Low socioeconomic status is associated with lower weight-loss outcomes 10-years after Roux-en-Y gastric bypass

Anthony Carden[1] · Kelly Blum[2] · Carlie J. Arbaugh[3] · Amber Trickey[2] · Dan Eisenberg[1,2]

Abstract

Background Roux-en-Y gastric bypass (RYGB) is the criterion standard operation for weight loss. Low socioeconomic status (SES) is common in the Veteran population undergoing bariatric surgery, but the impact of SES on long-term weight-loss outcomes is not known. We hypothesize that low socioeconomic status is associated with less weight loss after gastric bypass in long-term follow-up.

Methods We performed a retrospective review of patients undergoing RYGB at a single Veterans Affairs (VA) hospital. Patients with at least 10 years of follow-up data in the electronic health record were included in the analysis. Weight loss was measured as percent excess body mass index loss (%EBMIL). The primary predictor variable, median household income, was determined using zip codes of patient residences matched to publicly available 2010 U.S. census data. Univariate relationships between income, weight loss, and other patient characteristics were evaluated. We calculated a multivariate generalized linear model of %EBMIL to estimate independent relationships with median household income quartile while controlling for patients' age, race, sex, and VA distance.

Results Complete 10-year follow-up data were available for 83 of 92 patients (90.2%) who underwent RYGB between 2001 and 2007 and survived at least 10 years. The majority of patients were male (79.5%) and white (73.5%). The mean 10-year %EBMIL was 57.8% (SD: 29.5%, range $-36.0\% - 132.8\%$). In univariate analysis, income was significantly associated with race ($p < 0.001$) and median distance to the VA bariatric center ($p = 0.034$), but income did not differ by gender ($p = 0.73$) or age ($p = 0.45$). Multivariate analysis revealed significantly lower 10-year %EBMIL for patients with the lowest income compared to patients with low-mid income ($p = 0.03$) and mid-high income ($p = 0.01$), after controlling for gender, race, age, and VA distance.

Conclusions Low socioeconomic status is associated with lower weight-loss outcomes, 10 years after RYGB. Durable weight loss is observed in all income groups.

✉ Dan Eisenberg
daneisenberg@stanford.edu

1   Surgical Services, Palo Alto VA Health Care System, 3801 Miranda Avenue, 3801 Miranda Avenue, GS 112, Palo Alto, CA 94304, USA

2   Department of Surgery and Stanford-Surgery Policy Improvement Research and Education (S-SPIRE) Center, Stanford University School of Medicine, Stanford, CA, USA

3   Stanford School of Medicine, 291 Campus Drive, Stanford, CA, USA

Obesity among U.S. Veterans is a significant healthcare concern [1, 2]. Bariatric surgery remains a clinically and cost-effective treatment of morbid obesity, yet is performed in only a small fraction of eligible individuals [3–6]. Roux-en-y gastric bypass (RYGB) is the criterion standard treatment for severe obesity and its co-morbid conditions, and is associated with durable, long-term outcomes [7].

In addition to overweight and obesity, the Veteran population is also at risk for poverty and low socioeconomic status (SES) [8]. The SES of a patient's community, as measured by median income, is a quantifiable measure that may approximate local resources necessary to achieve and

maintain long-term weight loss, such as access to healthy food [9], exercise [10], counseling, and health care. While SES, race, and gender have been shown to correlate with rates of utilization of bariatric surgery [6, 11, 12], the impact of SES on long-term weight-loss outcomes after bariatric surgery is unclear, and has not been evaluated in the Veteran population.

In this study, we examined the impact of SES on long-term weight loss after RYGB in the Veteran population. We hypothesized an inverse association between SES and weight-loss success at 10 years after RYGB.

Materials and methods

After Institutional Review Board (IRB) approval, we performed a retrospective review of a prospective database of bariatric surgery at a single Veterans Affairs (VA) Medical Center, located in a suburban setting. We identified all patients who underwent RYGB at our institution; those individuals who did not have weight data in the electronic health record for at least 10 years after bariatric surgery were considered lost to follow-up and excluded from the study.

Patient records were evaluated for 10-year postoperative weight and BMI. SES was estimated using approximate household income, which was estimated by linking zip codes of patient residences at the time of surgery to publicly available U.S. Census data on median household income per zip code [13]. Google Maps online map software was used to obtain direct radial distances from patient residences to the primary VA hospital.

