Halo Effect for Bariatric Surgery
Collateral Weight Loss in Patients’ Family Members

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Context: Bariatric surgery is an effective treatment for morbid obesity, which is increasingly recognized as a familial disease. Healthy behavior transmission may be enhanced by family relationships.

Objective: To determine changes in weight and healthy behavior in patients who underwent Roux-en-Y gastric bypass surgery and their family members.

Design: Prospective, longitudinal, and multidimensional health assessment before and 1 year after index Roux-en-Y gastric bypass surgery.


Participants: Eighty-five participants (35 patients, 35 adult family members, and 15 children <18 years old).

Intervention: Roux-en-Y gastric bypass surgery and associated dietary and lifestyle counseling.

Main Outcome Measures: Weight and expected body mass index (calculated as weight in kilograms divided by height in meters squared). Secondary outcomes were waist circumference, quality of life (36-Item Short Form or Pediatric Quality of Life Inventory), healthy behaviors, eating behaviors, and activity levels.

Results: Participants were grouped by relationship to patient for analysis with paired 2-sample t tests. Before the operation, 60% of adult family members and 73% of children of patients undergoing Roux-en-Y gastric bypass surgery were obese. At 12 months after the operation, significant weight loss was observed in obese adult family members (from 234 to 226 lb; \( P = .01 \)). There was a trend for obese children to have a lower body mass index than expected for their growth curve (31.2 expected vs 29.6 observed; \( P = .07 \)). Family members increased their daily activity levels (adults, from 8 to 17 metabolic equivalent task–hours, \( P = .005 \); and children, from 13 to 22, \( P = .04 \)). Adult family members also had improved eating habits with less uncontrollable eating (from 35 to 28; \( P = .01 \)), emotional eating (from 36 to 28; \( P = .04 \)), and alcohol consumption (from 11 drinks per month to 1 drink per month; \( P = .009 \)).

Conclusion: Gastric bypass surgery may render an additional benefit of weight loss and improved healthy behavior for bariatric patients’ family members.

Arch Surg. 2011;146(10):1185-1190

Despite public health efforts, 26% of American adults are obese and an additional 40% are overweight. In 2008, there were 220,000 Roux-en-Y gastric bypass (RNYGB) operations performed in the United States. Bariatric surgery currently is the only effective and enduring treatment for morbid obesity. The benefits of RNYGB include weight loss, resolution of comorbidities, and improvements in overall mortality and specifically mortality related to diabetes, heart disease, and cancer.

The obesity epidemic in the United States is also affecting children, with 18% of children classified as overweight and 15% classified as obese on the basis of body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) for sex and age growth curves. The biggest risk factor for becoming an obese child is having an obese parent, and data from the Bogalusa Heart Study show that childhood obesity is strongly associated with obesity in adulthood.

During pregnancy and delivery, the risk of adverse maternal and fetal outcomes is lower after RNYGB. The obesity rate in children of mothers who have had RNYGB is 52% lower after surgery compared with the obesity rate in children born to the same mothers before surgery.
Weight changes and lifestyle modification may be social contagions. Christakis and Fowler, using findings from the Framingham Heart Study from 1975 to 2000, demonstrated that a person’s risk of becoming obese is influenced by associating with obese individuals. In that study, a person’s risk of becoming obese increased 57% if a friend became obese and 37% if a spouse became obese. The corollary holds true as well: weight loss has been shown to be socially contagious, with greater dietary weight loss achieved if a spouse also enrolls in a weight loss program or if a person participates in a weight loss support group. Social support leads to more success in other lifestyle changes. A person is 67% more likely to stop smoking if their spouse also stops smoking. If one member of the family makes drastic lifestyle changes following surgery, it is possible that other family members will adopt similar healthy habits.

The efficacy of RNYGB in inducing dramatic weight loss has been well proven in the literature, but few data document weight changes in the patient’s family members after RNYGB. To our knowledge, only 1 study has examined the effects of bariatric surgery on family members of patients who underwent gastric bypass surgery. The aim of this study was to observe any weight and lifestyle changes in spouses, parents, and children of RNYGB patients in the first year following surgery.

