*South African Journal of Clinical Nutrition* 2026; 39(3):131–139
https://doi.org/10.1080/16070658.2026.2710451

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SAJCN
ISSN 1607-0658 EISSN 2221-1268
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RESEARCH ARTICLE

# Weight regain after bariatric surgery: the role of surgical procedure and dietitian follow-up

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**Introduction:** Bariatric surgery (BS) is an effective long-term treatment for severe obesity, resulting in substantial weight loss (WL). However, weight regain (WR) is a common physiological response influenced by metabolic adaptation, plus physiological and behavioural factors, and may differ between surgery types. Postoperative dietitian follow-ups are vital for maintaining adherence and minimising WR.
**Aim:** To compare WR between two BS procedures (sleeve gastrectomy [SG] and Roux-en-Y gastric bypass [RYGBP]) and to evaluate the association between postoperative dietitian follow-up adherence and WR.
**Methods:** An observational ambispective (retrospective–prospective) analytical cohort study with a 10-year follow-up was conducted in Gauteng, South Africa, from March 2020 to January 2021. Adults (≥ 18 years) who underwent BS (SG or RYGBP) between 2009 and 2018 were included. Data on sociodemographics, anthropometry, and dietitian follow-up attendance were collected from multidisciplinary team retrospective medical records and cross-sectionally through structured telephone interviews (EvaSys$^{TM}$).
**Results:** Amongst 100 participants, 70.0% underwent RYGBP. The median age was 48.0 years (yrs) (IQR: 43.0–55.5), with more females (79%, $p = 0.047$). Median preoperative body mass index (BMI) was 44.8 kg/m$^2$ (IQR: 41.5–50.9), and median follow-up duration was 6.9 yrs (IQR: 5.0–8.4); longer in SG (9.0 yrs vs. 6.3 yrs, $p = 0.0001$). Overall, 63.0% were classified as good responders (≥ 50 percentage excess weight loss [%EWL]), with a higher proportion in RYGBP than in SG (72.9% vs. 40%, $p = 0.002$). Overall, median %EWL was 59.9%, lower in SG than RYGBP (44.2% vs. 61.6%, $p = 0.008$). Excess WR (> 15%) occurred in 67.0% of participants by two years post-surgery. Median WR of 23.3% (IQR: 12.6–37.5), beginning at a median of 2.3 yrs (IQR: 1.5–4.0), with SG showing higher median %WR than RYGBP (32.3% vs. 21.7%, $p = 0.032$). From the second postoperative year onwards, attendance at dietitian follow-up visits was poor (< 50%).
**Conclusion:** Approximately two-thirds achieved successful weight loss (≥ 50% EWL), with better outcomes observed following RYGBP compared with SG. However, excessive WR was common, occurring in 67% and beginning at about 2.3 yrs post-surgery. Poor attendance at dietitian follow-up visits was observed.

**Keywords:** excess weight loss (EWL), obesity, Roux-en-Y gastric bypass (RYGBP), sleeve gastrectomy (SG)

## Introduction

Obesity is a chronic, progressive and relapsing disease of global prevalence that is multifactorial and leads to adipose tissue dysfunction, with metabolic, biomechanical and psychosocial consequences.[1,2] In 2022, an estimated 890 million people globally were living with obesity,[3] and the prevalence is projected to rise to 50.0% by 2030.[4] In Gauteng province, South Africa (SA), 39.0% of women and 12.8% of men are obese.[5] Obesity can be managed and prevented through lifestyle-based interventions like dietary modifications, increased physical activity, behavioural therapy, pharmacotherapy and bariatric surgery (BS), or metabolic surgery.[6] Bariatric surgery seems to be one of the most effective long-term interventions, achieving sustained weight loss (WL) of over 15% at 10 years.[7] Nonetheless, after attaining nadir weight (the lowest weight post-surgery), weight regain (WR) is frequently observed.[8] Weight regain after BS is multifactorial, arising from modifiable behavioural factors (dietary non-adherence, physical inactivity, psychological and adherence to follow-up visits) and non-modifiable anatomic or physiological mechanisms[9,10].

