**Supplementary Material**



**Figure S1**. Infographic for participant attrition.

**Table S1**. Baseline demographics for all participants.

|  |  |
| --- | --- |
| **Variable** | **Total (*n* = 124)** |
| Age (years) | 42.8 ± 10.2 |
| Location |  |
| Cleveland | 64 (51.6%) |
| Fargo | 60 (48.4%) |
| Sex |  |
| Female | 100 (80.6%) |
| Male | 24 (19.4%) |
| Type of Surgery |  |
| Gastric Bypass | 87 (70.2%) |
| Sleeve Gastrectomy | 37 (29.8%) |
| Ethnicity |  |
| Black or African American | 23 (18.5%) |
| Caucasian | 92 (74.2%) |
| Hispanic or Latino | 2 (1.6%) |
| Native Hawaiian/Pacific Islander | 1 (0.8%) |
| More than one race | 6 (4.8%) |

Data are reported as mean ± SD for continuous variables and *n* (%) for categorical variables.

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**Figure S2**. Patient excess weight loss (%) from baseline weight at (a) 12-month v 18-month (Spearman *p* < 0.001; *r =* 0.92), (b) 12-month v 24-month (*p* < 0.001; *r =* 0.88), and (c) 18-month v 24-month (*p* < 0.001; *r =* 0.92). The dashed lines correspond to the 50% EWL response criterium. The solid black line corresponds to the identity line. Points are colored by patient outcome classification consistency and shapes represent patient surgery type.

**Table S2.** Differences in dietary intake between RYGB and SG patients.

1. Differences in dietary intake between RYGB and SG patients at each timepoint.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Energy (kcal)** |  |  | **Carbohydrates (g)** |  |  | **Protein (g)** |  |  | **Total fat (g)** |  |  |
|  | **RYGB** | **SG** | ***p-*value** | **RYGB** | **SG** | ***p-*value** | **RYGB** | **SG** | ***p-*value** | **RYGB** | **SG** | ***p-*value** |
| Baseline | 1867.34 ± 771.65 | 1888.68 ± 904.16 | 0.628 | 189.66 ± 81.61 (42.5%) | 219.93 ± 160.32 (47.8%) | 0.993 | 98.11 ± 41.13 (24.8%) | 134.52 ± 127.69 (34%) | 0.299 | 86.81 ± 51.88 (46.6%) | 126.02 ± 132.26 (67.1%) | 0.231 |
| Postop 1 month | 695.34 ± 281.61 | 804.36 ± 292.1 | 0.066 | 60.92 ± 48.25 (35.7%) | 65.07 ± 52.81 (32.1%) | 0.984 | 57.74 ± 39.7 (34.6%) | 69.05 ± 41.65 (36.2%) | 0.034 | 31.48 ± 36.22 (42.4%) | 41.52 ± 41.95 (46.9%) | 0.016 |
| Postop 6 month | 1047.58 ± 430.56 | 1140.78 ± 479.64 | 0.297 | 94.79 ± 59.89 (35.8%) | 96.33 ± 64.76 (33.1%) | 0.983 | 70.01 ± 45.58 (28.2%) | 85.01 ± 52.69 (32.1%) | 0.046 | 49.79 ± 42.89 (42.7%) | 57.87 ± 45.18 (46.2%) | 0.266 |
| Postop 12 month | 1216.3 ± 400.05 | 1230.09 ± 525.16 | 0.582 | 116.97 ± 57.96 (37.8%) | 100.9 ± 65.83 (30.6%) | 0.109 | 73.3 ± 37.63 (25.2%) | 77.12 ± 26.12 (27.1%) | 0.219 | 55.54 ± 34.7 (40.7%) | 55.88 ± 25.85 (41.2%) | 0.981 |
| Postop 18 months | 1331.8 ± 525.44 | 1216.23 ± 463.51 | 0.386 | 129.89 ± 62.07 (38.5%) | 107.82 ± 53.51 (34.3%) | 0.16 | 69.53 ± 23.51 (22.3%) | 73.03 ± 30.37 (25.1%) | 0.609 | 57.13 ± 25.49 (38.1%) | 51.84 ± 21.09 (38.9%) | 0.377 |
| Postop 24 months | 1240.25 ± 454.72 | 1268.91 ± 574.29 | 0.878 | 120.22 ± 59.02 (41.1%) | 114.62 ± 76.56 (33.6%) | 0.45 | 73.88 ± 41.62 (26.9%) | 74.44 ± 21.5 (26.8%) | 0.409 | 58.35 ± 42.64 (47.9%) | 50.63 ± 22.65 (37.1%) | 0.542 |

Data are reported as mean ± SD. *P*-values were computed by Wilcoxon’s rank-sum test. Data in parentheses report the average energy ratio for each macronutrient intake.