METHODS

From January 1, 2007, through December 31, 2009, we enrolled 35 families of patients with RNYGB in a prospective, longitudinal, and multidimensional health assessment at an academic bariatric center of excellence. To be included in the study, the family members had to be able to accompany the patient on all clinic visits, and the patient and family members had to live together in 1 domicile. Patients and family members were required to attend 3 patient preoperative educational sessions and all postoperative visits where lifestyle modification was emphasized (at 2 and 6 weeks and at 3, 6, and 12 months).

At each clinic visit, the standardized dietary and lifestyle counseling that accompanies bariatric surgery was given to patient and family members alike. Dietary recommendations to patients and family members specifically included an emphasis on a high-protein, high-fiber, low-fat, and low-sugar diet with small frequent meals consistent with post–gastric bypass surgery recommendations. At each of the 6 daily meals, patients and family members were instructed to have a serving size of 4 to 6 oz (7-21 g) of protein, 0 to 8 g of fat, 0 to 30 g of carbohydrates, and 200 to 300 calories. Family members were encouraged to take a daily multivitamin, with RNYGB patients taking the same as well as supplemental B12, iron, and calcium, as indicated. Lifestyle counseling daily goals included physical activity of 10,000 steps, 8 hours of sleep, alcohol moderation, and avoidance of watching more than 2 hours of television. Eighty-five study participants were followed up, comprising 35 patients, 26 spouses, 3 grandparents (of patients’ children), 6 adult children, and 15 children younger than 18. For analysis, spouses, grandparents, and adult children were combined into an adult family group (n = 35). Children younger than 18 are hereafter referred to as the children group (n = 15).

Before and 12 months after the operation, all participants were weighed and were given validated questionnaires measuring general health, eating habits, and activity levels.

Obesity in adults is defined as a BMI of 30 or greater. In children younger than 18, obesity is defined as a BMI at the 95th percentile or higher, using the BMI for sex and age growth charts of the Centers for Disease Control and Prevention (CDC). In adults, changes in weight from before to 1 year after the operation were measured simply as changes in weight. However, in children, weight change alone does not accurately reflect body content because a healthy child is expected to gain appropriate weight during the course of a year. Each child’s expected 1-year BMI was compared with their actual 1-year BMI using a paired t test, with P < .05 considered significant.

Several validated questionnaires were administered to patients and their families at the patient’s preoperative and 1-year postoperative appointments. The 36-Item Short Form (SF-36), a validated and widely used health survey, was used to measure general health in adult participants. The SF-36 can be scored to produce a total score as well as subscores for the domains of mental and physical health. Scores range from 0 to 100, with higher numbers indicating better health. Selected sections from the CDC’s Behavioral Risk Factor Surveillance System questionnaire were used to obtain data on television viewing habits and alcohol consumption. The Behavioral Risk Factor Surveillance System questionnaire is used by the CDC to follow state trends in health risk behaviors. The Three-Factor Eating Questionnaire scores eating habits from 0 to 100 on 3 domains: cognitive control of eating, uncontrolled eating, and emotional eating. The Food Frequency Questionnaire is a self-report food recall survey that estimates how frequently the respondents consume foods from the following food groups: dairy, fruits and vegetables, meats, carbohydrates, and junk food.

A metabolic equivalent task is a measure of energy expenditure. One metabolic equivalent task is equivalent to consuming 1 kilocalorie per kilogram of body weight per hour. The Seven-Day Physical Activity Recall questionnaire has participants estimate daily hours spent doing different activities and can calculate the mean daily metabolic equivalent task–hours of energy expended. The Medical Outcomes Study Sleep Scale is a 12-item questionnaire that evaluates the adequacy of sleep, the restfulness of sleep, and the degree of sleep disturbance. It is scored from 0 to 100, with higher numbers indicating more restful sleep.

