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Family factors that characterize adolescents with severe obesity and their role in weight loss surgery outcomes

Meg H. Zeller[1], **Sanita Hunsaker**[1], **Carmen Mikhail**[2,3], **Jennifer Reiter-Purtill**[1], **Mary Beth McCullough**[1], **Beth Garland**[2,3], **Heather Austin**[4], **Gia Washington**[2,3], **Amy Baughcum**[5], **Dana Rofey**[6], and **Kevin Smith**[5] **for the TeenView Study Group and in collaboration with the Teen-LABS Consortium**

[1]Cincinnati Children's Hospital Medical Center, Cincinnati OH

[2]Texas Children's Hospital, Houston, TX

[3]Baylor College of Medicine, Houston, TX

[4]Children's Hospital of Alabama, Birmingham, AL

[5]Nationwide Children's Hospital, Columbus, OH

[6]University of Pittsburgh Medical Center, Pittsburgh, PA

Abstract

Objective—To comprehensively assess family characteristics of adolescents with severe obesity and whether family factors impact weight loss outcomes following weight loss surgery (WLS).

Methods—Multi-site prospective data from 138 adolescents undergoing WLS and primary caregivers (Adolescent M_{age}=16.9; M_{BMI}= 51.5 kg/m^2; Caregiver: M_{age}=44.5; 93% female) and 83 non-surgical comparators (NSComp: Adolescent: M_{age}=16.1; $M_{\text{BMI=}}$ 46.9 kg/m^2; Caregiver: M_{age}=43.9; 94% female) were collected using standardized measures at pre-surgery/baseline, 1- and 2-years.

Results—The majority (77.3%) of caregivers were obese, with rates of caregiver WLS significantly higher in the WLS (23.8%) versus NSComp group (3.7%, $p<.001$). Family dysfunction was prevalent (≈1 in every 2–3 families), with rates higher for NSComp than the WLS group. For the WLS group, pre-operative family factors (i.e., caregiver BMI or WLS history, dysfunction, social support) were not significant predictors of adolescent weight loss at 1- and 2-years post-operatively, although change in family functioning over time emerged as a significant correlate of percent weight loss.

Please direct all correspondence to Meg H. Zeller, PhD, Division of Behavioral Medicine and Clinical Psychology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, MLC3015, Cincinnati, OH 45229, USA. meg.zeller@cchmc.org.

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Conclusions—Rates of severe obesity in caregivers as well as family dysfunction were clinically noteworthy, although not related to adolescent weight loss success following WLS. However, change in family communication and emotional climate over time emerged as potential targets to optimize weight loss outcomes.

Keywords

Severe Obesity; Bariatric Surgery; Family; Adolescents

Introduction

Emerging evidence supports the safety, efficacy, and improved physical and psychosocial health when adolescents with severe obesity (body mass index [BMI] ≥ 120% of the BMI-for-age 95th percentile) undergo weight loss surgery (WLS).[1–5] Elucidating factors that contribute to optimal/less optimal adolescent WLS outcomes are vital to inform patient care. Unlike adult WLS care, pediatrics requires the presence and involvement of caregivers. Best practice guidelines for adolescent WLS patient care stress the importance of assessing the family,[6–8] yet our understanding of family characteristics and their role in WLS outcomes is limited.

Obesity is typically a shared disease among family members, particularly mother and child, with known genetic and environmental contributions.[9,10] However, only a minority of youth with obesity (BMI ≥ 95th percentile) live in home environments characterized by “unhealthy” family functioning (i.e., higher conflict, less affective engagement, and/or poor communication compared to healthy samples or non-overweight youth[11–13]). That said, impaired family functioning is a known risk factor for poorer treatment outcomes in pediatric conditions reliant on regimen adherence, lifestyle change, and/or of high treatment intensity (e.g., diabetes, cystic fibrosis, organ transplant),[14–18] factors critical in the early WLS post-operative course. For adolescents specifically, impaired family functioning and communication with parents (i.e., low in frequency, conflictual) are also influential correlates of weight-related health practices.[19–21]

Our initial work described families of adolescents prior to undergoing Roux-en-Y gastric bypass (RYGB) compared to families of non-surgical adolescents with severe obesity seeking lifestyle intervention.[22] Caregiver obesity prevalence was high (86% BMI≥ 30 kg/m^2), with WLS caregivers (25%) more likely to have also undergone WLS themselves. Prevalence of clinical range caregiver-reported family dysfunction ($25.0\%_{WLS}$ vs. $35.7\%_{non\text{-}surgical,}$ ns) and psychological distress ($12.5\%_{WLS}$ vs. $39.3\%_{non\text{-}surgical,}$ ns) were low and remained stable at 1-year post-operatively. Sysko and colleagues demonstrated that adolescents’ report of greater pre-operative family conflict was predictive of poorer weight loss outcomes at 1-year post-operatively following adjustable gastric banding (AGB).[4] These early data warrant further investigation with larger samples and beyond the 1st post-operative year, particularly as weight loss trajectories begin to differentiate.[1]

