Author Manuscript
Author Manuscript
Author Manuscript
Author Manuscript

HHS Public Access
Author manuscript
Obesity (Silver Spring). Author manuscript; available in PMC 2015 April 01.

Published in final edited form as:
Obesity (Silver Spring). 2014 October ; 22(10): 2224–2229. doi:10.1002/oby.20827.

Collateral Weight Loss in Children Living with Adult Bariatric Surgery Patients: A Case Control Study

Annemarie G. Hirsch, PhD, MPH[1], **G. Craig Wood, MS**[2,3], **Lisa Bailey-Davis, DEd, MA, RD**[1], **Michelle R. Lent, PhD**[4], **Glenn S. Gerhard, MD**[5], and **Christopher D. Still, DO, FACN, FACP**[2,6]

[1]Geisinger Center for Health Research, Geisinger Health System

[2]Geisinger Obesity Institute, Geisinger Health System

[3]Weis Center for Research, Geisinger Health System

[4]Center for Obesity Research and Education, Temple University

[5]Institute for Personalized Medicine, Penn State College of Medicine

[6]Geisinger Center for Nutrition and Weight Management, Geisinger Health System

Abstract

Objective—To evaluate the impact of adult bariatric surgery on the Body Mass Index (BMI) of children living in the same household.

Design and Methods—A retrospective case-control study. Case dyads (n=128) were composed of one adult who had bariatric surgery and one child at the same address. Control dyads (n=384) were composed of an adult with obesity but no bariatric surgery and a child at the same address. We used a two-sample t-test to determine whether the differences between actual and expected BMI at follow-up (post-surgery) differed between children in the case and control dyads.

Results—Among boys who were overweight, boys who lived with a surgery patient had a lower than expected BMI post-surgery, while boys who did not live with a surgery patient had a higher than expected BMI at follow-up (p=0.045). Differences between actual and expected BMIs of children were not significantly different between cases and controls in girls or in children in other weight classes.

Conclusions—Overweight boys who lived with an adult bariatric surgery patient had a lower than expected BMI after surgery as compared to controls. Future studies may be warranted to determine the mechanisms by which these children experience collateral weight loss.

Users may view, print, copy, and download text and data-mine the content in such documents, for the purposes of academic research, subject always to the full Conditions of use:http://www.nature.com/authors/editorial_policies/license.html#terms

Corresponding Author: Annemarie G. Hirsch, PhD, MPH, Research Invesigator I, Geisinger Center for Health Research, Geisinger Health System, 100 N. Academy Avenue, Danville, PA 17822-0044, aghirsch@geisinger.edu, 570-214-4880 (phone), 570-214-9451 (fax).

Competing interests: the authors have no competing interests.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Keywords

Bariatric surgery; childhood obesity; case-control study

Introduction

The prevalence of obesity in children and adolescents remains high.[1] Despite reports of a decrease in some age groups, the obesity rate among children 2 to 19 years of age is 17%, with no significant change over the last decade,[1] and a continuing increase in the rate of severe obesity.[2] The association between childhood obesity and serious health problems in childhood and adulthood has significant implications for current and future morbidity and mortality.[3–5] Children of obese parents are at an increased risk of obesity, with obesity prevalence estimates as high as 43.8%.[6] Parental obesity is one of the strongest risk factors for childhood obesity and increases the risk of obesity in adulthood for both obese and nonobese children.[6–9] The relationship between parent and childhood obesity is likely attributable to a combination of genetic and family environmental influences. The environmental influences, including parental modeling of eating behavior, responsiveness to child signals, and availability of certain foods in the home, may offer possible targets for interventions. [10–12]

Previous studies have demonstrated a benefit of weight loss in family members when one adult family member participates in a weight management program.[13–15] Accordingly, the lifestyle and dietary modifications required following weight-loss surgery could result in the collateral benefit of weight loss in children living in the same household. To date, studies that have explored the impact of weight-loss surgery of adults on co-habitating children have been limited by small sample sizes and have produced conflicting results. Mothers who underwent bariatric surgery reported actively modeling healthy eating behaviors for their children to a greater extent than women awaiting surgery.[16] However, children of parents who had undergone weight-loss surgery reported less physical activity and more problem eating areas as compared to children of parents who had not undergone surgery.[17] Woodard et al. did not report a change in food choices after a parent had weight- loss surgery, but they did report an increase in physical activity. [18] However, there was not a significant difference in BMI in children before and after a parent had weight-loss surgery.