Statistical analysis

Patient characteristics, including median household income, age, race, sex, and distance to the VA, were analyzed for relationships with percent excess BMI loss (%EBMIL). Continuous variable distributions were evaluated for %EBMIL, age, median household income, and distance to the VA. Frequency distributions were evaluated for gender and race. Median household income and distance to the VA bariatric surgical center were not normally distributed; non-parametric descriptive statistics are presented. Income was grouped by quartiles, and race was characterized as white versus non-white or unreported.

The primary predictor variable of interest was median household income. We assessed relationships between income and other patient characteristics with univariate comparisons. A Fisher's exact test was performed to assess the relationship between income and race. A Chi-square test was calculated to evaluate the association between gender and income. A Kruskal–Wallis test was performed to evaluate the association between income and distance to the VA.

Analysis of variance was utilized to compare %EBMIL by income quartile groups.

A multivariate generalized linear model was calculated to assess relationships between measured patient characteristics and the dependent variable, %EBMIL. The primary independent variable was median household income quartile; the referent group was defined as the lowest income quartile. Additional covariates were included in the model to statistically adjust for age, race, sex, and distance to the VA. An alpha level of 0.05 was defined for statistical significance. Statistical analyses were performed in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Of 108 individuals who underwent RYGB at the study site from 2001 to 2007, a total of 16 patients (14.8%) died in the follow-up period. Among patients who were alive at 10 years, 9 (9.8%) were lost to follow-up. Thus, a total of 83 individuals (90.2%) were identified with complete follow-up data. The mean 10-year postoperative %EBMIL was 57.8% (SD: 29.5%, range -36.0 to -132.8) (Table 1). The mean age was 51.1 years (SD: 8.7, range 28–65), 73.5% were white, and 79.5% were male. The median census-derived household income was $51,116 (interquartile range $40,021–$69,341), and median distance to the VA was 67.7 miles (interquartile range 56.7–387.4).

Income was significantly associated with race ($p < 0.001$) and median distance to the VA ($p = 0.034$) (Table 2). There were no significant differences in income by gender ($p = 0.73$) or age ($p = 0.45$). Univariate analysis demonstrated meaningful variation in %EBMIL by income, but the differences did not reach statistical significance ($p = 0.16$).

The multivariate analysis revealed significantly lower 10-year %EBMIL for patients in the lowest income group compared to patients with low-mid income and mid-high income (Table 3). Compared to the lowest income group, patients with low-mid income had 18.6% more EBMIL ($p = 0.034$), and patients with mid-high income had 22.1% more EBMIL ($p = 0.013$) after controlling for gender, race, age, and distance to the VA bariatric surgical center (Fig. 1). The highest income group achieved 11.8% more weight loss than the lowest income group, but this difference was not statistically significant ($p = 0.18$). On average, patients residing farther away from the VA achieved less weight loss; however, these differences were not statistically significant.

Table 1 Characteristics of patients who underwent Roux-en-Y Gastric Bypass at the study site from 2001 to 2007 and survived at least 10 years

Characteristic	$n = (83)$
Sex, n (%)	
Male	66 (79.5%)
Female	17 (20.5%)
Race, n (%)	
White	61 (73.5%)
Black	9 (10.8%)
Latino	1 (1.2%)
Native	3 (3.6%)
Not reported	9 (10.8%)
Age (years)	
Mean (SD)	51.1 (8.7)
Range	28–65
Income quartiles	
Low	
n (%)	20 (24.1%)
Mean (SD)	34,007 (4,017)
Range	$25,934–$39,756
Low to mid	
n (%)	21 (25.3%)
Mean (SD)	45,119 (2,943)
Range	$40,021–$49,575
Mid to high	
n (%)	21 (25.3%)
Mean (SD)	58,947 (5,491)
Range	$51,116–$69,012
High	
n (%)	21 (25.3%)
Mean (SD)	91,020 (17,379)
Range	$69,431–$127,684
Distance to VA (miles)	
Median (IQR)	67.7 (56.7–387.4)
10 year % EBMIL	
Mean (SD)	57.8 (29.5)
Range	− 36.0 to 132.8

Discussion

In this study, we evaluated the impact of SES on long-term weight loss after bariatric surgery in the Veteran population. The Veteran population undergoing bariatric surgery is unique in the bariatric literature in that it is mostly male, and often resides a large distance from the bariatric center. We found that individuals residing in low-SES areas had significantly lower weight loss than low-mid and mid-high income patients, independent from gender, ethnicity, age, and distance from hospital. This relationship did not persist when using the low-mid quartile as reference, suggesting that if SES indeed has an impact on long-term weight loss after bariatric surgery, as this study suggests, it significantly affects only the low-SES population and dissipates in higher income groups.