A systematic review of 15 studies reported WR following BS; however, heterogeneity hampered comparisons.[8] Weight regained ranged from 8% to 23.8% of maximum WL within 3–6 years (yrs) for Roux-en-Y gastric bypass (RYGBP) and, being cognisant of bias with smaller sleeve gastrectomy (SG) groups, WR in SG appears higher than in RYGBP.[8] Weight regain is associated with notable medical, social and economic consequences,[11] including the recurrence of obesity-related comorbidities and a decline in quality of life.[12] Nevertheless, evidence indicates that BS confers durable metabolic and health benefits despite WR.[13]

The multidisciplinary team (MDT), with the dietitian playing a pivotal role in dietary and behaviour modification, is essential for sustaining long-term weight maintenance following BS,[9,14] confirmed by the new clinical practice guidelines for the management of obesity in SA.[15] However, evidence on the prevalence, patterns and contributing factors of WR following BS remains limited within the South African context. Therefore, this study evaluated pre- and post-surgery anthropometry outcomes (over a 10-year period) of BS surgery types (SG and RYGBP), including expected weight loss percentage (%EWL) and WR and the association between WR and frequency of dietitian follow-up visits in SA.

## Methods

### *Study design, study population and sampling*

An observational ambispective (retrospective–prospective) analytical cohort study with a 10-year follow-up, using

retrospective record reviews and a cross-sectional follow-up interview, was conducted between March 2020 and January 2021. The Sunward Park Bariatric Centre of Excellence (SWPBCE), Johannesburg, SA, performed 306 procedures from 2005 to 2018. In the single centre, 217 patients met the inclusion criteria: adults aged ≥ 18 years who had undergone either SG or RYGBP between 2009 and 2018. Patients who became pregnant post-surgery were excluded due to pregnancy-related weight changes. Ethical approval was obtained from the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the University of the Free State (HSD2020/0023/2403). The multidisciplinary team (MDT), consisting of a dietitian, psychologist, surgeon and specialist physician, granted written permission. Thereafter, participants were recruited through convenience sampling from available contact numbers in MDT files. While the projected statistical power indicated a required sample of 139 (Raosoft Inc, Seattle WA, USA), the actual sample size was limited by real-world constraints, most importantly the COVID-19 lockdown, time constraints, contact availability and provision of voluntary informed consent.

### Data collection

Data were collected using EvaSys™ (EvaSys GmbH, Lüneberg, Germany) in two sets of questionnaires. Retrospective data on surgical procedures, anthropometry, and attended visits were obtained from MDT medical records. Structured telephone patient interviews captured post-surgical sociodemographics and anthropometry information.

### Data analysis

The following variables were calculated: (i) body mass index (BMI) as weight (kg)/height ($m^2$) at baseline pre-surgery; (ii) ideal bodyweight (IBW) defined as weight to BMI of ≤ 24.99 kg/$m^2$; (iii) total weight loss (TWL) in kg, determined as ([pre-surgery weight – nadir weight]/pre-surgery weight) and calculated %TWL;[16] (iv) excess weight loss (EWL) in kg, calculated as ([pre-surgery weight-current weight]/[pre-surgery weight-IBW]); with %EWL derived accordingly;[17,18] and (v) weight regain (WR) calculated as ([current weight-nadir weight]/[pre-surgery weight-nadir weight]), with %WR.[19] Participants were categorised as good responders (≥ 50% EWL) or non-responders (< 50% EWL),[16] and WR was classified as adequate (< 10%), moderate (≥ 10%–≤ 15%) or excessive (> 15%).[12,20] Current and nadir weights were self-reported.

At the time of the study, the SWPBCE dietitian's individual follow-up protocol comprised 13 visits during the first post-surgery year (bi-weekly visits for the first two months coincide with stages of meal progression[21]), followed by monthly visits. Thereafter, four (quarterly) in the second year, two annually between years three to five, and one visit annually from year six onward. Dietitian attendance was expressed as the percentage of scheduled visits completed and categorised as good (> 75%), average (≥ 50%–≤ 75%), or poor (< 50%).[22]

### Statistical analysis

Descriptive statistics were calculated as frequencies and percentages for categorical variables and medians with interquartile ranges for skewed numerical data. Group differences were examined using cross-tabulation with chi-square tests for categorical variables, Fisher's exact test where expected counts were sparse and Mann–Whitney for two groups' numerical data. Spearman's correlation was performed for the relationship between percentage weight regain and postoperative dietitian visits. A $p$-value of < 0.05 was considered statistically significant.