Our aims were to (Aim 1) describe family characteristics of adolescents prior to WLS relative to adolescent comparators with severe obesity seeking non-surgical treatment. Characteristics included: caregiver BMI and history of WLS, caregiver- and adolescent-reported family functioning, caregiver psychological distress, adolescent perceived family social support (network size, satisfaction, caregiver presence in the home) and demographics (caregiver age and education, family composition). Based on aforementioned literature, we hypothesized the majority of primary caregivers would meet criteria for obesity while a minority of families would meet criteria for “unhealthy” family functioning or have caregivers reporting psychological distress, with no significant group differences. We anticipated no group differences in family social support. We expected a significantly higher rate of caregiver WLS for adolescents in the WLS group versus non-surgical caregivers. For the WLS group we (Aim 2) examined the impact of pre-operative family characteristics on adolescent weight loss at 12- and 24-months, hypothesizing unhealthy family functioning, caregiver psychological distress, and lower social support would negatively impact adolescent weight loss outcomes. We also explored whether stability versus any change in family functioning over time would impact adolescent weight loss outcomes

Methods

Study Design Overview

TeenView is an ancillary study to the Teen Longitudinal Assessment of Bariatric Surgery Consortium (Teen-LABS), a prospective observational cohort study being executed across five academic centers in the United States to document the safety and efficacy of WLS in 242 adolescent patients.[23] TeenView aims to characterize psychosocial risks and benefits of WLS across the first two post-operative years and recruited two cohorts (2008–2012): (1) Teen-LABS participants and their caregivers (“WLS”), and (2) demographically similar comparator adolescents with severe obesity and their caregivers (“NSComp”) in nonsurgical lifestyle modification programs at these five sites. TeenView was not designed as a comparative intervention trial (i.e., WLS vs. lifestyle modification), but to elucidate psychosocial benefits and risks associated with adolescent WLS relative to severe obesity’s “natural course”. Baseline/pre-surgical, 12-month (BMI only) and 24-month data were utilized in analyses. Institutional Review Boards approved study protocols.

Participants

TeenView eligibility required the adolescent: 1) had a baseline BMI ≥ 40 kg/m^2; was 2) 13–18 years of age; with 3) no developmental delay due to high reading demand; 4) a caregiver willing to participate; and 5) the ability to speak and read English. Of 159 Teen-LABS participants eligible, 14 declined and 4 (consented) could not participate prior to surgery, resulting in 141 participating adolescents (88.7%). The older sibling was excluded in sibling pairs (n=2) and 1 caregiver consented but could not participate prior to surgery, resulting in a pre-surgical WLS sample of 139 adolescents and 138 caregivers. At 24-months, 8 adolescents declined, 8 could not be located, and 1 had incomplete data, leaving 122 of 139 (87.8%) adolescents. For caregivers with participating adolescents, 89 of 122 (73.0%) continued to participate.

Comparator adolescents were recruited from TeenView research registries of study eligible youth within site-specific non-surgical lifestyle modification programs whose families were interested in study enrollment should their adolescent become a demographic match (i.e., gender, race, +/− 6 months in age) to a WLS group adolescent. During enrollment, 86 potential comparators emerged as demographic matches, and were approached, of whom 83 adolescents and caregivers (96.5%) agreed to participate. At 24-months, 3 adolescents declined and 5 could not be located, leaving 75 of 83 (90.4%) adolescents. For caregivers with participating adolescents, 71 of 75 (94.7%) continued to participate.

Procedure

Baseline (within 30 days prior to surgery), 12-month and 24-month follow-up measures were collected by trained study personnel at a clinical center using a standardized protocol via paper-and-pencil and/or laptop computer. Participants were informed via the consent/assent process that responses were confidential. If adolescent participants could not complete an in-person follow-up study visit, they completed paper/pencil forms at home or via web, with height and weight measurements obtained via field visits by study affiliates for WLS (n=7 at 12-months, n=18 at 24-months)[1] or as self-report for comparators (n=1 at 12-months, n=5 at 24-months).

