Am J Public Health. 2011;101:1474–80.

14. Oliveira AJ, Rostila M, de Leon AP, Lopes CS. The influence of social relationships on obesity: sex differences in a longitudinal study. Obesity. 2013;21:1540–7.

15. Kershaw KN, Hankinson AL, Liu K, Reis JP, Lewis CE, Loria CM, et al. Social relationships and longitudinal changes in body mass index and waist circumference: the coronary artery risk development in young adults study. Am J Epidemiol. 2014;179:567–75.

16. Still CD, Sarwer DB, Blankenship J, editors. The ASMBS Textbook of Bariatric Surgery: Volume 2: Integrated Health. New York: Springer; 2014.

17. Gottlieb BH, Bergen AE. Social support concepts and measures. J Psychosom Res. 2010;69:511–20.

18. Lanyon RI, Maxwell BM. Predictors of outcome after gastric bypass surgery. Obes Surg. 2007;17:321–8.

19. Canetti L, Berry EM, Elizur Y. Psychosocial predictors of weight loss and psychological adjustment following bariatric surgery and a weight-loss program: the mediating role of emotional eating. Int J Eat Disord. 2009;42:109–17.

20. Delin CR, Watts JMW, Bassett DL. An Exploration of the Outcomes of Gastric Bypass Surgery for Morbid Obesity: Patient Characteristics and Indices of Success. Obes Surg. 1995;5:159–70.

21. Livhits M, Mercado C, Yermilov I, Parikh J a, Dutson E, Mehran A, et al. Behavioral factors associated with successful weight loss after gastric bypass. Am Surg. 2010;76:1139–42.

22. Ray EC, Nickels MW, Sayeed S, Sax HC. Predicting success after gastric bypass: the role of psychosocial and behavioral factors. Surgery. 2003;134:555–63.

23. van de Laar A, de Caluwé L, Dillemans B. Relative outcome measures for bariatric surgery. Evidence against excess weight loss and excess body mass index loss from a series of laparoscopic Roux-en-Y gastric bypass patients. Obes Surg. 2011;21:763–7.

24. van de Laar A. Bariatric Outcomes Longitudinal Database (BOLD) suggests excess weight loss and excess BMI loss to be inappropriate outcome measures, demonstrating better alternatives. Obes Surg. 2012;22:1843–7.

25. Moore DD, Cooper CE. Life After Bariatric Surgery: Perceptions of Male Patients and Their Intimate Relationships. J Marital Fam Ther. 2016;42:495–508.

306 26. Ogle JP, Park J, Damhorst ML, Bradley LA. Social Support for Women Who Have Undergone Bariatric
307 Surgery. Qual Health Res. 2016;26:176–93.

308 27. Livhits M, Mercado C, Yermilov I, Parikh J a, Dutson E, Mehran A, et al. Is social support associated with
309 greater weight loss after bariatric surgery?: a systematic review. Obes Rev. 2011;12:142–8.

310 28. Stansfeld S, Marmot M. Deriving a survey measure of social support: The reliability and validity of the
311 close persons questionnaire. Soc Sci Med. 1992;35:1027–35.

312 29. Stansfeld SA, Fuhrer R, Shipley MJ. Types of social support as predictors of psychiatric morbidity in a
313 cohort of British Civil Servants (Whitehall II Study). Psychol Med. 1998;28:881–92.

314 30. Fuhrer R, Stansfeld SA. How gender affects patterns of social relations and their impact on health: a
315 comparison of one or multiple sources of support from “close persons”. Soc Sci Med. 2002;54:811–25.

316 31. Liao J, McMunn A, Mejía ST, Brunner EJ. Gendered trajectories of support from close relationships from
317 middle to late life. Ageing Soc. Cambridge University Press; 2018;38:746–65.

318 32. Schmitt DP, Allik J. Simultaneous administration of the Rosenberg Self-Esteem Scale in 53 nations:
319 exploring the universal and culture-specific features of global self-esteem. J Pers Soc Psychol. 2005;89:623–
320 42.

321 33. Pearlin LI, Schooler C. The structure of coping. J Health Soc Behav. 1978;19:2–21.

322 34. Verheijden MW, Bakx JC, van Weel C, Koelen M a, van Staveren W a. Role of social support in lifestyle-
323 focused weight management interventions. Eur J Clin Nutr. 2005;59 Suppl 1:S179–86.

324 35. Liebl L, Barnason S, Brage Hudson D. Awakening: a qualitative study on maintaining weight loss after
325 bariatric surgery. J Clin Nurs. 2016;25:951–61.

326 36. Pucci A, Tymoszuk U, Cheung WH, Makaronidis JM, Scholes S, Tharakan G, et al. Type 2 diabetes
327 remission 2 years post Roux-en-Y gastric bypass and sleeve gastrectomy: the role of the weight loss and
328 comparison of DiaRem and DiaBetter scores. Diabet Med. 2017;35:360–7.

329 37. Puhl RM, Brownell KD. Confronting and coping with weight stigma: an investigation of overweight and
330 obese adults. Obesity. 2006;14:1802–15.

331 38. Carr D, Friedman MA. Body Weight and the Quality of Interpersonal Relationships. Soc Psychol Q.
332 2006;69:127–49.

333 39. Bruze G, Holmin TE, Peltonen M, Ottosson J, Sjöholm K, Näslund I, et al. (in press). Associations of
334 Bariatric Surgery With Changes in Interpersonal Relationship Status. JAMA Surg. 2018; doi:
335 10.1001/jamasurg.2018.0215.