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Associations of daily weight management-focused social support with weight loss, activity behaviors, and eating regulation in the context of metabolic and bariatric surgery

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Abstract

Objective: Greater perceived social support (PSS) is associated with more favorable changes in weight loss, activity behaviors, and eating regulation after metabolic and bariatric surgery (MBS). However, studies have relied on generic, retrospective PSS measures, and stability of PSS levels and relations with weight loss and weight-related behaviors over time is unknown. Using smartphone-based Ecological Momentary Assessment, this study evaluated pre-to 1-year post-MBS changes in daily weight management-focused PSS and associations with weight loss, device-measured activity behaviors, and eating regulation before and during the initial year after MBS.

Method: Adult MBS patients (n = 71) received (1) an accelerometer to measure daily moderate-to-vigorous intensity physical activity (MVPA) and sedentary time (ST) minutes/day, and (2) a smartphone to complete morning weight-focused PSS ratings and eating regulation (dietary restraint/disinhibition) ratings at four semi-random times daily for 10 days at pre- and 3, 6, and 12-month postoperative. Generalized linear mixed models analyzed the associations of PSS with total weight loss (%TWL) and activity/eating outcomes.

Results: Participants on average reported relatively stable moderate-to-high PSS (3.98 on one to five scale) across assessments. Perceived social support was not related to %TWL, MVPA, or ST. Participants with higher PSS reported lower disinhibition and higher restraint than those with lower PSS (ps < 0.05); however, participants reported higher restraint on days that PSS was lower than their usual levels (p = 0.009).

Conclusions: MBS patients on average had stable PSS levels across time. Higher PSS levels were associated with greater resistance to overeating cues (disinhibition) and cognitive control to restrict food intake (restraint) over time. Additionally, participants reported higher restraint when PSS levels were lower than usual. Overall,

weight-focused PSS appeared to hold greater importance in relation to regulating eating behavior than engaging in activity behaviors or weight loss among MBS patients during the initial postoperative year.

Clinical Trial Registration: NCT02777177.

KEYWORDS
eating, metabolic bariatric surgery, physical activity, social support, weight loss

1 | INTRODUCTION

Perceived social support (PSS) refers to an individual's perception that family, friends, and significant others will be available to provide support when it is needed.[1] Social support is hypothesized to positively influence and be important for maintaining physical, psychological, and social health.[2] This influence may occur directly, with social support fulfilling needs for companionship, intimacy, and sense of belonging, and/or indirectly by strengthening personal coping resources to mitigate adverse health consequences of stressors and promoting increased performance of health behaviors (e.g., physical activity [PA]).[2] These processes of influence may also operate reciprocally whereby better psychosocial and physical health status contributes to greater ability to seek out and maintain supportive relationships.[2]

Social support, in the context of metabolic and bariatric surgery (MBS), is considered key to achieving positive surgical experiences and outcomes. The American Society of Metabolic and Bariatric Surgery recommends that MBS programs offer support groups both preoperatively to help patients prepare for MBS, and postoperatively to aid patients in adjusting to changes, maintaining connection with the clinical team, and staying committed to sustaining weight loss and health improvements.[3] This recommendation is supported by some studies,[4–8] but not all,[9] that show MBS support group attendance is related to better weight outcomes and adherence to postoperative behavioral recommendations. However, because most of these studies did not measure PSS, it is unclear whether increases in PSS are the primary driver of support group-related improvements in surgical outcomes or whether, for example, support group attendance serves as a proxy for other factors that contribute to improved outcomes. Further, many patients do not regularly attend MBS support groups suggesting that they seek and rely on other sources of social support (e.g., family and friends).[5]

Research that has directly assessed PSS in MBS patients suggests that higher PSS levels are associated with a wide range of benefits including fewer surgical complications, greater weight loss, lower depression and disordered eating, and positive changes in PA.[5,10–13] Conversely, both quantitative and qualitative data suggest that deficits in PSS contribute to smaller weight losses, reduced surgery satisfaction and feelings of loneliness, struggle, and self-blame during weight recurrence.[14,15]