Measures

BMI and percent weight loss—Adolescent and caregiver measured height and weight data were used to calculate BMI (kg/m^2). Adolescent percent weight loss was calculated as ([weight$_{\text{pre-surgery}}$ − weight$_{\text{follow-up}}$]/weight$_{\text{pre-surgery}}$)*100. Percent change in weight (versus BMI) is the recommended standard metric in bariatric outcome research to facilitate interpretation and comparison across bariatric samples and studies,[24] but also assumes height is stable. In further support of our approach, Teen-LABS recently demonstrated little increase in adolescent height over time, with the magnitude of BMI reduction nearly identical to that of weight reduction.[1]

Family functioning—The Family Assessment Device (FAD)[25] is a psychometrically sound 60-item questionnaire validated for caregiver and adolescent (> 12 years) report assessing six dimensions of family functioning: Problem-solving (ability to resolve problems), Communication (exchange of clear and direct verbal information), Roles (division of responsibility in completing family tasks), Affective Responsiveness (ability to respond with appropriate emotion), Affective Involvement (degree to which family members are involved and interested in one another), Behavior Control (manner used to express and maintain standards of behavior) and a separate scale of overall General Functioning (FAD-GF). Higher scores indicate poorer family functioning (i.e., greater dysfunction), with clinical cut-off scores for each dimension differentiating "healthy" versus "unhealthy" family functioning.[26] For the current study, internal consistencies across time were adequate (caregiver α=0.69–0.85; adolescent α=0.69–0.88).

Caregiver distress—The Symptom Checklist 90 (SCL-90-R)[27] is a psychometrically sound 90-item instrument assessing current psychological symptoms. The Global Severity Index (GSI), considered the best summary measure, combines information on the number and intensity of symptoms present. A GSI total T score ≥63 or on any two dimensions indicates clinically significant psychological distress. GSI internal consistency for caregivers was 0.97.

Social support—The Children's Social Support Questionnaire[28] measures the size and quality of a child/adolescent's social support network with acceptable psychometrics. Family network size was computed by counting the number of family members (e.g., caregiver, sibling, grandparent, or other relative) adolescents listed as part of their network. Adolescents rated how happy they were with each (1= very unhappy to 5 = very happy), averaged across family members.

Caregiver Presence—A composite scale (8 items) from the National Longitudinal Study of Adolescent Health (Add Health)[29,30] measured adolescents' perception of the frequency of resident maternal (e.g., mother, stepmother, grandmother, etc.) and/or paternal (e.g., father, stepfather, grandfather, etc.) figures' presence in the home over the course of a typical week at four potentially unsupervised times: mealtimes, before and after school, and bedtime. The higher of either maternal or paternal presence at these four times was used and averaged (scores range from 0–4). A higher score indicates greater caregiver presence.

Other measures—Caregivers completed a demographic questionnaire providing caregiver gender, age, education, and family composition. Caregivers reported whether they had undergone WLS and the procedure date.

Statistical Analyses

For hypothesized analyses, missing data were handled via maximum likelihood estimation. Nesting of participants within the five sites was controlled for via specialized commands in Mplus Version 7.3 (i.e., 'Cluster = site' and 'Type = Complex', respectively) to avoid possible Type-1 errors. Preliminary analyses compared groups (WLS versus NSComp) on pre-surgical demographic factors and BMI with significant differences ($p<.0.05$) controlled in subsequent analyses. Potential attrition bias was examined, with baseline characteristics of longitudinal participants compared to those with data at baseline only using t-tests and chi-square tests.

For Aim 1, multiple logistic regression was used to examine group differences (0=NSComp, 1=WLS) at baseline for binary dependent variables indicating unhealthy family functioning (FAD) or clinical levels of female caregiver distress (SCL-90R). Group differences in mean levels of continuous variables (e.g., social support, caregiver presence) were tested with analyses of covariance. For Aim 2, linear regression analyses were used to examine baseline adolescent and caregiver demographics and BMI, family functioning, social support, caregiver distress, and caregiver presence in the prediction of percent weight loss from baseline to 12- and 24-months for the WLS group. Finally, a series of linear regression analyses were used to explore if change in family clinical status over time, either improving (i.e., unhealthy to healthy) or declining (i.e., healthy to unhealthy), relative to maintaining clinical status in each adolescent reported FAD domain was associated with percent change in weight at 24-months.

Results

Participant Characteristics

The majority of adolescents were White and female (Table 1). Adolescents in the WLS group were older (p <.001), with a higher baseline BMI (p<.001) than NSComp. Most were living in dual caregiver homes, with participating “primary” caregivers typically the biological mother, with at least a high school education, and employed.