We leveraged an existing bariatric surgery research database and electronic health record (EHR) to conduct the first case-control study, and the largest study to date, evaluating the impact of adult bariatric surgery on the Body Mass Index (BMI) trajectory of children living in the same households. We hypothesized that children living in households with one adult who underwent weight-loss surgery would experience significant reductions in BMI compared to children living with one adult with obesity who had not undergone weight-loss surgery.

Methods

We conducted a retrospective matched case control study using data from a large integrated health system's EHR and existing bariatric surgery research database.[19] The health system

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

serves > 400,000 primary care patients and has had an EHR system for outpatient care since 2001. The bariatric surgery research database includes imported EHR data as well as other data collected in the clinic during pre- and post-surgery visits (waist circumference, weight loss goals, etc.) Since January 2004, when patients enroll in the bariatric surgery program, they are offered participation in an ongoing research program in obesity. More than ninety percent of patients approached agree to participate and these patients are included in the bariatric surgery research database.[19]

Case dyads

For this study, a case dyad was composed of one adult from the bariatric surgery research database and one child living at the same address. We identified all adults in the bariatric database who had Roux-en-Y gastric bypass (RYGB) surgery between January 2004 and October 2011 (n=2803). We identified children in the health system who lived at the same address as these bariatric surgery patients by matching current home addresses from the EHR. To account for subtle variations in address nomenclature (e.g., street vs. St.) and/or misspellings, addresses were matched on latitude and longitudinal coordinates using ArcGIS software.[20] Locations with > 6 matches were removed because prior analysis indicated that they are often addresses for nursing homes, large apartment buildings without numbers, or prisons. Given that we were using address matches in the EHR to find cohabitants of bariatric patients, only children who had received care within the health system and therefore had a record in the EHR were included in the study.

Children could be included in the case dyad if they were between ages 6 and 16 at 12-months prior to the adult's bariatric surgery. Cases were excluded if they did not have at least one clinical encounter during which a weight and height were recorded in the EHR during the adult cohabitant's pre-surgical period (6–18 months before surgery) or did not have at least one encounter during which a weight and height were recorded in the EHR between 18–30 months after surgery. Children were excluded if they had evidence of pregnancy during the study period, as determined by ICD-9 codes in the EHR.

Control dyads

A control dyad was composed of an adult with obesity and a child who lived at the same address. Adults in the control dyad had to receive their primary care within the health system, have a BMI ≥35 and could not have any history of weight-loss surgery documented in the EHR. To identify control children, we matched addresses using the same method as described for cases. The child of the control dyad had to be 6 to 16 years of age at any time during the study period (January 2004 to October 2011) and had ≥ 2 clinical encounters with both weight and height measured that were 24–48 months apart. As with controls, children were excluded if they had any evidence of pregnancy documented in the EHR. Control dyads were matched (3:1) to case dyads on adult characteristics (gender; age within 5 years of bariatric adult; BMI within 3 kg/m^2 of the pre-surgery BMI bariatric adult) and child characteristics (gender, age within 2 years of the bariatric household child; BMI percentile within the same BMI group as the bariatric household).

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

BMI

Per the inclusion criteria, every child in the case dyads had a pre- and post-surgical BMI measured. For cases, the pre-surgical BMI was calculated using the weight and height measured at a clinical encounter closest to 12 months prior to surgery. The post-surgical BMI was calculated using the weight and height measured at a clinical encounter closest to 24 months after surgery. An expected post-operative BMI was also calculated using the preoperative BMI and age/height measures at the post-operative measure. For children in the control dyads, we calculated corresponding baseline and follow-up actual and expected BMIs by using paired height/weight measures occurring 24- 48 months apart.