In children younger than 18, validated pediatric questionnaires were used in place of the SF-36, the Behavioral Risk Factor Surveillance System questionnaire, and the Medical Outcomes Study Sleep Scale. Information on general health and risk factors was collected via the Pediatric Quality of Life Inventory, version 4.0, which scores from 0 to 4.0 on 4 generic core scales: physical, emotional, social, and school. Information on lifestyle choices and healthy behaviors was gathered using the Health Behavior in School-aged Children questionnaire, a standard questionnaire developed by the International Research Institute and now used by the World Health Organization to follow up changes in healthy behaviors in more than 43 countries.

All analyses were performed using Stata software, version 7.0 (StataCorp, College Station, Texas). Approval of the Stanford Human Subjects Review Board was obtained, and all participants signed research consent forms.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

The demographic distribution of the patient population in our study was representative of the overall patient population undergoing bariatric surgery (Table 1). It should be noted that the patient with RNYGB primarily performed both food acquisition and preparation.
CHANGES IN WEIGHT, BMI, AND WAIST CIRCUMFERENCE

The weight loss observed in patients was typical for patients undergoing gastric bypass at our institution (Table 2). The mean weight of adult family members decreased from 220 to 198 lb but was not statistically significant. However, when adult family members were divided into groups on the basis of obesity before the operation, significant differences became apparent. Obese adult family members underwent significant decreases in weight from 234 to 226 lb ($P = .01$), whereas weight decreases of nonobese adult family members were not significant (from 180 to 176 lb). Body mass index, a function of weight, underwent similar trends in adult family members. Waist circumference among all adult family member did not change significantly (from 108 to 105 cm), but among obese adult family members, it did change significantly (from 119 to 111 cm) ($P = .03$). There was no change in the waist circumference of nonobese adult family members, which remained at 99 cm.

Weight changes in children required different analysis to take into account their natural growth. As expected, children gained weight in the year following surgery, from 118 to 126 lb ($P = .04$). Along with the increases in weight, there were increases in the height of the children, so that there were no significant changes in BMI for all children (from 26.3 to 26.3), obese children only (30.3 to 29.6), or nonobese children only (18.3 to 19.8). Body mass index alone does not accurately reflect whether a child is of normal weight because a healthy BMI in children is determined by BMI for sex and age growth curves. The BMI for sex and age growth curves from the CDC were used to predict a 1-year postoperative BMI for each child if he or she were to continue along his or her current growth trajectory. These expected 1-year BMIs were compared with each child's observed 1-year BMI with a paired $t$ test. The mean expected BMI of 27.0 was higher than the mean observed BMI of 26.3 for all children. In obese children only, the expected BMI of 31.2 was higher than the observed BMI of 29.6 ($P = .07$), and in nonobese children the expected BMI of 18.8 was lower than the observed BMI of 19.8. Waist circumference in children is another measure that would be expected to increase appropriately during the course of a year in a growing child. Waist circumference in all children did not change from 84 to 85 cm; in obese children, it remained stable from 91 to 93 cm; and in nonobese children, it did not change (Table 2).

ADULT FAMILY MEMBERS’ QUALITY OF LIFE AND HEALTH BEHAVIORS

The total SF-36 score for gastric bypass patients improved significantly from 51 to 73 ($P < .001$) (Table 3). The total SF-36 score among adult family members remained at 73 from before to 1 year after the operation. The SF-36 subscores for the domains of mental and physical health underwent similar changes, with significant improvements in every domain for patients and with no statistically significant changes seen in adult family members (data not shown). Questions from the Behavioral Risk Factor Survey on alcohol consumption revealed decreases in the mean number of alcoholic drinks consumed per month by patients (from 5.1 to 0.2) and by adult family members (from 11.4 to 0.8). The number of hours spent watching television each day is shown in the Figure. Patients and adult