Despite growing evidence that higher PSS levels are associated with improved behavioral adherence, psychological health, and weight outcomes after MBS, the design and methodological limitations of previous research reveal important knowledge gaps. First, because most studies have been cross-sectional, little is known about the relative stability of PSS levels across pre-and postoperative time points. Moreover, it is not clear how average PSS levels relate to weight loss over time or to activity and eating behaviors on a daily level. Second, previous research has largely relied on generic self-report PSS measures rather than weight management-focused PSS measures, which may be more salient to MBS patients' experiences and more useful for assessing relationships with weight and weight-related behaviors. Furthermore, because prior PSS measures involve retrospective reports, they are prone to biases such as forgetting and memory heuristics.

To counter the above limitations, the current study used smartphone-based Ecological Momentary Assessment (EMA) to repeatedly sample patients with weight management-focused PSS levels daily for 10 days before and at 3, 6, and 12 months after MBS. This study aimed to evaluate: (1) changes in PSS levels across the above timepoints; (2) concurrent and prospective associations of PSS with weight and weight loss; and (3) the degree to which PSS levels at the beginning of the day were related to activity (moderate-to-vigorous intensity physical activity [MVPA] and sedentary time [ST] measured via accelerometry) and eating regulation (dietary restraint and disinhibition measured via EMA) behaviors on that day. It was hypothesized that higher PSS levels would be associated with greater weight loss, higher levels of MVPA (and lower levels of ST) and better eating regulation (lower disinhibition and higher dietary restraint) on a daily level.

2 | METHODS

2.1 | Participant

This study used data from a parent prospective cohort study focused on identifying behavioral and psychosocial predictors of MBS outcomes. Participants were recruited from two university-based hospital MBS centers, the Miriam Hospital (Providence, RI, USA; Site 1) and the Beth Israel Deaconess Medical Center (Boston, MA, USA; Site 2), during a preoperative clinic visit. Eligibility criteria included ≥21 years of age, body mass index (BMI) ≥ 35 kg/m^2, and being scheduled for the Roux-en-Y gastric bypass or sleeve gastrectomy (SG) procedure. Exclusion criteria included receiving

treatment for weight loss or weight-related behaviors outside standard surgical care and reported the presence of a condition (e.g., uncontrolled severe mental illness) or factors (e.g., plans to geographically relocate) that could undermine the ability to complete the study protocol.

2.2 | Procedure

The full protocol details of the parent study were published in Goldstein et al.[16] and registered at www.clinicaltrials.gov (NCT02777177). Patients first completed a telephone screening interview with the research staff to determine initial eligibility. Patients then visited the research center where they were asked to complete informed consent, undergo height and weight measurements, and be trained on the EMA and activity monitoring protocols using a study-provided Android smartphone with the PiLR Health™ application (MEI Research Ltd.) and a wrist-worn accelerometer, respectively. For the EMA protocol, participants received a prompt on their smartphone at the start of each day for 10 days to complete a brief PSS survey. Participants also received four semi-random daily prompts assessing eating regulation around the anchors of 11:00 AM, 2:00 PM, 5:00 PM, and 8:00 PM. Compliance with daily prompts was monitored by the EMA system and made visible to participants in real-time. Participants wore the wrist-worn accelerometer for 24 h/day on the same 10 days that EMA was completed. For both the EMA and accelerometer protocols, participants were given additional days to provide data if they experienced technical or other challenges to ensure adequate compliance. Participants were compensated $75 for completing the baseline assessment plus $0.50 for each completed EMA survey. The above assessment procedures were repeated at 3, 6, and 12 months after MBS. All procedures were approved by the institutional review boards of The Miriam Hospital and Beth Israel Deaconess Medical Center.