Statistical Analyses

The primary outcome of the study was whether the change in BMI from baseline (pre-surgery) to follow-up (post-surgery) differed between children living with adults who had bariatric surgery and children living with adults with obesity and no history of bariatric surgery. We compared actual to expected BMI using a paired t-test in both the case and control groups. We then compared the mean differences between actual and expected BMI between cases and controls using a two-sample t-test. All analysis was conducted for all children and then stratified by initial BMI percentile (normal, overweight, obese), age (6–11 and 12–16), and/or gender. This study was approved by the health system’s Institutional Review Board.

Results

Study population

Using the matching algorithm described above, we identified 128 case dyads and 384 control dyads (Figure 1). Cases and controls were matched on age, gender, and BMI (Table 1). Adults in both groups were primarily female (93%) with an average age of approximately 40 years. The average BMI for adults was 46 kg/m^2 in cases and 45 kg/m^2 in controls, with 67% of children in both groups having a baseline BMI percentile of at least 85. In both groups, there were more male (59%) than female children. On average, children were between 11–12 years of age. The time period between baseline and follow-up for controls was approximately the same duration of time as between pre- and post-surgery BMI percentile measures in cases with a mean time for controls of 2.9 years (SD=0.4, range=2.0–4.0 years), and a mean time for cases of 3.0 years (SD=0.4, range=2.1–3.7 years).

Change in BMI from pre- to post-bariatric surgery

Changes in BMI within the children of the case group were examined after stratifying by initial BMI by comparing the measured BMI with an expected BMI extrapolated from pre-operative BMI and age/height measures at the post-operative measure. In cases with a BMI percentile below 84, the actual BMI was significantly greater than the expected BMI at 24-months after the adults bariatric surgery (20.6 vs. 19.5, p=0.0016). For those with initial BMI indicating overweight (i.e. 85 to 94 percentile) the difference between expected versus actual BMI was not significant. There was also no significant difference between actual versus expected BMI in the cases with obesity; however there were significant differences

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

when these children were stratified by age and gender. Girls whose initial BMI percentile was between 95 and 100 had a significantly lower actual BMI compared to expected (Table 2). Children ages 6 to 11 with obesity had a significantly lower actual BMI compared to the expected BMI (27.3 vs. 29.2 kg/m^2, p 0.034)

Changes in BMI in cases versus controls

To determine if the differences observed between expected and actual BMI in the case group were significantly different than in the control group, we compared the mean differences in both groups. The mean differences in actual and expected BMIs were not significantly different between cases and controls, except among boys who were overweight (BMI =85 to 94 percentile) at baseline (Tables 2 and 3). In this subgroup the actual BMI among male cases was 1.3 kg/m^2 lower than expected, as compared to male controls, who had an actual BMI an average of 0.6 kg/m^2 higher than expected(p=0.045).

Discussion

We conducted the first case control study evaluating the impact of sharing a household with an adult weight-loss surgery patient on the body weights of children. We determined that the BMI trajectory of children with obesity living with weight-loss surgery patients was not significantly different than the BMI trajectory of children with obesity living with obese adults with no history of surgery. Our findings were consistent with Woodard et al. who found that children with obesity whose parents had undergone surgery did not have a significantly lower than expected BMI at post-surgery.[18] Woodard and colleagues did not compare the BMI changes in children living with parents who had undergone surgery to the BMI changes in a non-surgical control group, as we did in our study.