Of the baseline sample (N=222), 197 adolescents (88.7%) were retained at 24-months, of whom 37 (18.8%) participated without a caregiver. Among adolescents, attrition analyses demonstrated membership in the longitudinal (n=197; baseline + 24-months) versus the non-longitudinal (n=25, baseline only) sample was unrelated to group (WLS, NSComp), adolescent BMI, gender, race, age or mean FAD-GF score. Among caregivers, longitudinal (n=160) versus non-longitudinal membership (n=62) was unrelated to adolescent BMI, gender, or race, caregiver reported mean FAD-GF score, psychological distress, or history of WLS. However, significantly more caregivers were non-longitudinal in the WLS versus NSComp group ($36.0\%_{\textit{caregiver-non-longitudinal;}}$14.5% $_{\textit{caregiver-longitudinal},}$ χ^2=11.95, p=.001). Adolescents of non-longitudinal caregivers were significantly older at baseline ($M_{\textit{age-non-longitudinal}}$ =17.01 ± 1.51 years; $M_{\textit{age-longitudinal}}$ =16.42 ± 1.37 years, t=−2.83, p=0.01).

Pre-operative/baseline family characteristics

Caregiver weight status and WLS history—The majority (77.3%) of primary caregivers met criteria for obesity (i.e., BMI ≥ 30 kg/m^2) or severe obesity (59.3%) (i.e., BMI ≥ 35 kg/m^2 or class 2) with no significant differences in caregiver BMI between groups (Table 1). Caregiver and adolescent BMI were significantly and positively correlated (WLS: r=0.32, p<.001; NSComp: r=0.23, p=.045). Caregivers in the WLS group were significantly more likely to have undergone WLS than NSComp (p<.001).

Family functioning and caregiver psychological distress—Percentages of families meeting clinical cutoffs denoting “unhealthy” family functioning (adolescent and caregiver report) are detailed in Table 2. The WLS group reported significantly less impairment than NSComp across all FAD domains from both informants after controlling for adolescent BMI and age. A notable percentage of adolescents in the WLS group reported clinical dysfunction in communication, affective involvement and behavior control, while the majority of NSComp exceeded cut-offs for each domain. From the caregiver perspective, the most prevalent unhealthy domains were FAD-GF, roles and affective involvement. Significantly fewer caregivers met criteria for clinical distress (GSI) at baseline in the WLS group relative to NSComps ($23.4\%_{\text{WLS}}$, $43.6\%_{\text{NSComp},}$ p<.001).

Adolescent perception of family social support and caregiver presence—Family members constituted approximately half of adolescents’ total network size ($46.4\%_{\text{WLS}}$, $42.2\%_{\text{NSComp}}$), with a caregiver included by a majority of adolescents ($80.6\%_{\text{WLS}}$, $73.5\%_{\text{NSComp}}$). Adolescents reported a caregiver was typically present in the home at mealtimes, before and after school and/or at bedtime (M_{WLS} =3.44±0.71; M

$_{NSComp}$ =3.42±0.71). After controlling for adolescent BMI and age, no significant group differences were noted in caregiver presence or family network size (M_{WLS}=3.59± 2.46; M_{NSComp}=3.08± 2.22, ns), however the WLS group reported significantly greater happiness with family social support (M_{WLS}=4.37± 0.85; M_{NSComp}=4.11± 0.87, p = .02).

Impact of pre-operative family factors on adolescent weight loss outcomes following WLS

Adolescent BMI and percent change in weight from pre-surgery/baseline to 12- and 24-month follow-up are presented in Table 3. Linear regression analyses were limited to adolescents who underwent RYGB or VSG, given the small sample size for AGB patients (n=3). For this WLS sample, analyses examined whether baseline demographic, BMI, caregiver/family factors or adolescent reported FAD-GF were predictive of greater percent weight loss from baseline to 12- as well as 24-months. Only adolescent gender was a significant predictor, with males demonstrating greater weight loss at both time points (Table 4). Adolescent happiness with social support was significantly related to percent weight loss at 12-months, but not at 24-months.

Change in family functioning and adolescent percent weight loss at 24-months following WLS

Subgroups representing those who maintained versus changed in family clinical status (healthy vs. unhealthy) from baseline to 24-months following surgery for each adolescent-reported FAD scale were created (Table 5). The majority maintained their healthy or unhealthy status within each domain. A smaller percentage improved (i.e., unhealthy to healthy) or declined (i.e., healthy to unhealthy) in one or more domain.

Linear regression analyses were used to explore if either improving or declining relative to maintaining status (i.e., healthy or unhealthy at both time points) significantly predicted percent change in weight at 24-months. Gender was included as a covariate given its significant association with weight loss outcomes (Table 4). Relative to the maintain group, improving in communication (unhealthy to healthy) was associated with greater percent weight loss at 24-months ($M_{maintain}$=29.8% ± 10.9; $M_{improve}$= 32.9% ± 9.4; unstandardized B = 4.38, p=.006). Declining affective responsiveness (healthy to unhealthy) was associated with lower percent weight loss at 24-months ($M_{maintain}$=31.5% ± 10.1; $M_{decline}$= 24.1% ± 9.4; unstandardized B = −6.35, p=.001). No other significant effects were identified.