## Results

The following results were obtained.

### Sociodemographics

A total of 100 participants were included (30.0% SG; 70.0% RYGBP), with the cohort predominantly middle-aged (median age: 48.0 yrs, IQR: 43.0–55.5) (Table 1), with a significantly higher proportion of females (79.0%, $p = 0.047$) (info not in

**Table 1:** Sociodemographic and anthropometry per bariatric surgery type[8,12,17–21]

| Participant characteristics | Total ($n = 100$) | Sleeve gastrectomy ($n = 30$) | Roux-en-Y gastric bypass ($n = 70$) | $p$-value between surgery types |
|---|---|---|---|---|
| Median age at the time of the study (years) | 48.0 (IQR: 43.0–55.5) | 49.5 (IQR: 45.0-55.0) | 48.0 (IQR: 42.0–56.0) | 0.315 |
| Anthropometry | Median total (IQR); (min–max) | Median (IQR); (min–max) | Median (IQR); (min–max) | $p$-value between surgery types |
| Pre-surgery: | | | | |
| Weight at first visit (kg) | 128.0 (114.5–147.0); (87.0–275.0) | 140.5 (114.0–163.0); (98.0–275.0) | 126.0 (115.0–141.0); (87.0–211.0) | 0.143 |
| BMI at first visit (kg/$m^2$) | 44.8 (41.5–50.9); (35.3–83.0) | 46.8 (41.9–52.6); (37.4–83.0) | 44.5 (41.3–50.0); (35.3–74.8) | 0.508 |
| Post-surgery: | | | | |
| Nadir weight (kg) | 80.0 (70.0–98.0); (37.0–149.0) | 87.0 (72.0–109.0); (61.0–149.0) | 77.5 (69.0–94.0); (37.0–145.0) | 0.035* |
| Excess weight loss percentage (%EWL) | 59.9 (43.3–78.3); (−52.2–176.1) | 44.2 (28.5–70.1); (−47.3–105.2) | 61.6 (49.0–82.5); (−52.2–176.1) | 0.008* |
| Reported total weight regain (kg) | 12.0 (8.0–20.0); (2.0–45.0) | 18.5 (10.0–25.0); (2.0–45.0) ($n = 28$) | 11.5 (8.0–15.0); (2.0–30.0) ($n = 66$) | 0.010* |
| Time weight regain started (years) | 2.3 (1.5–4.0); (0.9–8.5) | 2.0 (1.7–3.0); (1.0–8.4) ($n = 29$) | 3.0 (1.5–4.0); (0.9–8.5) ($n = 66$) | 0.272 |
| Weight regain percentage (%WR) | 23.3 (12.6–37.5); (−57.0–1800) | 32.3 (14.7–58.0); (0.0–1800.0) | 21.7 (12.0–34.1); (−57.1–127.0) | 0.032* |
| % EWL Classification, $n$ (%): | | | | |
| Poor responders (< 50% EWL) | 37 (37.0) | 22 (60.0) | 15 (27.1) | 0.002* |
| Good responders (≥ 50% EWL) | 63 (63.0) | 8 (40.0) | 55 (72.9) | |

Mann–Whitney $U$ and chi-square test; *$p < 0.05$ considered statistically significant.

table). The overall median follow-up duration was 6.9 years (IQR: 5.0–8.4), for the RYGBP group 6.3 yrs (IQR: 4.7–7.3) and significantly longer for the SG group at 9.0 yrs (IQR: 7.4–9.6, $p \leq 0.0001$). Follow-up duration ranged from 1 to 10 yrs post-surgery (info not in table).

### *Pre- and post-surgery anthropometry*

For the total cohort, the median pre-surgery weight was 128.0 kg (IQR: 114.5–147.0) with a median BMI of 44.8 kg/m$^2$ (IQR: 41.5–50.9), indicating morbid obesity (Table 1). The overall median nadir weight post-surgery was 80.0 kg (IQR: 70.0–98.0), with the SG group's significantly higher (87.0 kg vs. 77.5 kg, $p = 0.035$). The median %EWL for all was 59.9% (IQR: 43.3–78.3), reflecting a good response, although significantly lower in the SG group (44.2% vs. 61.6%, $p = 0.008$). Overall, nearly two-thirds (63.0%) of participants were classified as good responders ($\geq$ 50% EWL), with a significantly higher proportion in the RYGBP group (72.9% vs. 40.0%, $p = 0.002$). The total median percentage weight loss (%TWL) was 37.5% (IQR: 31.7–43.6) (info not in table).