We did find a difference in the BMI trajectory of male children who were overweight (BMI percentile 85–94) based on whether or not they resided with a bariatric surgery patient. Overweight male children who lived with a surgery patient had a lower than expected BMI post-surgery, while males who did not live with a surgery patient had a higher than expected BMI at follow-up. A limitation of our study is that it did not contain data on dietary and physical activity behaviors that could help explain the sex differences in how children responded to adult weight-loss surgery and previous studies have had mixed results. Previous studies have found sex differences in how children benefit from family-based obesity treatment, with boys showing better response to physical activity interventions.[21] Woodard and colleagues reported that while children of bariatric surgery patients increased their daily activity levels after surgery, there was no significant change in eating habits. Watowicz et al., however, reported that children of adults who had weight-loss surgery reported less physical activity and poorer eating habits compared to children of non-surgical parents.[17] A prospective study that captures physical activity and dietary behaviors before and after surgery could help elucidate the differences in how boys and girls respond to weight-loss surgery of an adult in the household.

Ventura and Birch have demonstrated that parental modeling of intake and availability of healthy food predicts healthier children over time. [11] Based on this evidence, we originally hypothesized that the dietary behaviors required after weight-loss surgery would influence

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

the dietary behavior of children in the household, and ultimately, their BMI. However, in our study the BMI trajectory in children living with adults who had surgery compared with children living with non-surgical adults did not significantly differ. It is possible that in addition to the benefits of modeling health food intake, the weight-loss surgery resulted in restrictive child-feeding practices, which have been consistently found to be associated with higher child weight and higher levels of eating in the absence of hunger.[11,22–24] Positive parental modeling described by Ventura and Birch may have been cancelled out by the impact of child-feeding practices in some households. Future studies should collect information on parental modeling and child feeding practices before and after surgery to determine whether surgery is beneficial or detrimental to their children's eating behavior.

Overall, children with obesity in our study, whether or not they resided with bariatric surgery patients, had a significantly lower BMI (31.4 kg/m^2) at follow-up compared to their expected BMI (32.3 kg/m^2). While we hypothesized that children living with surgery patients would have a lower than expected BMI post-surgery, we were surprised to find weight loss in the children who did not reside with a surgery patient. It is possible that the lower than expected BMIs could be attributed to the health system's obesity prevention efforts or to policy changes at the state and national levels that resulted in better management of childhood obesity in primary care during the study period.[25] Alternatively, the lower than expected measures could be regression to the mean (i.e. the baseline measure was extreme and tended to be closer to their average measure on follow-up).

The prevalence of obesity among children living with bariatric surgery patients in this study was 40 percent, which is more than twice as high as the national average (17%).[2,26] This high prevalence is consistent with previous studies of obesity in children of obese adults.[6,8] These children are at risk for a host of significant physical and emotional health problems, including cardiovascular disease, cancer, and kidney failure, and low self-esteem.[5,27,28] While our study does not support a collateral benefit of bariatric surgery in most children, we demonstrated a benefit in boys. Identifying an opportunity to lower BMI in overweight boys is particularly important, given that there has been a significant increase in obesity prevalence among men and boys over the last decade, while obesity rates have remained stable in girls and women.[26] Bariatric surgery offers a unique opportunity to identify children at high risk of obesity for a weight-loss intervention. Given that the adult family member is already engaged in making lifestyle changes, this may present an opportunity to target the parent for a family-based healthy lifestyle intervention.[12,13,29]

To the best of our knowledge, our study is the largest study of the effect of RYGB surgery on the weight of children in the same household and the only study to utilize matched controls. There were, however, several limitations to our study. First, we determined whether children and adults lived together by matching their current addresses in the EHR but children or adults may not have lived together at the time of surgery. Second, all BMI data were derived from height and weight measurements recorded in the EHR. As a result, we allowed for wide time intervals when defining pre- (6 to 18 months before surgery) and post-surgery (18 to 30 months post-surgery) BMIs. We used similar time intervals in cases and controls to minimize the effects of these intervals on our results. Third, children without height and weight measures in the EHR were excluded, which may have excluded healthier

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

children who were less likely to have doctor visits, though these criteria were again applied to both cases and controls. Finally, we did not analyze potential genetic influences on weight loss. While the adult and child in each dyad shared a home address, we cannot assume, based on our data, that all adult/child dyads were biologically related. The relationship between parent and childhood obesity is likely attributable, in part, to genetic influences and data suggest that genetic variants may influence weight loss in patients with extreme obesity after bariatric surgery.[9–11,30–33]

Conclusion

Most children living with weight-loss surgery patients did not have a different BMI trajectory than children living with non-surgery obese adults. A subgroup of children, overweight boys, did display significantly lower BMI trajectories than controls. Future studies should explore the potential mechanisms that bariatric surgery induces collateral weight loss.