Discussion

Utilizing a multi-site controlled longitudinal observational design, we provide a comprehensive view of family factors which characterize adolescents with severe obesity presenting for clinical intervention, with a specific focus on the role of family factors in adolescent weight loss outcomes at 2-years following WLS. Findings can be summarized around 5 key points.

First, as expected, the overwhelming majority of primary caregivers who sought intervention (WLS or lifestyle intervention) for their adolescent with severe obesity also met criteria for severe obesity (3 out of 5 caregivers ≥ class 2 obesity), with caregiver and adolescent BMIs significantly correlated. Moreover, nearly 1 in 4 adolescents at the time of surgery had a primary caregiver who had previously undergone WLS. This underscores how severe obesity is a shared disease within families seeking intervention. Further, while there are often multiple WLS patients within families,[31] this now includes pediatric age-range offspring.

Second, unlike initial estimates[22] the prevalence of family dysfunction in the WLS group was clinically noteworthy (≈1 in every 2–3 families). In addition to general impairment (i.e., FAD-GF), dysfunction focused on unhealthy communication, family members showing less interest and investment in each other (i.e., affective involvement), and challenges to how the family works together to complete routine daily tasks (i.e., roles). Rates of caregiver psychological distress were also higher (nearly 1 in every 4) than previous estimates (12%).[22] Thus, it appears clinical WLS programs are approving adolescent candidates for surgery who have varied family status – including some with significant dysfunction, and from the adolescent’s viewpoint, in particular.

Third, although consistent with other recently published baseline TeenView findings,[32,33] unexpected significant group differences were found for many of the present family domains, whereby NSComp showed greater impairment than the WLS group. Unlike adolescents presenting for first-line non-surgical interventions, adolescents who undergo WLS may be a unique clinical group. Achieving WLS candidacy involves navigating a complex process with multiple levels of decision-makers (i.e., supportive caregivers, a referring physician, the clinical team, insurance approval). Ultimately, adolescents with poorly managed psychosocial health and/or greater family dysfunction may not seek or be referred for surgery (i.e., NSComp), drop out of this intensive clinical care pathway during the pre-operative phase, or are subsequently deferred or denied access by the clinical team. These are important areas for future research.

Fourth, contrary to hypotheses, an adolescent’s perception of *pre-operative* family functioning (healthy or unhealthy) was not predictive of their weight loss success at 1 or 2 years post-operatively. Nor were pre-operative caregiver psychological distress, frequency of caregiver presence in the home, or the family social support network. While adolescent happiness with family social support was important to initial weight loss at 12-months, this was not sustained at 24-months. Moreover, adolescent weight loss outcomes were not impacted by pre-operative caregiver BMI or history of WLS. Perhaps these specific pre-operative family factors are not relevant in understanding adolescent weight loss outcomes. Certainly the seminal work emerging from the adult WLS literature has demonstrated there are few “useful” pre-operative predictors of adult success.[34] Alternately, clinical care pathways at these five clinical centers may have effectively managed dysfunction, as all include a licensed mental health practitioner.[35]

Finally, exploratory findings suggested a *change* in the adolescent’s perception of family functioning may be an important signal for optimizing weight loss success. For most adolescents, perceptions of family’s functioning remained stable over time. However, adolescents who reported a positive change in family communication achieved better weight loss outcomes (≈ 3% more weight lost) at 24-months. Moreover, those who moved from healthy to unhealthy patterns in how family members respond with “appropriate quality or quantity of affect” (i.e. affective responsiveness) were less successful at weight loss at 24-

months (≈ 7.4% less weight lost). These findings are consistent with a recent adolescent behavioral weight loss intervention trial where *change* in communication style between mother and adolescent, but not pre-treatment communication style, impacted weight loss outcomes.[36] While causation cannot be inferred, future research regarding whether clinical interventions that target improving family communication and maintaining a healthy emotional climate optimize adolescent weight loss outcomes across the first two post-operative years are indicated.

There are several caveats and limitations. Although consistent with national WLS trends,[37,38] the Teen-LABS patient population is primarily White and female. While concordance between informants (adolescent, caregiver) was not tested, it is considered "normative" for adolescents to perceive greater family impairment than their caregivers.[39] Further, pre-operative family factors may play an important role in outcomes not addressed herein (i.e., perioperative safety, psychosocial health). All adolescents in the WLS group proceeded through routine care pathways in their respective programs. It is unknown (and beyond scope) whether they received adjunctive family-based psychological care post-operatively.