### *Weight regain*

The median self-reported WR from nadir to the time of the study overall was 12.0 kg (IQR: 8.0–20.0), with significantly greater WR observed in the SG group (18.5 kg vs. 11.5 kg, $p = 0.010$). Overall, WR occurred after a median of 2.3 years (IQR: 1.5–4.0). The median %WR for the cohort was excessive at 23.3% (IQR: 12.6–37.5), significantly higher in the SG group (32.3% vs. 21.7%, $p = 0.032$) (Table 1). Overall, two-thirds (67.0%) experienced excess WR (> 15%) two years post-surgery (Figure 1 and Table 2).

At two years post-surgery, the RYGBP group had a significantly lower median weight (83.0 kg vs. 95.5 kg, $p = 0.008$). This difference remained significant at three years (84.5 kg vs. 95.0 kg, $p = 0.022$), four years (85.0 kg vs. 95.0 kg, $p = 0.044$) and five years post-surgery (85.5 kg vs 95.0 kg, $p = 0.046$). Beyond five years, no significant differences were observed between groups, with weight trajectories appearing to converge (Figure 2 and Table 3).

### *Attendance at scheduled visits to the dietitian*

Currently, no South African guidelines exist regarding scheduled follow-up visits after BS. Dietitian visit attendance declined markedly from 57.0% (moderate–good adherence) in the first year post-surgery to 8.0% in the second year. However, moderate–good attendance showed a slight increase in the third (12.4%), fourth (14.1%) and fifth (11.4%) years post-surgery (Table 4).

### *Reasons for not attending more visits*

Several challenges were reported for non-attendance of scheduled dietitian visits post-surgery. The most frequently cited reasons included work commitments (48.0%), perceived lack of time (39.0%) and financial constraints (38.0%). Additionally, 26.0% of participants reported feeling embarrassed due to insufficient weight loss, while 19.0% indicated that they had already met their personal goal. Smaller portions reported perceiving no need for further visits (9.0%), finding the visits unhelpful (5.0%), or not being informed about follow-up requirements (2.0%). An additional 17.0% cited other unspecified reasons.

### *Association and correlation between postoperative dietitian follow-up visits and weight regain*

The median number of postoperative dietitian visits was low at 7 (IQR 5–11), ranging from 0 to 20 visits. Spearman's correlation showed a low, non-significant correlation between percentage weight regain and total postoperative dietitian visits in the total cohort ($r = 0.122$, $p = 0.225$), and within the surgical subgroups. There was no significant difference in the number of post-operative dietitian visits between the SG and RYGBP groups ($p = 0.976$), although percentage weight regain was significantly higher in the SG group ($p = 0.032$) (Table 5).

## Discussion

The current study found that individuals undergoing BS for WL were predominantly middle-aged and female (79.0%). This finding is consistent with global trends, as reported by the International Federation for the Surgery of Obesity and Metabolic Disorders global registry (2015–2018), which