1. Differences in dietary intake for RYGB and SG patients relative to baseline intake.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **RYGB** | | | |  | **SG** | | | |
| **Timepoint** | **Calories** | **Carbohydrates** | **Protein** | **Total fat** |  | **Calories** | **Carbohydrates** | **Protein** | **Total fat** |
| **BL – 1M** | 1.17E-40 | 1.06E-33 | 9.53E-11 | 3.86E-17 |  | 1.94E-13 | 5.85E-12 | 2.00E-05 | 7.21E-08 |
| **BL – 6M** | 9.64E-22 | 1.36E-19 | 8.14E-06 | 2.37E-08 |  | 2.40E-07 | 4.48E-08 | 0.001322692 | 1.49E-05 |
| **BL – 12M** | 1.13E-13 | 1.22E-11 | 0.000119676 | 4.43E-06 |  | 5.04E-06 | 1.77E-07 | 0.000210171 | 9.98E-06 |
| **BL – 18M** | 2.40E-09 | 4.91E-08 | 1.32E-05 | 1.28E-05 |  | 5.22E-06 | 1.29E-06 | 9.59E-05 | 5.22E-06 |
| **BL – 24M** | 3.17E-12 | 2.77E-10 | 0.000217192 | 3.36E-05 |  | 3.36E-05 | 8.13E-06 | 0.000217192 | 8.13E-06 |

*P*-values were computed by univariate linear regression and adjusted using the BH procedure.

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**Figure S3**. Energy ratio comparisons between outcome groups when classified at 12-months (a-c), 18-months (d-f), and 24-months (g-i) post-surgery. Data are presented as means ± standard errors. Statistical differences are analyzed by Wilcoxon’s rank-sum test. \* indicates *p* < 0.05, \*\* indicates *p* < 0.01, and \*\*\* indicates *p* < 0.001 responder versus suboptimal responder.