Studies with short- and mid-term follow-up have failed to demonstrate different weight-loss outcomes in different socioeconomic groups. In a study of 309 patients, Akkary et al. found no significant impact of median income on weight loss, 1 year after gastric bypass [14]. Another study of 2-year outcomes after surgery found that weight loss was not significantly related to insurance status (used as a proxy for income) in a prospective study of 131 patients who underwent vertical banded gastroplasty [15]. While Gullick et al. suggested that SES, as reflected by race, may correlate with 5-year weight loss in bariatric surgery [16].

Our study results suggest that low regional income status may be a potential barrier to optimal weight-loss outcomes in the long-term. This may be a reflection of inadequate access to postoperative bariatric care, as has been suggested by other studies [17]. Further studies are needed to determine which aspects of the patient's socioeconomic environment contribute to surgical outcomes. Our findings suggest that individuals with a low socioeconomic status may represent a group with unmet long-term needs after bariatric surgery, who could benefit from closer long-term follow-up and specialty bariatric care. Nonetheless, this group still had very good weight-loss outcomes, further suggesting the durability of the RYGB in all patients.

Physical distance has been studied as a potential barrier to health care delivery. A national retrospective cohort study in Canada using geographic cluster analysis showed that having a bariatric facility in the same public health unit as a residential neighborhood was associated with 6.6 times higher odds of being in a bariatric high-use cluster, suggesting that geographic distance to bariatric centers influences care delivery [18]. For this reason, we wanted to ensure that our findings were a reflection of median income, and not a reflection of the patient's physical distance from our bariatric center. While our data did show a trend towards less weight loss for those patients living farther from the bariatric team, this trend did not contribute to the observed effect of SES on weight loss.

Factors affecting access to preoperative and postoperative bariatric are not yet fully understood, and their impact on long-term outcomes are not fully elucidated. Several other factors have previously been found to affect access to care, including income, education level, gender, rural environment, race, and insurance status. An open cohort of over 22,000 individuals that underwent bariatric surgery in Sweden showed that individuals from the lowest socioeconomic groups were less likely to undergo bariatric surgery than individuals with intermediate educational and income levels despite having the highest rates of morbid obesity [17].

Table 2 Univariate relationships between household income (quartiles) and patient characteristics including weight loss

	Low	Low to mid	Mid to high	High	p value*
Sex, (% n)					0.78
Male	17 (25.8%)	17 (25.8%)	15 (23.7%)	17 (25.8%)	
Female	3 (17.7%)	4 (23.5%)	6 (35.3%)	4 (23.5%)	
Race, (% n)					< 0.001
White	15 (24.6%)	14 (23.0%)	14 (23.0%)	18 (29.5%)	
Non-white	3 (23.1%)	4 (30.8%)	5 (38.5%)	1 (7.7%)	
Not reported	2 (22.2%)	3 (33.3%)	2 (22.2%)	2 (22.2%)	
Age					0.45
Mean (SD)	53.3 (5.9)	50.4 (9.1)	49.0 (11.0)	51.8 (8.1)	
Range	39.0–65.0	32.0–63.0	28.0–65.0	31.0–65.0	
Distance to VA					0.034
Median (IQR)	88.0 (65.6–387.4)	92.1 (67.7–220.7)	87.7 (57.4–525.2)	17.6 (10.6–62.4)	
10 year % EBMIL					0.16
Mean (SD)	45.9 (36.5)	62.8 (27.6)	65.2 (27.8)	56.7 (23.1)	
Range	− 36.0 to 111.6	26.1–132.8	28.1–120.9	17.3–100.9	

*p values were calculated using a Chi-square test, Fisher's exact test, Kruskal–Wallis tests, and analysis of variance

Table 3 Multivariate generalized linear model results estimating associations between weight loss and patient characteristics including socioeconomic status

| Factor	Reduced model		Full model	
	Coefficient (95% CI)	p value	Coefficient (95% CI)	p value
SES (vs. low)				
Low to mid	16.9 (− 0.5, 34.3)	0.056	18.6 (1.4, 35.7)	0.034
Mid to high	19.3 (1.9, 36.6)	0.030	22.1 (4.7, 39.6)	0.013
High	10.8 (− 6.6, 28.1)	0.23	11.8 (− 5.4, 29.0)	0.18
Gender (vs. female)	–			
Male	–		8.8 (− 8.1, 25.7)	0.31
Ethnicity (vs. White)	–			
Non-White	–		0.5 (− 16.9, 18.0)	0.95
Not reported	–		− 3.2 (− 23.1, 16.6)	0.75
Age (years)	–		0.4 (− 0.4, 1.2)	0.31
Distance to VA (miles)	–		0.0001 (− 0.009, 0.009)	0.98