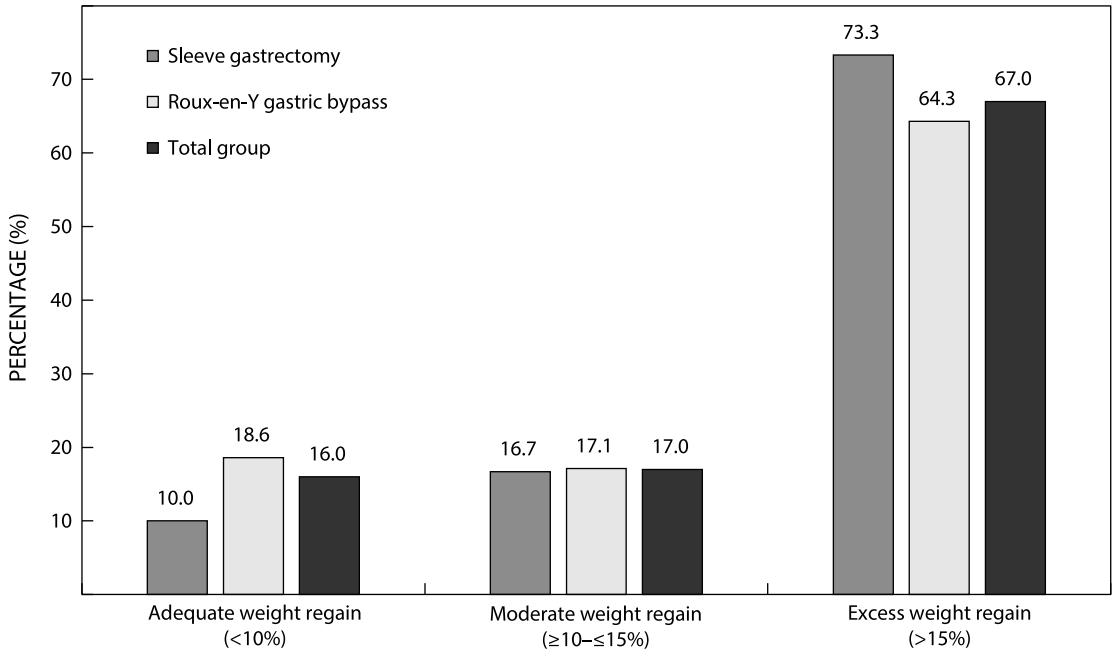
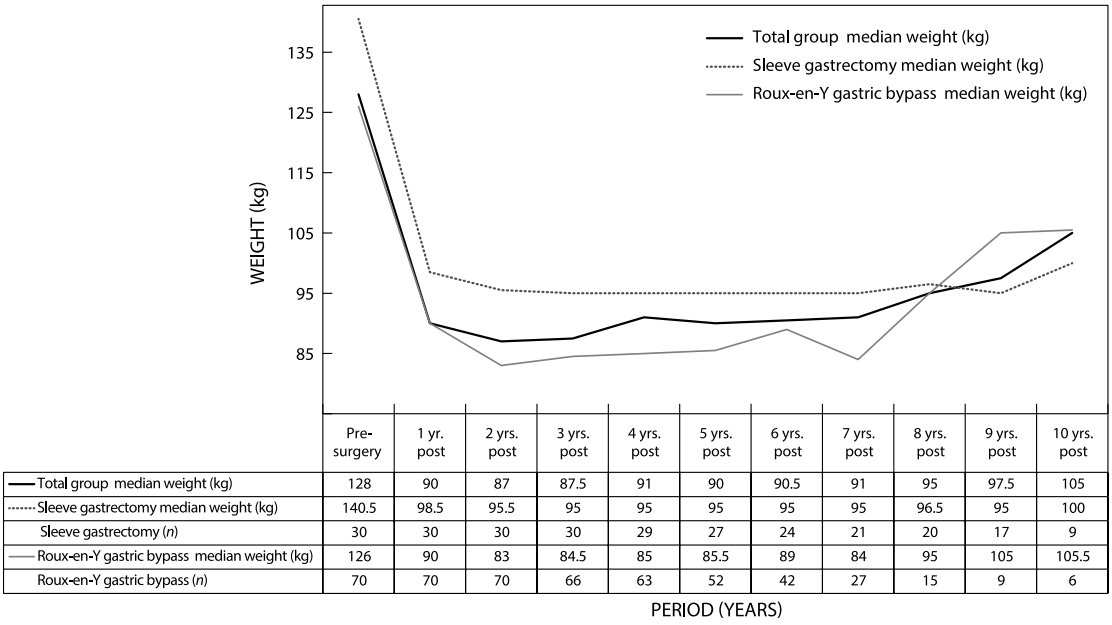