**Table S3**. Comparison of nutrition intake between groups for patients characterized as responders vs. suboptimal responders at 18 months post-surgery.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Responder** |  | **Suboptimal responder** |  |  |
|  |  | **(*n* = 78)** |  | **(*n* = 23)** | **R2** | ***p*-value** |
| **Baseline** | **Weight (kg)** | 125.68 ± 22.74 |  | 145.23 ± 31.02 | 0.1 | **0.003** |
|  | **Energy (kcal)** | 1808.77 ± 773.15 |  | 1984.93 ± 804.29 | 0.009 | 0.402 |
|  | **Carbohydrates (g)** | 188.42 ± 96.05 |  | 216.43 ± 158.49 | 0.011 | 0.997 |
|  |  | (42.4%) |  | (45.3%) |  |  |
|  | **Protein (g)** | 103.8 ± 61.56 |  | 128.95 ± 138.25 | 0.015 | 0.144 |
|  |  | (26%) |  | (31%) |  |  |
|  | **Total fat (g)** | 93.02 ± 71.59 |  | 118.03 ± 139.17 | 0.013 | 0.18 |
|  |  | (48.7%) |  | (61.7%) |  |  |
| **Postop** | **Weight (kg)** | 109.37 ± 18.54 |  | 130.85 ± 28.84 | 0.156 | **<0.001** |
| **1 month** | **Energy (kcal)** | 690.77 ± 277.94 |  | 852.43 ± 232.15 | 0.062 | **0.003** |
|  | **Carbohydrates (g)** | 61.88 ± 55.06 |  | 69.45 ± 38.19 | 0.004 | 0.107 |
|  |  | (35.8%) |  | (32.8%) |  |  |
|  | **Protein (g)** | 60.02 ± 46.67 |  | 67.96 ± 25.15 | 0.006 | **0.029Δ** |
|  |  | (36.6%) |  | (32.4%) |  |  |
|  | **Total fat (g)** | 35.84 ± 46.42 |  | 33.97 ± 15.5 | <0.001 | 0.31 |
|  |  | (48.9%) |  | (35.1%) |  |  |
| **Postop** | **Weight (kg)** | 91.86 ± 16.93 |  | 117.64 ± 25.95 | 0.242 | **<0.001** |
| **6 months** | **Energy (kcal)** | 1024.27 ± 405.75 |  | 1288.53 ± 496.14 | 0.063 | **0.021Δ** |
|  | **Carbohydrates (g)** | 89.56 ± 57.4 |  | 119.33 ± 69.25 | 0.041 | 0.058Δ |
|  |  | (34.4%) |  | (38.3%) |  |  |
|  | **Protein (g)** | 70.74 ± 46.81 |  | 94.61 ± 61.59 | 0.038 | **0.014** |
|  |  | (29%) |  | (31.7%) |  |  |
|  | **Total fat (g)** | 48.8 ± 42.99 |  | 68.95 ± 53.32 | 0.033 | **0.022Δ** |
|  |  | (43%) |  | (50.5%) |  |  |
| **Postop** | **Weight (kg)** | 86.05 ± 16.4 |  | 116.49 ± 23.99 | 0.334 | **<0.001** |
| **12 months** | **Energy (kcal)** | 1197.46 ± 424.22 |  | 1309.02 ± 501.45 | 0.012 | 0.548Δ |
|  | **Carbohydrates (g)** | 114.47 ± 62.45 |  | 102.35 ± 59.55 | 0.007 | 0.313Δ |
|  |  | (37.1%) |  | (29.5%) |  |  |
|  | **Protein (g)** | 71.99 ± 36.89 |  | 87.46 ± 26.05 | 0.035 | **0.002Δ** |
|  |  | (25.4%) |  | (28.6%) |  |  |
|  | **Total fat (g)** | 54.39 ± 34.57 |  | 60.34 ± 27.51 | 0.006 | 0.364Δ |
|  |  | (40.7%) |  | (41.2%) |  |  |
| **Postop** | **Weight (kg)** | 86.18 ± 15.96 |  | 117.51 ± 21.64 | 0.368 | **<0.001** |
| **18 months** | **Energy (kcal)** | 1307.61 ± 544.68 |  | 1247.25 ± 350.57 | 0.002 | 0.922 |
|  | **Carbohydrates (g)** | 126.52 ± 63.97 |  | 109.43 ± 42.45 | 0.014 | 0.252 |
|  |  | (37.7%) |  | (35.1%) |  |  |
|  | **Protein (g)** | 66.52 ± 24.52 |  | 85.02 ± 25.69 | 0.09 | **0.004** |
|  |  | (21.9%) |  | (27.8%) |  |  |
|  | **Total fat (g)** | 56.07 ± 25.31 |  | 53.11 ± 20.03 | 0.003 | 0.724 |
|  |  | (38.5%) |  | (37.7%) |  |  |

Data are reported as mean ± SD. *P*-values were computed by Wilcoxon’s rank-sum test. Data in parentheses report the average energy ratio for each macronutrient intake. R2 was calculated by univariate linear models. Bold *p* values indicate *p* < 0.05 responder versus suboptimal responder. Δ corresponds with significant comparisons observed by Lim et al. (2020).