Finally, Teen-LABS planned enrollment of consecutive surgical patients across five sites resulted in observation of outcomes of 3 surgical procedures, with the VSG newly emerging as a surgical option for adolescents during this specific enrollment period (2008–2012). Teen-LABS, and therefore the present ancillary study, were not designed or intended as comparative clinical trials. Procedural decisions were made not only on an individual basis (i.e., patient/family preference, clinical team's recommendation), but were also driven by site- and time-specific factors. For example, the availability of the VSG procedure for adolescents varied in time by clinical site. Moreover, participants' surgical procedure type was ultimately determined by insurance panels, which for VSG proved more challenging during the Teen-LABS enrollment period given it's "investigational" status for adolescents.[41,42] Thus, "site" was a critical covariate in our analyses to control for any potential bias. That said, the initial weight loss outcome data of the RYGB and VSG appear remarkably similar. In addition, it is noteworthy that, due to our exclusion of AGB patients from outcome analyses (i.e., small sample size), the present findings may not be generalizable to the AGB patient, particularly given differing treatment demands and outcome trajectories associated with this device-based intervention. As bariatric surgery continues to evolve as a treatment option for the adolescent with severe obesity, further research specifically designed to explore the role of family functioning in procedural decision-making and treatment outcomes will prove informative.

Conclusions

While pre-operative family factors were unrelated to adolescent weight loss success at 1- and 2-years post-operatively, change in family communication and emotional climate over time emerged as potential targets to optimize weight loss outcomes. Future studies that examine psychosocial trajectories of continuity and change over time in parallel with adolescent weight loss are clearly needed. Outcome pathways are likely complex where, for example, one could consider family factors playing a mediating or moderating (i.e., indirect) role. Interestingly, the most common family characteristic emerging from these data was obesity itself and speak to a “severe” family disease – which is preventable. The fact that 2% of primary caregivers of adolescents who undergo WLS have previously undergone WLS suggests this intensive intervention is emerging as a family weight loss tool. Post hoc analyses indicated that these caregivers underwent WLS when the adolescent was approximately 11 years of age (age range= 4.2–17.3 years), when these youth were likely earlier in their obesity’s progression. Daniels and Kelly asserted the need for innovative solutions to *prevent* the development of severe pediatric excess weight.[40] Perhaps tailoring interventions to target offspring at the time of mothers WLS is one step in this direction. High prevalence of family dysfunction and severe obesity’s persistence for non-surgical comparators paints a bleak picture of future health and well-being.

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What is already known about this subject?

- Adolescent severe obesity is on the rise, with weight loss surgery emerging as a viable treatment option for pediatric patients
- Impaired family functioning is a risk factor for poorer treatment outcomes in many chronic pediatric conditions
- Elucidating family factors that contribute to optimal/less optimal adolescent outcomes are vital to inform patient care.

What does this study add

- Prevalences of severe obesity in primary caregivers as well as family dysfunction were clinically noteworthy in adolescents with severe obesity presenting for surgical and non-surgical weight loss intervention.
- Adolescents with severe obesity seeking first-line lifestyle intervention showed greater family impairment, suggesting adolescents who pursue and undergo weight loss surgery may be a unique clinical group.
- While pre-operative family factors had no predictive value in adolescent weight loss success at 1- and 2-years post-operatively, change in family communication and emotional climate over time emerged as potential targets to optimize weight loss outcomes.

Table 1

Pre-surgical/baseline demographic characteristics of WLS adolescents and NSComp adolescents and their families.

	Total (N=222) **Mean ± SD%**	**WLS (n =139)** **Mean ± SD%**	**NSComp (n = 83)** **Mean ± SD%**	p^a
Adolescent				
Age	16.59 ±1.44	16.86 ±1.39	16.11 ±1.40	<.001
% Female	80.6%	79.9%	81.9%	0.71
% White	61.7%	66.2%	54.2%	0.08
BMI	49.77 ± 7.89	51.52 ±8.32	46.85 ±6.12	<.001
Surgical Procedure				
% Gastric Bypass		61.9%		
% Sleeve Gastrectomy		36.0%		
% Adjustable Band		2.2%		
Caregiver[b]				
Age	44.27 ± 7.50	44.47 ± 6.41	43.93 ± 9.05	0.63
% Female	93.6%	93.4%	94.0%	0.87
% History of WLS	16.1%	23.8%	3.7%	<0.001
% Employed (full or part-time)	53.0%	58.8%	43.4%	0.03
Education				0.18
% ≤ High School Graduation	42.5%	39.0%	48.2%	
% 1+ Years Post-Secondary	57.5%	61.0%	51.8%	
BMI[c]	38.05 ± 9.63	37.84 ± 9.35	38.36 ± 10.08	0.71
% Normal	8.3%	8.9%	7.2%	
% Overweight	14.6%	10.6%	20.5%	
% Obesity (class 1)	18.0%	18.7%	16.9%	
% Severe Obesity (class 2)	20.9%	26.0%	13.3%	
% Severe Obesity (class 3)	27.7%	25.2%	31.3%	
% Superobesity	10.7%	10.6%	10.8%	
Family				
% Single Caregiver Home	33.3%	31.6%	36.1%	0.49