**Figure 1:** Weight regain categories per surgery type for year two postoperatively.[8,12,16,20]

**Table 2:** Association between weight regain categories and surgery types

| | Adequate weight regain < 10% | | | | | Moderate weight regain ≥ 10%–≤ 15% | | | | | Excess weight regain > 15% | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sleeve gastrectomy (SG) | | Roux-en-Y gastric bypass (RYGBP) | | Total | Sleeve gastrectomy | | Roux-en-Y gastric bypass | | Total *p*-value | Sleeve gastrectomy | | Roux-en-Y gastric bypass | | Total | *p*-value |
| **Years post-surgery** | ***n*** | **%** | ***n*** | **%** | ***n*; %** | ***n*** | **%** | ***n*** | **%** | | ***n*** | **%** | ***n*** | **%** | ***n*; %** | |
| 2 years ($n = 100$) % for SG, $n = 30$; RYGBP, $n = 70$ (Figure 1) | 3 | 10.0 | 13 | 18.6 | 16; 16.0 | 5 | 16.7 | 12 | 17.1 | 17; 17.0 | 22 | 73.3 | 45 | 64.3 | 67; 67.0 | 0.542 |
| 3 years ($n = 96$) % for SG, $n = 30$; RYGBP, $n = 66$ | 3 | 10.0 | 12 | 18.2 | 15; 15.6 | 5 | 16.7 | 12 | 18.2 | 17; 17.7 | 22 | 73.3 | 42 | 63.6 | 64;66.7 | 0.549 |
| 4 years ($n = 92$) % for SG, $n = 29$; RYGBP, $n = 63$ | 3 | 10.3 | 11 | 17.5 | 14; 15.2 | 5 | 17.3 | 12 | 19.0 | 17; 18.5 | 21 | 72.4 | 40 | 63.5 | 61; 66.3 | 0.627 |
| 5 years ($n = 79$) % for SG, $n = 27$; RYGBP, $n = 52$ | 3 | 11.1 | 10 | 19.2 | 13; 16.5 | 5 | 18.5 | 8 | 15.4 | 13; 16.5 | 19 | 70.4 | 34 | 65.4 | 53; 67.0 | 0.771 |
| 6 years ($n = 66$) % for SG, $n = 24$; RYGBP, $n = 42$ | 2 | 8.4 | 9 | 21.4 | 11; 16.6 | 5 | 20.8 | 5 | 11.9 | 10; 15.2 | 17 | 70.8 | 28 | 66.7 | 45; 68.2 | 0.291 |
| 7 years ($n = 48$) % for SG, $n = 21$; RYGBP, $n = 27$ | 2 | 9.5 | 6 | 22.2 | 8; 16.6 | 4 | 19.1 | 3 | 11.1 | 7; 14.6 | 15 | 71.4 | 18 | 66.7 | 33; 68.8 | 0.454 |
| 8 years ($n = 35$) % for SG, $n = 20$; RYGBP, $n = 15$ | 2 | 10.0 | 4 | 26.7 | 6; 17.1 | 4 | 20.0 | 1 | 6.6 | 5; 14.3 | 14 | 70.0 | 10 | 66.7 | 24; 68.6 | 0.297 |
| 9 years ($n = 26$) % for SG, $n = 17$; RYGBP, $n = 9$ | 2 | 11.8 | 2 | 22.2 | 4; 15.4 | 3 | 17.6 | 1 | 11.1 | 4; 15.4 | 12 | 70.6 | 6 | 66.7 | 18; 69.2 | 0.833 |
| 10 years ($n = 15$) % for SG, $n = 9$; RYGBP, $n = 6$ | 2 | 22.2 | 2 | 33.3 | 4; 26.7 | 2 | 22.2 | 1 | 16.7 | 3; 20.0 | 5 | 55.6 | 3 | 50.0 | 8; 53.3 | 1.000 |

Chi-square or Fisher's exact test with Monte Carlo simulation; *$p < 0.05$ considered statistically significant.




| | Pre-surgery | 1 yr. post | 2 yrs. post | 3 yrs. post | 4 yrs. post | 5 yrs. post | 6 yrs. post | 7 yrs. post | 8 yrs. post | 9 yrs. post | 10 yrs. post |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total group median weight (kg) | 128 | 90 | 87 | 87.5 | 91 | 90 | 90.5 | 91 | 95 | 97.5 | 105 |
| Sleeve gastrectomy median weight (kg) | 140.5 | 98.5 | 95.5 | 95 | 95 | 95 | 95 | 95 | 96.5 | 95 | 100 |
| Sleeve gastrectomy (*n*) | 30 | 30 | 30 | 30 | 29 | 27 | 24 | 21 | 20 | 17 | 9 |
| Roux-en-Y gastric bypass median weight (kg) | 126 | 90 | 83 | 84.5 | 85 | 85.5 | 89 | 84 | 95 | 105 | 105.5 |
| Roux-en-Y gastric bypass (*n*) | 70 | 70 | 70 | 66 | 63 | 52 | 42 | 27 | 15 | 9 | 6 |