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### Table 1. Demographic Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients (n = 35)</th>
<th>Adult Family Members (n = 35)</th>
<th>Children (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SE), y</td>
<td>48 (2)</td>
<td>49 (3)</td>
<td>12 (1)</td>
</tr>
<tr>
<td>Female sex, %</td>
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<td>37</td>
<td>55</td>
</tr>
<tr>
<td>White race, %</td>
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<td>56</td>
<td>23</td>
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<tr>
<td>Educational level beyond high school, %</td>
<td>94</td>
<td>97</td>
<td>NA</td>
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</tbody>
</table>

### Table 2. Weight Changes in Obese vs Nonobese Family Members

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SE)</th>
<th>Before Surgery</th>
<th>1 Year After Surgery</th>
<th>$P$ Value</th>
</tr>
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<tbody>
<tr>
<td>Patients (100% obese)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Weight, lb</td>
<td>295 (10)</td>
<td>197 (8)</td>
<td>&lt;.001</td>
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<tr>
<td>BMI</td>
<td>48.7 (1.4)</td>
<td>33.3 (1.2)</td>
<td>&lt;.001</td>
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</tr>
<tr>
<td>Waist circumference, cm</td>
<td>135 (4)</td>
<td>103 (5)</td>
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</tr>
<tr>
<td>Obese adult family</td>
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<td></td>
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<tr>
<td>Weight, lb</td>
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<td>198 (10)</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>108 (4)</td>
<td>105 (3)</td>
<td>.18</td>
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</tr>
<tr>
<td>Obese adult family</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonobese adult family</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight, lb</td>
<td>180 (9)</td>
<td>176 (9)</td>
<td>.69</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>33.1 (1.3)</td>
<td>30.7 (1.6)</td>
<td>.23</td>
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</tr>
<tr>
<td>Waist circumference, cm</td>
<td>26.3 (0.7)</td>
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<td>.94</td>
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<tr>
<td>Obese children</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Nonobese children</td>
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<tr>
<td>Weight, lb</td>
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<tr>
<td>BMI</td>
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<td>Waist circumference, cm</td>
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<td>.89</td>
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</tr>
<tr>
<td>Nonobese children</td>
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<td></td>
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<td></td>
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<tr>
<td>Weight, lb</td>
<td>91 (7)</td>
<td>93 (5)</td>
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<td>BMI</td>
<td>18.3 (2.5)</td>
<td>19.8 (1.8)</td>
<td>.17</td>
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</tr>
<tr>
<td>Waist circumference, cm</td>
<td>69 (5)</td>
<td>69 (6)</td>
<td>.27</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NA, not applicable.

a Obesity defined for adults as BMI of 30 or more and for children as 95th percentile or more for weight and age.
family members reported sleeping the same number of hours as before; patients reported that their sleep became significantly more restful, but this change was not observed in family members.

PEDIATRIC QUALITY OF LIFE AND HEALTH BEHAVIORS

As shown in Table 4, the Pediatric Quality of Life Inventory revealed small increases in the children’s quality of life, but these changes were not significant. The Health Behavior in School-aged Children questionnaire showed decreases in the number of hours that children watched television and used a computer daily, but these did not achieve statistical significance (Figure). There was a significant increase in the percentage of children who reported being on a diet (from 25% to 50%) ($P = .01$).

EATING HABITS

One year following surgery, both patients and adult family members had significant changes in their eating habits (Table 5). Patients’ cognitive control of eating significantly increased from a mean of 47 to 72, uncontrollable eating decreased from 44 to 15, and emotional eating decreased from 56 to 25 ($P < .001$ for all). Adult family members showed no significant change in cognitive control of eating but did have significant mean decreases in uncontrolled eating from 35 to 28 ($P = .01$) and in emotional eating from 36 to 28 ($P = .04$). Children of
gastric bypass patients did not undergo significant changes in cognitive control of eating, uncontrolled eating, or emotional eating (Table 5).

The Food Frequency Questionnaire showed significant changes in the food choices of patients, but there were no significant changes in the food choices of adult family members or children. One year following surgery, patients ate fewer mean servings of carbohydrates (from 1.54 to 1.02; \( P = .001 \)), vegetables (from 2.20 to 1.71; \( P = .04 \)), and junk food (from 1.31 to 0.64; \( P < .001 \)) than they did before surgery (data not shown).