Acknowledgments

Support for this project was provided by National Institutes of Health grants: P30 DK072488 and R01 DK088231. Annemarie Hirsch had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Davis, Lent, Gerhard, and Still contributed to the study concept and design, acquisition and interpretation of data, critical revision of the manuscript for important intellectual content, obtaining funding and administrative and technical support. G Craig Wood conducted and is responsible for the data analysis.

References

1. Ogden C, Carroll M, Kit B, Flegal K. Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA. 2014; 311(8):806–814. [PubMed: 24570244]
2. Skinner A, Skelton J. Prevalence and trends in obesity and severe obesity among children in the United States, 1999–2012. JAMA Pediatr. 2014 On-line.
3. Reilly J, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. Int J Obes. 2011; 35(1):891–898.
4. Reilly J, Methven E, McDowell Z, et al. Health consequences of obesity. Arch Dis Child. 2003; 88(9):748–752. [PubMed: 12937090]
5. Daniels S, Arnett D, Eckel R, et al. Overweight in children and adolescents: Pathophysiology, consequences, prevention, and treatment. Circulation. 2005; 111(15):1999–2012. [PubMed: 15837955]
6. Reilly J, Armstrong J, Dorosty A, et al. Early life risk factors for obesity in childhood: Cohort study. BMJ. 2005; 330(7514):453.
7. Whitaker R, Wright J, Pepe M, Seidel K, Deitz W. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med. 1997; 337(13):869–873. [PubMed: 9302300]
8. Agras W, Hammer L, McNicholas F, Kraemer H. Risk factors for childhood overweight: A prospective study from birth to 9.5 years. J Pediatr. 2004; 145(1):20–25. [PubMed: 15238901]
9. Santiago S, Zazpe I, Cuervo M, Martinez J. Risk factors for overweight/obesity in preschool children: An ecological approach. Nutr Hosp. 2012; 27(2):599–605. [PubMed: 22732989]
10. Savage J, Fisher J, Birch L. Parental influence on eating behavior: Conception to adolescence. J Law Med Ethics. 2007; 35(1):22–34. [PubMed: 17341215]
11. Ventura A, Birch L. Does parenting affect children's eating and weight status? Int J Behav Nutr Phys Act. 2008; 5:15. [PubMed: 18346282]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