BMI= Body Mass Index; NSComp= non-surgical comparison; WLS=weight loss surgery

[a] p-values are based on two-tailed independent t-tests when examining mean values and on Chi-Square tests or Fisher's exact tests when examining percentages.

[b] Demographic information was available for 136 bariatric caregivers, with the exception of caregiver BMI (n=123) and history of WLS (n=130). Demographic information was available for 83 comparison caregivers with the exception of history of WLS (n=81).

[c] BMI definitions are as follows: Normal: 18.5–24.9; Overweight: 25.0–29.9; Obesity (class 1): 30.0–34.9; Severe Obesity (class 2): 35.0–39.9; Severe Obesity (class 3): 40.0–49.9; Superobesity: >50.

Table 2

Clinical levels of family dysfunction using the FAD for WLS adolescents and NSComp adolescents and their families at baseline.

	WLS (n =138)	NSComp (n = 83)	OddsRatio	*p*
Adolescent Report				
General Functioning (FAD-GF)	44.2%	72.3%	0.29	0.01
Problem Solving	29.7%	51.8%	0.35	0.005
Communication	50.7%	72.3%	0.37	<0.001
Roles	42.0%	67.5%	0.34	0.006
Affective Responsiveness	44.2%	67.5%	0.33	<0.001
Affective Involvement	66.7%	83.1%	0.39	0.02
Behavior Control	46.4%	68.7%	0.36	<0.001
Caregiver Report				
General Functioning (FAD-GF)	38.0%	53.0%	0.54	0.01
Problem Solving	13.9%	24.1%	0.46	0.006
Communication	28.5%	48.2%	0.36	0.002
Roles	48.9%	61.4%	0.53	0.01
Affective Responsiveness	19.0%	38.6%	0.30	<0.001
Affective Involvement	44.5%	61.4%	0.45	0.03
Behavior Control	29.2%	32.5%	0.75	0.39

Abbreviations: FAD= Family Assessment Device; FAD-GF= Family Assessment Device-General Functioning; NSComp= non-surgical comparison; WLS=weight loss surgery

[a] p-values were based on logistic regressions with adolescent age and BMI as covariates.

Table 3

Percent weight change from baseline to 12 and 24 months and BMI at 24 months for WLS adolescents and NSComp adolescents.

	Percent Weight Change from baseline to 12 months[a]			Percent Weight Change from baseline to 24 months[b]			BMI at 24 months[c]		
	Mean ± SD	**Range**	**n**	**Mean ± SD**	**Range**	**n**	**Mean ± SD**	**Range**	**n**
Roux-en-Y Gastric Bypass and Sleeve Gastrectomy (combined)	−31.28% ± 7.99	−13.29 to −52.77	123	−30.58% ± 10.48	−3.92 to −52.63	121	35.79 ± 8.49	22.63 to 61.35	119
Roux-en-Y Gastric Bypass	−31.31% ± 7.88	−13.29 to −48.15	79	−30.64% ± 10.52	−3.92 to −52.63	80	36.55 ± 8.77	22.63 to 61.35	78
Sleeve Gastrectomy	−31.24% ± 8.29	−15.01 to −52.77	44	−30.46% ± 10.53	−4.09 to 50.64	41	34.36 ± 7.83	23.92 to 60.81	41
Adjustable Gastric Band	−13.02% ± 5.26	−9.24 to −19.02	3	−5.16% ± 10.49	+3.44 to −16.85	3	44.48 ± 8.06	36.10 to 52.17	3
NSComp	+4.86% ± 9.19	+52.16 to −20.74	62	+6.98% ± 10.81	+39.72 to −22.78	67	48.65 ± 8.37	29.90 to 89.29	67

Note: WLS=weight loss surgery; NSComp = non-surgical comparison; SD=standard deviation

[a] $((\text{weight}_{\text{12-months}} - \text{weight}_{\text{pre-surgery}})/\text{weight}_{\text{pre-surgery}})*100$

[b] $((\text{weight}_{\text{24-months}} - \text{weight}_{\text{pre-surgery}})/\text{weight}_{\text{pre-surgery}})*100$

[c] Percent change in BMI from baseline to 12 months $((\text{BMI}_{\text{12-months}} - \text{BMI}_{\text{pre-surgery}})/\text{BMI}_{\text{pre-surgery}})*100$ and from baseline to 24 months $((\text{BMI}_{\text{24-months}} - \text{BMI}_{\text{pre-surgery}})/\text{BMI}_{\text{pre-surgery}})*100$ was also computed for each group.