PERIOD (YEARS)

**Figure 2:** Median weight trajectory pre- and post-surgery per surgery type and follow-up duration.

**Table 3:** Median postoperative weight according to surgery type and follow-up duration

| Follow-up period (year[s] post-surgery) | *n* | Sleeve gastrectomy (*n* = 30) Median weight (kg) (IQR); (min-max) | Roux-en-Y gastric bypass (*n* = 70) Median weight (kg) (IQR); (min–max) | Median weight *p*-value between surgery types |
|---|---|---|---|---|
| Weight 1 year | 100 | 98.5 (75.0–128.0); (65.0–170.0) (*n* = 30) | 90.0 (75.0–105.0); (61.0–148.0) (*n* = 70) | 0.203 |
| Weight 2 years | 100 | 95.5 (84.0–120.0); (65.0–155.0) (*n* = 30) | 83.0 (75.0–98.0); (58.0–151.0) (*n* = 70) | 0.008* |
| Weight 3 years | 96 | 95.0 (84.0–115.0); (61.0–162.0) (*n* = 30) | 84.5 (75.0–102.0); (54.0–156.0) (*n* = 66) | 0.022* |
| Weight 4 years | 92 | 95.0 (80.0–120.0); (61.0–165.0) (*n* = 29) | 85.0 (75.0–104.0); (49.0–159.0) (*n* = 63) | 0.044* |
| Weight 5 years | 79 | 95.0 (84.0–115.0); (61.0–165.0) (*n* = 27) | 85.5 (72.0–100.0); (43.0–163.0) (*n* = 52) | 0.046* |
| Weight 6 years | 66 | 95.0 (82.5–117.0); (61.0–170.0) (*n* = 24) | 89.0 (72.0–105.0); (42.0–163.0) (*n* = 42) | 0.101 |
| Weight 7 years | 48 | 95.0 (81.0–120.0); (61.0–175.0) (*n* = 21) | 84.0 (70.0–108.0); (42.0–117.0) (*n* = 27) | 0.103 |
| Weight 8 years | 35 | 96.5 (84.0–113.5); (66.0–175.0) (*n* = 20) | 95.0 (79.0–108.0); (70.0–113.0) (*n* = 15) | 0.359 |
| Weight 9 years | 26 | 95.0 (82.0–120.0); (70.0–180.0) (*n* = 17) | 105.0 (88.0–108.0); (70.0–115.0) (*n* = 9) | 0.830 |
| Weight 10 years | 15 | 100.0 (85.0–135.0); (70.0–190.0) (*n* = 9) | 105.5 (105.0–108.0); (70.0–116.0) (*n* = 6) | 0.859 |

Mann–Whitney *U* test; *$p < 0.05$ considered statistically significant.

recorded 77.1% of BS patients as female.[23] In SA, 81.0%–82.0% of females aged 45–65 years are living with overweight or obesity.[5] Furthermore, in 2022, SA ranked 25th globally for female obesity prevalence (47.4%), surpassing the United States (43.8%), which ranked 36th.[24] In this study, most patients (70.0%) underwent RYGBP, which is internationally regarded as the gold standard procedure for morbid obesity[25] due to its higher %EWL and superior improvement in obesity-related comorbidities.