**Table S4**. Comparison of nutrition intake between outcome groups at 12 months post-surgery. The sample size was limited to those patients who participated for the entirety of the study.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Responder** |  | **Suboptimal responder** |  |  |
|  |  | **(*n* = 69)** |  | **(*n* = 21)** | **R2** | ***p*-value** |
| **Baseline** | **Weight (kg)** | 126.01 ± 21.13 |  | 146.67 ± 31.57 | 0.127 | **0.004** |
|  | **Energy (kcal)** | 1809.5 ± 684.94 |  | 1887.69 ± 783.98 | 0.002 | 0.805 |
|  | **Carbohydrates (g)** | 191.25 ± 117.75 |  | 203.48 ± 107.7 | 0.002 | 0.589 |
|  |  | (41.7%) |  | (47.9%) |  |  |
|  | **Protein (g)** | 104.8 ± 88.73 |  | 118.73 ± 75.59 | 0.005 | 0.209 |
|  |  | (25.5%) |  | (32.6%) |  |  |
|  | **Total fat (g)** | 90.69 ± 90.82 |  | 111.26 ± 76.99 | 0.01 | 0.085 |
|  |  | (46.6%) |  | (66.8%) |  |  |
| **Postop** | **Weight (kg)** | 110.27 ± 18.12 |  | 130.76 ± 29.13 | 0.173 | **0.001** |
| **1 month** | **Energy (kcal)** | 669.9 ± 238.59 |  | 932.39 ± 310.73 | 0.161 | **<0.001** |
|  | **Carbohydrates (g)** | 55.97 ± 45.43 |  | 82.23 ± 47.99 | 0.056 | **0.007** |
|  |  | (33.9%) |  | (34.7%) |  |  |
|  | **Protein (g)** | 59.33 ± 41.28 |  | 64.42 ± 23.15 | 0.003 | 0.170Δ |
|  |  | (36.8%) |  | (28.9%) |  |  |
|  | **Total fat (g)** | 31.49 ± 39.02 |  | 38.42 ± 17.98 | 0.007 | **0.02** |
|  |  | (44.5%) |  | (36.4%) |  |  |
| **Postop** | **Weight (kg)** | 91.16 ± 14.14 |  | 120.43 ± 26.51 | 0.331 | **<0.001** |
| **6 months** | **Energy (kcal)** | 1009.64 ± 429.35 |  | 1316.72 ± 497.32 | 0.077 | **0.010**Δ |
|  | **Carbohydrates (g)** | 88.61 ± 64 |  | 112.82 ± 59.37 | 0.025 | **0.037**Δ |
|  |  | (34.7%) |  | (34%) |  |  |
|  | **Protein (g)** | 77.27 ± 58.3 |  | 76.97 ± 30.74 | <0.001 | 0.391 |
|  |  | (32.2%) |  | (23.7%) |  |  |
|  | **Total fat (g)** | 51.92 ± 52.6 |  | 61.28 ± 26.7 | 0.007 | **0.016**Δ |
|  |  | (46.5%) |  | (41.7%) |  |  |
| **Postop** | **Weight (kg)** | 85.28 ± 14.28 |  | 118.58 ± 23.99 | 0.413 | **<0.001** |
| **12 months** | **Energy (kcal)** | 1143.57 ± 426.84 |  | 1396.66 ± 472.81 | 0.058 | 0.064Δ |
|  | **Carbohydrates (g)** | 107.97 ± 65.21 |  | 112.72 ± 59.42 | 0.001 | 0.744Δ |
|  |  | (36.1%) |  | (30.9%) |  |  |
|  | **Protein (g)** | 73.28 ± 37.92 |  | 84.63 ± 26.53 | 0.018 | **0.021**Δ |
|  |  | (27.3%) |  | (25.6%) |  |  |
|  | **Total fat (g)** | 52.06 ± 35.84 |  | 64.45 ± 26.74 | 0.024 | **0.035**Δ |
|  |  | (40.7%) |  | (41.2%) |  |  |

Data are reported as mean ± SD. *P*-values were computed by Wilcoxon’s rank-sum test. Data in parentheses report the average energy ratio for each macronutrient intake. R2 was calculated by univariate linear models. Bold *p* values indicate *p* < 0.05 responder versus suboptimal responder. Δ corresponds with significant comparisons observed by Lim et al. (2020).



**Figure S4**. Dietary intake between 12 and 24 months (a) calories, (b) carbohydrates, (c) protein, (d) total fat. The dashed red line corresponds to the identity line. Correlation coefficients (*r*) and *p*-values were calculated using Spearman’s rank correlation.



**Figure S5**. Proportion of responder and suboptimal responder patients consuming the recommended daily 1.1-1.5 g protein per kg ideal body weight when weight loss outcomes were classified at (a) 12-months, (b) 18-months, and (c) 24-months after surgery. Proportions were calculated by patients meeting the minimum recommended intake at each post-surgical assessment up to the month of weight loss outcome classifications.



**Figure S6**. Energy ratio comparisons between outcome groups when classified at 12-months (a-c), 18-months (d-f), and 24-months (g-i) post-surgery. Data are presented as means ± standard errors. Statistical differences are analyzed by Tukey’s HSD test. \* indicates *p* < 0.05, \*\* indicates *p* < 0.01, and \*\*\* indicates *p* < 0.001 between time points.