Mean and Standard deviation values at 12 months for each group are as follows: Roux-en-Y Gastric Bypass and Sleeve Gastrectomy (combined): −31.15%±8.20; Roux-en-Y: −31.05%±8.10; Sleeve Gastrectomy: −31.35%±8.48; Adjustable Gastric Band: −13.44%±4.76; NSComp: +3.76%±10.67. Means and Standard deviation values at 24 months: Roux-en-Y Gastric Bypass and Sleeve Gastrectomy (combined): −30.76%±10.64; Roux-en-Y: −30.68%±10.65; Sleeve Gastrectomy: −30.92%±10.74; Adjustable Gastric Band: −7.01%±8.61; NSComp: +5.06%±12.41.

Table 4

Baseline predictors of adolescent percent change in weight from baseline to 12 months and 24 months for WLS adolescents (n=136)[a] and their families.

	Percent Change in Weight 12 months			**Percent Change in Weight 24 months**		
Baseline Predictors	***β***	**SE**	***p*-value**	***β***	**SE**	***p*-value**
Adolescent						
Baseline BMI	−0.13	0.12	0.30	−0.12	0.26	0.65
Gender: Female	−5.61	0.96	<0.001	−7.58	3.00	0.01
Race: Non-White	−1.33	1.57	0.40	−1.18	2.11	0.58
Age	−0.22	0.64	0.73	−0.41	0.61	0.50
Family Functioning (FAD-GF)	1.39	2.78	0.62	2.35	3.83	0.54
Family Social Support Network Size	−0.22	0.37	0.56	−0.17	0.53	0.75
Happiness with Family Social Support[b]	0.80	0.41	0.047	0.69	0.82	0.40
Caregiver						
BMI	0.13	0.14	0.35	0.18	0.21	0.41
Caregiver History of WLS	−0.03	2.28	0.99	−0.01	3.00	0.99
Female Caregiver Psychological Distress[c]	0.96	2.38	0.69	0.48	2.54	0.85
Caregiver Presence	0.14	0.96	0.88	0.56	1.31	0.67

Note: BMI =body mass index; FAD-GF = Family Assessment Device-General Functioning; SCL-90R= Symptom Checklist 90-Revised; WLS = weight loss surgery

[a] Three participants who had undergone adjustable gastric banding were excluded from these analyses.

[b] For participants who listed no family members as part of their social support network, happiness was set to 0.

[c] Clinical range on the SCL-90R was used, with 0=not clinical, 1= clinical.

Table 5

Maintenance versus change in clinical status of family dysfunction over time using adolescent report on the FAD for WLS adolescents (n=118)[a].

Clinical Status from Baseline to 24 months[b]	**Maintain: Healthy n (%)**	**Maintain: Unhealthy n (%)**	**Improve n (%)**	**Decline n (%)**
General Functioning	49 (41.5%)	42 (35.6%)	11 (9.3%)	16 (13.6%)
Problem Solving	65 (55.1%)	17 (14.4%)	19 (16.1%)	17 (14.4%)
Communication	41 (34.7%)	38 (32.2%)	22 (18.6%)	17 (14.4%)
Roles	54 (45.8%)	33 (28.0%)	19 (16.1%)	12 (10.2%)
Affective Responsiveness	49 (41.5%)	37 (31.4%)	15 (12.7%)	17 (14.4%)
Affective Involvement	18 (15.3%)	60 (50.8%)	21 (17.8%)	19 (16.1%)
Behavior Control	36 (30.5%)	41 (34.7%)	14 (11.9%)	27 (22.9%)

Note: FAD=Family Assessment Device

[a] Missing data for n=18. Three participants who had undergone adjustable gastric banding were excluded.

[b] Maintain Healthy refers to non-clinical levels of family dysfunction at baseline and 24 months.

Maintain Unhealthy refers to clinical levels of family dysfunction at both time points. Improve refers to changing from clinical dysfunction status at baseline to non-clinical (i.e., Unhealthy to Healthy) at 24 months. Decline refers to changing from non-clinical dysfunction status at baseline to clinical (i.e., Unhealthy to Healthy) at 24 months.