**ACTIVITY LEVELS**

Activity levels increased in patients from 11.3 to 14.0 metabolic equivalent task-hours per day. There were significant increases in daily activity levels in adult family members (from 7.8 to 16.8 metabolic equivalent task-hours) and in children (from 12.9 to 22.4) (Figure and Table 5).

Previous studies have shown that obesity may be a social contagion and that by associating with obese individuals a person is more likely to become obese. Our study may demonstrate that bariatric surgery in selected populations can provide a reverse corollary and induce weight loss and healthy behaviors in people surrounding the patient.

In our study, weight loss occurred in both nonobese and obese adult family members. The significant weight loss observed in obese adult family members represented a loss of 3% of their total body weight. This weight loss of 3% is within the range of 2% to 5%, which is the 12-month weight loss achieved by overweight women following the Atkins, Zone, Ornish, and LEARN (Lifestyle, Exercise, Attitudes, Relationships, and Nutrition) diets. The similarity in 12-month weight loss suggests that living with a gastric bypass patient and undertaking a structured diet plan along with the patient may have an equivalent effect on weight. Adult family members in this study reported significantly less uncontrollable eating and less emotional eating. These data suggest that following surgery, family members were conscious of and attempting to limit maladaptive eating patterns. Furthermore, although family members could have lost similar weight on a structured weight loss program, family members of a person undergoing gastric bypass are more likely to participate in weight loss given the physical proximity to patient’s television viewing, exercise options, and/or food selection. Perhaps the best indicator of dietary success is adherence, and having a family member undergo weight loss surgery is a powerful reminder for dietary modification.

Seventy-three percent of the children in this study were obese. Following the parent’s surgery, these obese children had BMIs lower than those expected by their plotted growth curves. Children were twice as likely to report being on a diet to lose weight 1 year after their parent had gastric bypass surgery, suggesting that having a parent lose weight has children adopt more weight scrutiny. The children in this study also benefited from fewer daily hours of television viewing and from increased physical activity after a parent underwent a bariatric procedure. For this group, the study shows that gastric bypass surgery not only benefits the patient but also may render a halo effect of weight loss and healthy behavior for the patient’s family members and children.

Obesity is a family health concern. This study demonstrates that weight loss can be a family intervention whereby family members can mutually support each other in their goal of weight loss. Weight loss surgery for 1 family member may be weight loss for all the family with properly applied dedication and resources. With the steadily increasing use of weight loss surgery, there may be ample opportunity for family members to benefit from tertiary prevention of obesity. Patients undergoing gastric bypass make drastic changes in their eating habits and lifestyle, and it is likely that these new behaviors affect their family members and friends who are themselves at high risk of being obese. Bariatric surgery provides an opportunity for intervention for many individuals beyond the patient. Bariatric surgery programs should encourage family involvement in support groups and education sessions to capitalize on these halo effects. This study demonstrates that performing a gastric bypass operation on 1 patient has a halo of positive effect on the weight, eating habits, activity levels, and health behaviors of the entire family.

**REFERENCES**

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Financial Disclosure: None reported.


Correction

Error in Data. In the article titled “Halo Effect for Bariatric Surgery: Collateral Weight Loss in Patients’ Family Members” by Woodard et al, published in the October issue of the Archives (2011;146[10]:1185-1190), data given in the last 3 rows of Table 2 (“Waist circumference, cm”) and 1 sentence in the text on page 1187 was incorrect. The Table 2 entries reading left to right should have read as follows: “Waist circumference, cm 84 (5), 85 (5), and .89, Obese children 91 (7), 93 (5), and .77, and Nonobese children 69 (5), 69 (5) and .27.” Farther down in the same column of the continued text lines 7 through 10 should have read as follows: “Waist circumference in all children did not change from 84 to 85 cm; in obese children, it remained stable from 91 to 93 cm; and in nonobese children, it did not change.”