12. Birch L, Davison K. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am. 2001; 48(4):893–907. [PubMed: 11494642]
13. Golan M. Parents as agents of change in childhood obesity--from research to practice. Int J Pediatr Obes. 2006; 1(2):66–76. [PubMed: 17907317]
14. Golan R, Schwarzfuchs D, Stampfer J, Shai I. Halo effect of a weight-loss trial on spouses: The DIRECT-spouse study. Public Health Nutr. 2010; 13(4):544–549. [PubMed: 19706214]
15. Gorin A, Wing R, Fava J, et al. Weight loss treatment influences untreated spouses and the home environment: Evidence of a wripple effect. Int J Obes. 2008; 32(11):1678–1684.
16. Walters-Bugbee S, McClure K, Kral T, Sarwer D. Maternal child feeding practices and eating behaviors of women with extreme obesity and those who have undergone bariatric surgery. Surg Obes Relat Dis. 2012; 8(6):784–791. [PubMed: 22940240]
17. Watowicz R, Taylor C, Eneli I. Lifestyle behaviors of obese children following parental weight loss surgery. Obes Surg. 2012; 23(2):173–178. [PubMed: 22941333]
18. Woodard G, Encarnacion B, Peraza J, Hernandez-Boussard T, Morton J. Halo effect of bariatric surgery: Collateral weight loss in patients' family members. Arch Surg. 2011; 146(10):1185–1190. [PubMed: 22006878]
19. Wood GC, Chu X, Manney C, et al. An electronic health record-enabled obesity database. BMC Med Inform Decis Mak. 2012; 12:45. [PubMed: 22640398]
20. ESRI. ArcGIS desktop: Release 10. 2011
21. Epstein L, Paluch R, Raynor H. Sex differences in obese children and siblings in family-based obesity treatment. Obes Res. 2012; 9(12):746–753. [PubMed: 11743058]
22. Williamson D, Martin C, York-Crowe E, et al. Measurement of dietary restraint: Validity tests of four questionnaires. Appetite. 2007; 48(2):183–192. [PubMed: 17101191]
23. Neumark-Sztainer D, Wall M, Haines J, Story M, Eisenberg M. Why does dieting predict weight gain in adolescents? findings from project EAT-II: A 5-year longitudinal study. J Am Diet Assoc. 2007; 107(3):448–455. [PubMed: 17324664]
24. Neumark-Sztainer D, Wall M, Story M, Standish A. Dieting and unhealthy weight control behaviors during adolescence: Associations with 10-year changes in body mass index. J Adolesc Health. 2012; 50(1):80–86. [PubMed: 22188838]
25. Coleman K, Hsii A, Koebnick C, et al. Implementation of clinical practice guidelines for pediatric weight management. J Pediatr. 2012; 160(6):918–922. [PubMed: 22240108]
26. Ogden C, Carroll M, Kit B, Flegal K. Prevalence of obesity in the united states, 2009–2010. NCHS Data Brief. 2012; 82
27. Freedman D, Mei Z, Srinivasan S, Berenson G, Dietz W. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bogalusa heart study. J Pediatr. 2007; 150(1):12–17. [PubMed: 17188605]
28. Puhl R, Latner J. Stigma, obesity, and the health of the nation's children. Psychol Bull. 2007; 133(4):557–580. [PubMed: 17592956]
29. Wilfley D, Tibbs T, Van Buren D, Reach K, Walker M, Epstein L. Lifestyle interventions in the treatment of childhood overweight: A meta-analytic review of randomized controlled trials. Health Psychol. 2007; 26(5):521–532. [PubMed: 17845100]
30. Moore B, Mirshahi U, Yost E, et al. Long-term weight-loss in gastric bypass patients carrying melanocortin 4 receptor variants. PLoS One. 2014; 9(4):e93629. April 18, 2014. [PubMed: 24705671]
31. Rinella E, Still C, Shao Y, et al. Genome-wide association of single-nucleotide with weight loss outcomes after roux-en-Y gastric bypass surgery. J Clin Endocrinol Metab. 2013; 98(6):E1131–E1136. April 18, 2014. [PubMed: 23633212]
32. Mirshahi U, Still C, Masker K, Gerhard G, Carey D, Mirshahi T. The MC4RI251L) allele is associated with better metabolic status and more weight loss after gastric bypass surgery. J Clin Endocrinol Metab. 2011; 96(12):E2088–E2096. April 18, 2014. [PubMed: 21976721]
33. Still C, Wood G, Chu X, et al. High allelic burden of four obesity SNPs is associated with poorer weight loss outcomes following gastric bypass surgery. Obesity. 2011; 19(8):1676. April 18, 2014. [PubMed: 21311511]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

What is already known about this subject?

- Previous studies have demonstrated a benefit of weight loss in family members when one adult family member participates in a weight management program.
- To date, studies that have explored the impact of weight-loss surgery of adults on co-habitating children have been limited by small sample sizes and have produced conflicting results.

What this study adds?