2.3 | Measures

2.3.1 | EMA surveys

Perceived social support was assessed at the beginning of each day using five items adapted to focus on weight management from the 10-item Multidimensional Scale of PSS.[17] These five items were selected as having the best face validity for being most broadly representative of the construct. Participants were instructed to rate the items (e.g., "I have friends and family with whom I can share ups and downs related to my weight" and "There is a special person who is around when I need help with my weight") on a Likert-type scale ranging from 1 ("strongly disagree") to 5 ("strongly agree") based on how they felt at that moment. Perceived social support items were averaged for each day to create a daily composite score, which was used in day-level analyses. The multilevel reliability was adequate (within-subjects omega = 0.79; between-subjects omega = 0.97). Average daily scores were averaged across the 10-day protocol for assessment-level analyses.

Eating regulation was assessed four at each of the four daily EMA surveys using five items adapted from the cognitive restraint (e.g., "I consciously eat slowly in order to cut down on how much I eat") and disinhibition (e.g., "Things just taste so good that I keep on eating even when I am no longer hungry") subscales of the Three Factor Eating Questionnaire.[18] Each item was rated on a Likert-type scale ranging from 1 ("never") to 5 ("always") with mean subscale scores calculated at each prompt. Restraint and disinhibition items were averaged for each day to create daily composite scores (for day-level analyses) and were averaged across the 10-day protocol (for assessment-level analyses).

2.3.2 | Activity behaviors (moderate-to-vigorous intensity physical activity and sedentary time)

Daily MVPA and ST were assessed using an ActiGraph GT9X Link wrist-worn accelerometer (ActiGraph, LLC). Participants had to wear the accelerometer for ≥10 h/day for ≥4 days at each assessment to be included in analyses. Sleep and non-wear (i.e., ≥90 min without movement using vector magnitude counts and with allowance of interruptions of ≤2 min of non-zero counts) periods were identified and removed. Vector magnitude counts per minute threshold for wrist-worn Actigraph accelerometers were used to estimate the daily time spent in ST (<2000 counts per minute) and MVPA (≥7500 counts per minute).[19,20]

2.3.3 | BMI, weight (kg) and percentage of total weight loss

Trained research staff measured participants' height (mm) with a wall-mounted Harpenden stadiometer and weight to the nearest 0.1 kg with a calibrated digital scale. %TWL was calculated at each assessment point as follows: ([baseline weight—follow-up weight (i.e., 3, 6, or 12-month weight)] ÷ baseline weight) * 100%.

2.4 | Statistical approach

Participants' PSS was calculated both at the day level (i.e., the mean of the five PSS items that were completed at the beginning of the day) as well as at the wave level (i.e., the mean level of PSS across all EMA days within a given assessment timepoint [pre or 3, 6, or 12 months postoperative]). Descriptive statistics were calculated to characterize participants' PSS, and repeated measures analysis of variance (ANOVA) was conducted to assess changes in PSS across EMA waves.

To assess primary study aims, separate generalized linear mixed models (GLMMs) were used to examine whether PSS was associated with %TWL, eating regulation (i.e., restraint and disinhibition) and

activity behaviors (i.e., MVPA and ST). Spearman correlations assessed the degree to which variables were associated with potential covariates; final models included age (at baseline), sex, and educational attainment as covariates, and GLMMs assessing MVPA and ST included accelerometer wear time as a covariate. Time (months since surgery) was also screened as a covariate but did not contribute to any model. Given the non-normal distribution of MVPA, a negative binomial distribution was specified for these analyses; linear distributions were employed for all other GLMMs. Generalized linear mixed models utilized all available data.

2.4.1 | PSS and weight outcomes

The first GLMMs assessed the degree to which PSS was related to concurrent and prospective weight outcomes (i.e., %TWL at the same and next EMA wave). In addition to covariates, each GLMM included the fixed effects of PSS, which was decomposed into within- and between-person effects. Within-person PSS was person-mean centered (i.e., reflecting the degree to which a participants' average PSS during the EMA wave differed from his/her own average across EMA waves), whereas between-person PSS was grand-mean centered (i.e., reflecting the degree to which a participant's average PSS across EMA waves differed from other participants' average PSS across waves). The prospective model lagged the within-person %TWL from the prior EMA wave. Each GLMM specified a random intercept and AR1 covariance structure given the nested nature of the data.