A population-based study in Michigan categorized patients into SES groups using zip codes, and showed that rates of bariatric surgery were low among males regardless of race [19]. In a study using the 2006 Nationwide Inpatient Sample of 774,000 patients, rural patients were 23% less likely to receive bariatric surgery than urban patients [20]. Those rural patients that were also non-white, male, poorer, sicker, and non-privately insured rarely received bariatric surgery.

This study is limited by its retrospective design and concentration on a single VA center. As such, we do not have data to account for potential migration over the 10-year follow-up period. In addition, while patient zip codes have been used by others as markers of socioeconomic environment, they remain an approximation that may not reflect the individual patient, and do not account for the possibility of patient mobility. Furthermore, our Veteran patient population sampled in this study was majority male and white, which may impact weight-loss outcomes in general.

Our data suggest that bariatric surgery is effective for weight loss at 10-year follow-up in Veterans. However, a low-income environment is a risk factor for inferior long-term weight loss. Further study is needed in larger long-term bariatric cohorts to determine which factors related to low SES most significantly affect postoperative weight loss.

Fig. 1 Multivariate analysis of 10-year %EBMIL for patients in the lowest income group compared to patients with low-mid income, mid-high income, and high income, adjusted for age, race, and distance to the bariatric surgical center

Percentage Excess BMI Loss
By Median Household Income Quartile
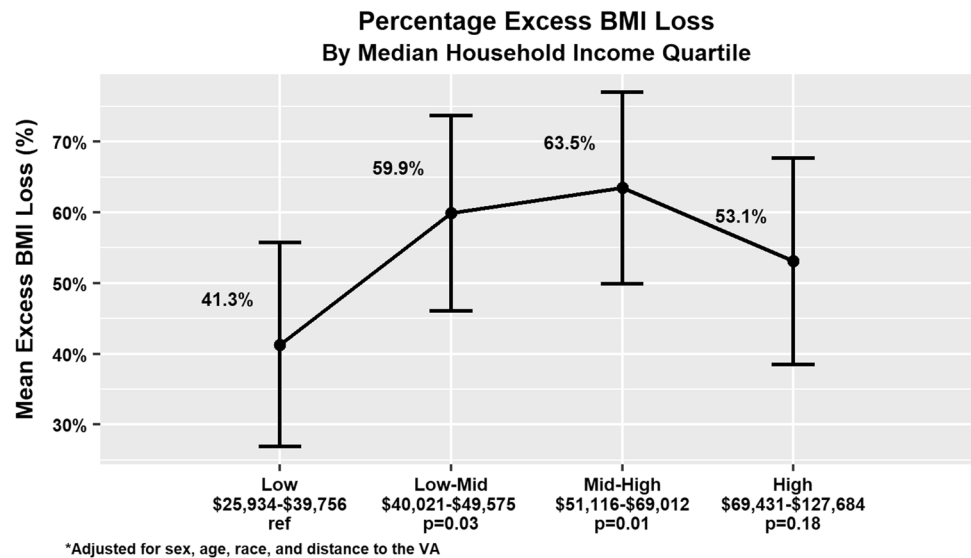
Conclusion

Low socioeconomic status is associated with lower weight-loss outcomes 10 years after gastric bypass, compared to weight loss in higher socioeconomic groups. This is independent of patient's distance to bariatric center. Nonetheless, all groups demonstrate a durable weight loss in long-term follow-up after RYGB.

Compliance with ethical standards

Disclosures Anthony Carden, Kelly Blum, Carlie Arbaugh, Amber Trickey, and Dan Eisenberg have no conflicts of interest or financial ties to disclose.