- We conducted the first case-control study, and the largest study to date, evaluating the impact of adult bariatric surgery on the Body Mass Index (BMI) trajectory of children living in the same households.
- Overweight male children who lived with a surgery patient had a lower than expected BMI post-surgery, while males who did not live with a surgery patient had a higher than expected BMI at follow-up.
- The BMI trajectory of children with obesity living with weight-loss surgery patients was not significantly different than the BMI trajectory of children with obesity living with obese adults with no history of surgery.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

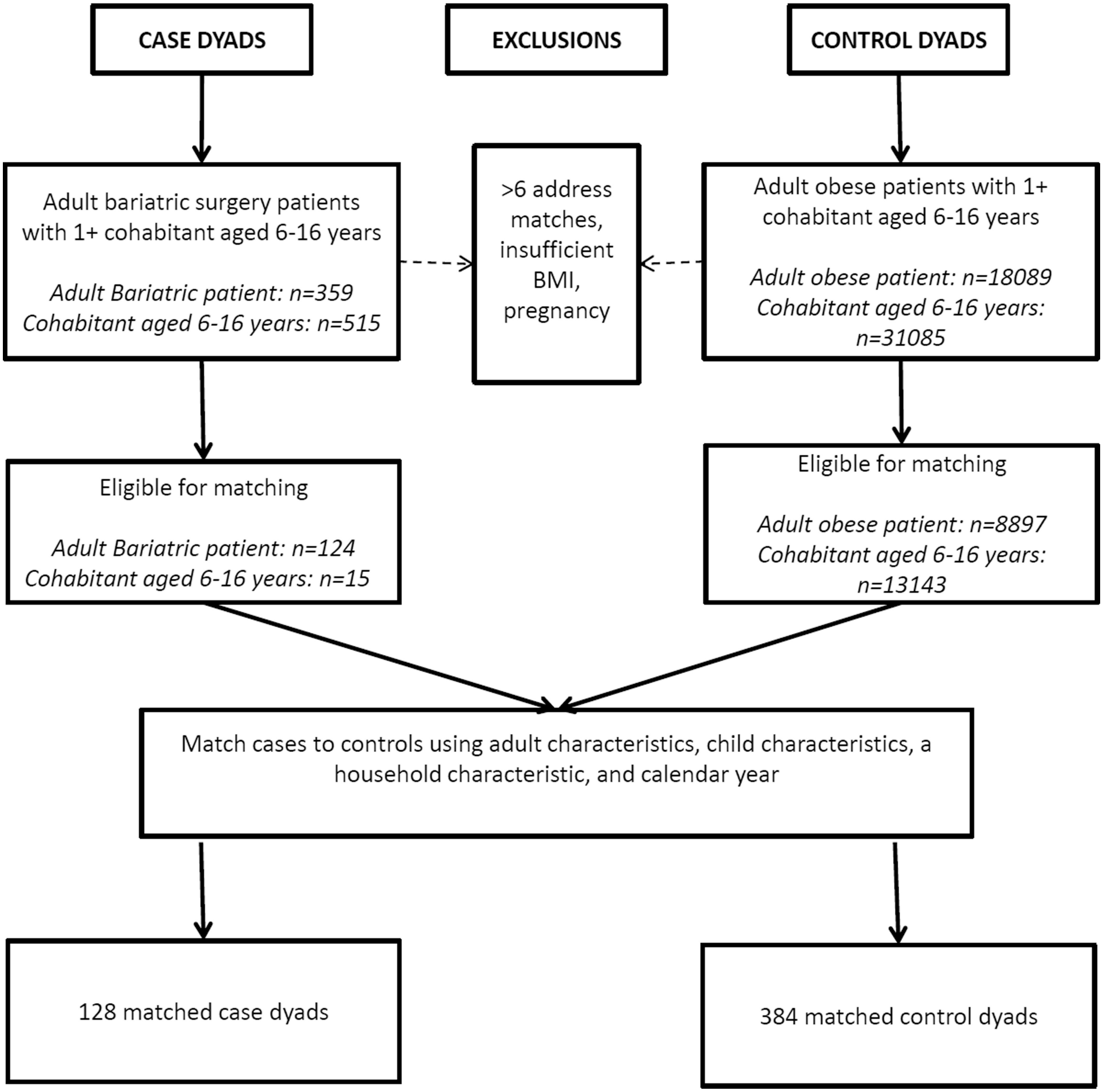

Figure 1.
Case/Control Selection Process

Author Manuscript
Author Manuscript
Author Manuscript
Author Manuscript

Table 1

Characteristics of the study population (N=512 child-adult dyads)