2.4.2 | PSS, activity behaviors, and eating regulation

Similar GLMMs were conducted to assess the degree to which PSS at the beginning of the day was related to MVPA, ST, restraint, and disinhibition on that day. A different approach to centering was used given that outcome variables were assessed multiple times within each wave. Within-person PSS was person-mean centered at the wave level (i.e., reflecting the degree to which a participant's daily PSS differed from his/her own average during the EMA wave), whereas between-person PSS was grand-mean centered (i.e., reflecting the degree to which a participant's average PSS during the EMA wave differed from other participants' average PSS). Given the skewed distribution of MVPA over time, a negative binomial distribution was specified for this GLMM. Analyses were limited to participants with at least some data for PSS and dependent variables of interest.

3 | RESULTS

Descriptive statistics are provided in Table 1. Of 170 participants screened, 92 consented, 77 completed the baseline assessment, and 71 had MBS and provided sufficient EMA and actigraphy data for analysis at baseline (33 at Site 1; 38 at Site 2). The number of participants providing sufficient data for inclusion in analysis at follow-up visits included 61 participants at 3-month (26 at Site 1; 35 at Site 2), 54 participants at 6-month (25 at Site 1; 29 at Site 2), and 49 participants at 12-month (25 at Site 1; 24 at Site 2) follow-ups. The average compliance to beginning-of-day EMA signals (when PSS was measured) ranged from 83% to 87% across EMA waves. The majority of participants were female (91.5%) and attended some college or higher educational attainment (83.9%), and 40.8% were married. Most participants (74.6%) underwent the SG procedure and identified as White (n = 40; 56.3%; non-Hispanic White: n = 37). The remaining participants were identified as Black or African American (n = 21), American Indian or Alaskan Native (n = 1), or other races (n = 13). Study non-completers (i.e., no data at 12-month follow-up) were younger than study completers (40.3 versus 46.3 years; p = 0.03); non-completers and completers did not differ on baseline weight or other sociodemographic characteristics (p's > 0.05).

3.1 | Changes in PSS and associations with weight outcomes

The repeated measures ANOVA did not show a main effect of time (F[3] = 0.62, p = 0.567), indicating that there was no significant

TABLE 1 Descriptive statistics.

	Baseline/ Pre-surgery		3 months post-surgery		6 months post-surgery		12 months post-surgery	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age at baseline (years)	44.31	11.11	-	-	-	-	-	-
Social support	3.97	1.05	4.00	1.04	3.96	1.11	3.94	1.19
Percent total weight loss	-	-	−17.02	3.53	−23.60	5.74	−26.92	8.66
Restraint	2.95	0.46	3.24	0.54	3.26	0.54	3.23	0.55
Disinhibition	2.39	0.83	1.80	0.57	1.91	0.59	1.87	0.62
Sedentary time (daily min.)	634.26	129.19	629.48	114.61	607.70	126.50	573.82	109.93
MVPA time (daily min.)	38.98	26.50	40.99	34.06	45.06	36.30	46.66	42.39

Abbreviation: MVPA, moderate to vigorous physical activity.

change in PSS across EMA waves. Table 2 displays GLMM results. Generalized linear mixed models assessing weight outcomes did not show between- or within-person effects of PSS in relation to concurrent or prospective %TWL (ps = 0.308 to 0.899).

3.2 | Associations of PSS with activity behaviors and eating regulation

Between- and within-person PSS were not related to activity behaviors, ST (ps = 0.870 and 0.669) or MVPA (ps = 0.890 and 0.077), at the daily level. In contrast, PSS was related to eating regulation variables. Specifically, there were significant between- and within-person effects of PSS predicting restraint, albeit in different directions (between-person PSS: $B = 0.07$, SE = 0.04, $p = 0.040$; within-person PSS: $B = -0.03$, SE = 0.01, $p = 0.019$). That is, participants with greater overall PSS reported higher levels of restraint compared to those with lower PSS; however, on days during which participants reported less PSS than their usual level, they reported higher levels of restraint. There was also a significant between-person effect of PSS predicting disinhibition ($B = -0.13$, SE = 0.05, $p = 0.011$), indicating participants who had greater overall PSS reported less disinhibited eating compared to those who had less PSS. There was not a significant within-person effect of PSS predicting disinhibition ($p = 0.478$).