References

1. Das SR, Kinsinger LS, Yancy WS Jr, Wang A, Ciesco E, Burdick M, Yevich SJ (2005) Obesity prevalance among Veterans at Veterans affairs medical facilities. Am J Prev Med 28:291–294
2. Koepsell TD, Littman AJ, Forsberg CW (2012) Obesity, overweight, and their life course trajectories in Veterans and non-Veterans. Obesity 20:434–439
3. Klein S, Ghosh A, Cremieux PY, Eapen S, McGavock TJ (2011) Economic impact of the clinical benefits of bariatric surgery in diabetes patients with BMI> = 35 kg/m. Obesity (Silver Spring) 19:581–587
4. Neovius M, Narbro K, Keating C, Peltonen M, Sjoholm K, Agren G, Sjostrom L, Carlsson L (2013) Health care use during 20 years following bariatric surgery. JAMA 308:1132–1141
5. Fouse T, Schauer P (2016) The socioeconomic impact of morbid obesity and factors affecting access to obesity surgery. Surg Clin North Am 96:669–679
6. Bhogal SK, Reddigan JI, Rotstein OD, Cohen A, Glockler D, Tricco A, Smylie JK, Glazer SA, Pennington J, Conn LG, Jackson TD (2015) Inquity to the utilization of bariatric surgery: a systematic review and metaanalysis. Obes Surg 25:888–899
7. Adams TD, Davidson LE, Litwin SE, Kim J, Kolotkin RL, Nanjee MN, Gutierrez JM, Frogley SJ, Ibele AR, Brinton EA, Hopkins PN, McKinlay R, Simper SC, Hunt SC (2017) Weight and metabolic outcomes 12 years after gastric bypass. N Engl J Med 371:1143–1155
8. National Center for Veterans Analysis and Statistics (2015) Veteran poverty trends. United States Department of Veteran Affairs, Washington, DC
9. Chai W, Fan JX, Wen M (2018) Association of individual and neighborhood factors with home food availability: evidence from the National Health and Nutrition Examination Survey. J Acad Nutr Diet 118(5):815–823
10. O'Donaghue G, Kennedy A, Puggina A, Aleksova K, Buck C, Burns C, Cardon G, Carlin A, Ciarapica D, Colotto M, Condello G, Coppinger T, Cortis C, D'Haese S, De Craemer M, Di Blasio A, Hansen S, Iacoviello L, Issartel J, Izzicupo P, Jaeschke L, Kanning M, Ling F, Luzak A, Napolitano G, Nazare J, Perchoux C, Pesce C, Pischon T, Polito A, Sannela A, Schulz H, Simon C, Sohun R, Steinbrecher A, Schlicht W, MacDonncha C, Capranica L, Boccia S (2017) Socio-economic determinants of physical activity across the life course: a "determinar of diet and physical activity" (DEDIPAC) umbrella literature review. PLoS ONE 13:e0190737
11. Wallace A, Young-Xu Y, Hartley D, Weeks W (2009) Racial, socioeconomic, and rural-urban disparities in obesity-related bariatric surgery. Obes Surg 20:1354–1360
12. Keating C, Backholer K, Moodie M, Stevenson C, Peeters A (2015) Differences in the rates of treatment of severe obesity using bariatric surgery across socioeconomic groups. JAMA Surg 150:367–368
13. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk
14. Akkary E, Nerlinger A, Yu S, Dziura J, Duffy AJ, Bell RL (2009) Socioeconomic predictors of weight loss after laparoscopic Roux-Y gastric bypass. Surg Endosc 23(6):1246–1251
15. Durkin AJ, Bloomston M, Murr MM, Rosemurgy AS (1999) Financial status dose not predict weight loss after bariatric surgery. Obes Surg 9:524–526
16. Gullick A, Graham L, Richman J, Kakade M, Stahl R, Grams J (2014) Association of race and socioeconomic status with outcomes following laparoscopic Roux-en-Y Gastric bypass. Obes Surg 25:705–711

17. Memarian E, Calling S, Sundquist K, Sundquist J, Li X (2014) Sociodemographic differences and time trends of bariatric surgery in Sweden 1990–2010. Obes Surg 24:2109–2116

18. Doumouras AG, Saleh F, Sharma AM, Anvari S, Gmora S, Anvari M, Hong D (2017) Geographic and socioeconomic factors affecting delivery of bariatric surgery across high- and low-utilization healthcare systems. Br J Surg 104:891–897

19. Birkmeyer NJ, Gu N (2012) Race, soecioeconomic status, and the use of bariatric surgery in Michigan. Obes Surg 22:259–265

20. Wallace AE, Young-Xu Y, Hartley D, Weeks WB (2010) Racial, socioeconomic, and rural-urban disparities in obesity-related bariatric surgery. Obes Surg 20:1354–1360