	Bariatric dyad N=128	Control dyad N=384	p-value
Adult characteristics			
Gender			
Female, % (n)	93% (n=119)	93% (n=357)	0.999
Male, % (n)	7% (n=9)	7% (n=27)	
Age, mean years (SD)	40.6 (6.3)	40.4 (6.3)	0.729
BMI, mean kg/m^2 (SD)	46.0 (5.9)	45.3 (6.1)	0.242
Child characteristics			
Gender			
Female, % (n)	41% (n=52)	41% (n=156)	0.999
Male, % (n)	59% (n=76)	59% (n=228)	
Age, mean years (SD)	11.6 (3.2)	11.5 (3.1)	0.785
BMI percentile			
Normal: 5–84%tile, % (n)	38% (n=48)	38% (n=144)	0.999
Overweight: 85–94%tile, % (n)	23% (n=29)	23% (n=87)	
Obese: >95%tile, % (n)	40% (n=51)	40% (n=153)	
Household characteristic			
# children in household			
1, % (n)	31% (n=40)	28% (n=107)	0.463
2+, % (n)	69% (n=88)	72% (n=277)	

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2

Comparison of change in BMI from pre- to post-surgery between girls living with adults who have bariatric surgery and girls living with adults who have obesity but have not had bariatric surgery

BMI percentile	Age	Cases		Controls		Cases vs. Controls p-value
		N	Mean difference SD)	N	Mean difference (SD)	
0–84	6–11	9	0.9 (1.7)	30	1.5 (1.9)	0.434
	12–16	13	0.4 (1.5)	36	0.5 (2.7)	0.774
	6–16	22	0.6 (1.6)	66	1.0 (2.4)	0.403
85–94	6–11	5	0.7 (1.3)	16	0.1 (2.4)	0.565
	12–16	3	−0.2 (2.0)	8	−0.8 (2.7)	0.746
	6–16	8	0.4 (1.5)	24	−0.2 (2.5)	0.529
95–100	6–11	10	−1.2 (2.1)	35	−1.9 (3.0)[^]	0.505
	12–16	12	−1.9 (4.0)	31	−2.2 (2.8)[^]	0.785
	6–16	22	−1.6 (3.2)[^]	66	−2.0 (2.9)[^]	0.543

[*] Actual weight minus expected weight

[^] Difference between actual and expected: p<.05

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 3

Comparison of change in BMI from pre- to post-surgery between boys living with adults who have bariatric surgery and boys living with adults who have obesity but have not had bariatric surgery

BMI percentile	Age	Cases		Controls		Cases vs. Controls p-value
		N	Mean change (SD)*	N	Mean change (SD*)	
0–84	6–11	17	1.1 (2.6)	45	1.0 (2.1)^	0.794
	12–16	9	2.4 (3.1)^	33	0.5 (2.0)	0.030
	6–16	26	1.6 (2.8)^	78	0.8 (2.1)	0.187
85–94	6–11	12	−1.4 (5.1)	34	1.0 (3.8)	0.083
	12–16	9	−1.0 (2.9)	29	0.1 (3.1)	0.324
	6–16	21	−1.3 (4.2)	63	0.6 (3.5)	0.045
95–100	6–11	10	−2.5 (4.8)	32	−2.8 (9.5)	0.900
	12–16	19	1.8 (5.1)	55	1.0 (3.9)	0.509
	6–16	29	0.3 (5.3)	87	−0.4 (6.7)	0.622

* Actual minus expected weight

^ Difference between actual and expected: $p<.05$