4 | DISCUSSION

This study has three main findings. The first main finding is that participants on average reported moderate-to-high levels of PSS across the pre- and postoperative (3, 6, and 12-month) time points. This finding suggests that participants felt they had adequate social support from friends and family around managing their weight leading up to MBS and these perceptions remained relatively stable during the initial year after MBS.

The second main finding is that PSS levels were not related to weight loss, in contrast with previous research.[5,11–13] Although the reasons for this discrepancy are not entirely clear, one possible explanation is that the current study focused on specific types and sources of PSS. The PSS survey items largely reflected emotional and appraisal/esteem types of social support from friends and family (e.g., "I have friends and family with whom I can share ups and downs related to my weight"). It is likely that different types of social support (e.g., informational and instrumental) provided by individuals outside patients' family and friend support networks (e.g., members of the MBS multidisciplinary clinical team and patient peers) are also important for facilitating greater weight loss after MBS.[14,21,22] This may include receiving advice from clinical dieticians regarding ways to avoid undesirable gastrointestinal symptoms or cooking tips from fellow patients. Additionally, whereas most studies have assessed PSS more generally and not in relation to a specific goal, the current

TABLE 2 Generalized linear mixed model (GLMM) results.

	Concurrent %TWL			Prospective %TWL			Restraint			Disinhibition		
	B	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
Intercept	−30.73	4.47	<0.001	−30.03	4.49	<0.001	2.96	0.31	<0.001	1.53	0.39	<0.001
Age	0.11	0.07	0.143	0.12	0.07	0.119	0.00	0.01	0.778	0.00	0.01	0.968
Sex	1.86	2.71	0.493	1.74	2.74	0.526	0.16	0.19	0.398	0.18	0.24	0.461
Education	0.71	0.63	0.259	0.52	0.62	0.406	0.04	0.04	0.385	0.10	0.05	0.077
Social support (between)	−0.22	0.84	0.791	−0.11	0.85	0.899	0.07	0.04	0.040	−0.13	0.05	0.011
Social support (within)	1.39	1.47	0.346	1.37	1.34	0.308	−0.03	0.01	0.019	−0.01	0.01	0.478

	MVPA time			Sedentary time		
	B	*SE*	*p*	*B*	*SE*	*p*
Intercept	−295.56	46.17	<0.001	3.76	0.44	<0.001
Age	1.17	0.75	0.121	−0.01	0.01	0.051
Sex	57.12	26.77	0.033	−0.40	0.26	0.121
Education	17.64	6.10	0.004	−0.05	0.06	0.440
Weartime	0.76	0.01	<0.001	<0.001	0.00	<0.001
Social support (between)	−0.88	5.41	0.870	0.07	0.04	0.077
Social support (within)	−2.75	6.43	0.669	−0.01	0.04	0.899

Note: Sex was coded such that women were the reference category.

Abbreviations: %TWL, percent total weight loss; MVPA, moderate to vigorous physical activity.

study assessed weight management-focused PSS from friends and family before and during the immediate year after MBS. It is possible that weight management-focused PSS from family and friends might be less important when patients are actively losing weight and more so when they are experiencing weight recurrence and potentially struggling with feelings of shame and self-blame.[14] Future studies should employ multidimensional PSS measures during different phases of patients' weight trajectories to better understand how different types and sources of PSS relate to weight loss and weight recurrence.

The third main finding is that PSS was related to eating regulation but not activity behaviors. With respect to eating regulation, between-person results showed that participants with higher PSS levels reported lower disinhibition and higher restraint, suggesting that higher PSS levels might have helped MBS patients to resist the temptation of food and cues to overeat. Given research showing that higher disinhibition is associated with smaller weight losses and greater weight recurrence among MBS patients,[23,24] research is needed to determine whether strategies to increase patients' PSS from friends and family can help increase resistance to cues that can lead to overeating.

In contrast, within-person results showed that on days when participants' PSS levels were lower than usual, they reported higher levels of dietary restraint. This novel and important finding showcases the power of EMA as a measurement tool and the ability to gain near real-time insights into how MBS patients attempt to regulate their eating in their daily life when feeling they have less support from friends and family regarding their weight management efforts. This finding also suggests that dietary restraint may function as a coping mechanism for MBS patients during periods of lower perceived availability of social support.

Perceived social support, however, was not associated with MVPA or ST. This is in contrast to findings from the only other similar study by Kovacs and colleagues,[25] who found that higher PSS and larger pre-to postoperative increases in PSS were associated with higher PA levels and larger pre-to postoperative PA changes, respectively. However, it might not be appropriate to compare these findings given significant variations in methodology that ultimately represent different research questions. The former study assessed associations between PSS for PA (from family, friends and coworkers) and self-reported PA throughout the past week among patients who varied widely in where they were in their weight trajectory (i.e., <3 to 24-month postoperative). The current study assessed the associations of PSS for overall weight management with objectively measured MVPA and ST on a daily level at the same time points before and during the initial year after MBS. Results suggest that PSS from family and friends did not contribute to differences in daily MVPA and ST between participants or within the same participant during each assessment.

Taken together, the above findings suggest that daily weight-focused PSS from friends and family may hold greater importance for the regulation of eating behaviors than activity behaviors among MBS patients. This could be due to differences in how often, how long, and the social context in which these behaviors are performed. For example, compared to sustained bouts of PA, eating episodes for MBS patients occur more frequently throughout the day, cumulative daily time spent eating is likely greater, and eating likely occurs more often in the company of family and friends, possibly resulting in more opportunities to receive and feel support. Future studies should assess the frequency and context in which PSS for weight management and specific behaviors is provided.

While this study has the multiple above-mentioned strengths that advance scientific rigor and understanding of the relationship of PSS to weight and behavioral outcomes in MBS patients, several limitations should also be noted. There are no data available on the level of participant engagement in clinically offered services including support groups; however, the PSS measure focused only on friends and family (not health care professionals and fellow patients) as sources of social support. We could not determine whether PSS from friends and family, even if high, was welcome or the most preferred source of social support. The study period was limited to the immediate post-surgical year when most participants were actively losing weight. It is possible that relationships of social support with weight, eating and activity outcomes may differ during weight stability and recurrence. Although protocol compliance was high within assessment waves, there was moderate participant attrition across assessment waves, which may affect the internal validity of the findings. The sample may also be subject to selection bias as participants completed an intensive assessment protocol and may be more conscientious than the average MBS patient. Therefore, this analysis and related findings should be treated as exploratory and hypothesis-generating.

5 | CONCLUSION

This study is the first to assess changes in daily weight management-focused PSS from family and friends and associations with weight, eating, and activity outcomes before and during the initial year after MBS. Participants reported stable moderate-to-high PSS levels across assessments. Perceived social support was not related to weight loss or daily engagement in activity behaviors. However, participants with higher levels of PSS reported less disinhibited eating and higher restraint than those with lower levels of PSS; however, higher levels of dietary restraint were reported on days when PSS levels were lower than their usual levels. Additional research is needed to evaluate: the relative importance of PSS types, sources, and foci in relation to weight, energy balance behaviors, and other important MBS outcomes (e.g., surgery satisfaction, psychiatric symptoms, and disordered eating) at different points in patients' weight trajectory; and whether engaging patients' support systems and/or enhancing the social support components of

adjunctive interventions can improve MBS patients' adherence to recommended behaviors and weight and other related outcomes.

AUTHOR CONTRIBUTIONS

Dale S. Bond and J. Graham Thomas conceived the study and design. Dale S. Bond and J. Graham Thomas acquired the data.Kathryn E. Smith and DSB analyzed and interpreted the data. Dale S. Bond and Kathryn E. Smith drafted the manuscript. All authors revised the manuscript for intellectual content and approved the final version of the completed manuscript. We thank the study participants for their commitment to this study.

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CONFLICT OF INTEREST STATEMENT

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