Pre-surgery median BMI (44.8 kg/m$^2$) indicated morbid obesity, similar to a Spanish study ($n = 445$) with an initial BMI of 44.9 kg/m.[2,26] The present study demonstrated a favourable response to BS in terms of WL loss outcome, with an overall median nadir weight of 80.0 kg (IQR: 70.0–98.0) and a median %EWL of 59.9% (IQR: 43.3–78.3). Nearly two-thirds of participants (63.0%) were classified as good responders (≥ 50% EWL), with a significantly higher proportion of good responders observed in the RYGBP group. These findings are slightly lower than reported in a Spanish study ($n = 212$), where 79.7% of participants achieved ≥ 50% EWL; however, the shorter follow-up period (5 years) may not have captured the potential for long-term WR.[27]

Overall, two-thirds (67.0%) experienced excess WR (>15%) despite being classified as good responders with %EWL. Weight regain is a complex, multifactorial and partly expected phenomenon following WL, which is influenced by several physiological adaptations. These include alterations in gut hormone secretion, specifically decreased leptin, peptide (PYY), glucagon-like peptide-1 (GLP-1) and increased ghrelin secretion, that collectively enhance appetite stimulation.[28] Additionally, a reduction in resting energy expenditure contributes to sustained metabolic adaptation. In addition to psychological adaptations, psychological and behavioural factors such as overeating, heightened cravings for energy-dense foods and emotional or stress eating may also contribute to WR.[29] Furthermore, increased appetite following WL can result in an estimated rise in energy intake of approximately 420 kJ/day.[30] Genetic predisposition influences metabolic rate, appetite regulation and the efficiency of fat storage.[31] Emerging evidence suggests that adipose tissue can retain an epigenetic memory of obesity even after WL intervention, potentially facilitating WR.[31] Moreover, the broader obesogenic environment is characterised by the widespread availability of processed, high-energy foods,[29,32] leading to increased weight. Unfortunately,

**Table 4:** Dietitian visits attendance categories post-surgery

| Years post-surgery and number of scheduled visits | Poor attendance (< 50%) | | | | | Moderate attendance (≥ 50%–≤ 75%) | | | | | Good attendance (> 75%) | | | | | *n* | *p*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sleeve gastrectomy | | Roux-en-Y gastric bypass | | Total | Sleeve gastrectomy | | Roux-en-Y gastric bypass | | Total | Sleeve gastrectomy | | Roux-en-Y gastric bypass | | Total | | |
| | *n* | % | *n* | % | *n*; % | *n* | % | *n* | % | *n*, % | *n* | % | *n* | % | *n*; % | | |
| 1 year (13 visits) | 14 | 46.7 | 29 | 41.4 | 43; 43.0 | 9 | 30.0 | 26 | 37.1 | 35; 35.0 | 7 | 23.3 | 15 | 21.4 | 22; 22.0 | 100 | 0.789 |
| 2 years (4 visits) | 28 | 93.3 | 64 | 91.4 | 92; 92.0 | 0 | 0.0 | 1 | 1.4 | 1; 1.0 | 2 | 6.7 | 5 | 7.1 | 7; 7.0 | 100 | 1.000 |
| 3 years (2 visits) | 29 | 96.7 | 55 | 83.3 | 84; 87.6 | 0 | 0.0 | 6 | 9.1 | 6; 6.2 | 1 | 3.3 | 5 | 7.6 | 6; 6.2 | 96 | 0.253 |
| 4 years (2 visits) | 28 | 96.6 | 51 | 81.0 | 79; 85.9 | 1 | 3.5 | 10 | 15.9 | 11; 12.0 | 0 | 0.0 | 2 | 3.2 | 2; 2.1 | 92 | 0.183 |
| 5 years (2 visits) | 24 | 88.9 | 46 | 88.5 | 70; 88.6 | 2 | 7.4 | 4 | 7.7 | 6; 7.6 | 1 | 3.7 | 2 | 3.9 | 3; 3.8 | 79 | 1.000 |
| 6 years (1 visit) | 22 | 91.7 | 39 | 92.9 | 61; 92.4 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 2 | 8.3 | 3 | 7.1 | 5; 7.6 | 66 | 1.000 |
| 7 years (1 visit) | 18 | 85.7 | 24 | 88.9 | 42; 87.5 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 3 | 14.3 | 3 | 11.1 | 6; 12.5 | 48 | 1.000 |
| 8 years (1 visit) | 18 | 90.0 | 14 | 93.3 | 32; 91.4 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 2 | 10.0 | 1 | 6.7 | 3; 8.6 | 35 | 1.000 |
| 9 years (1 visit) | 17 | 100.0 | 9 | 100.0 | 26; 100.0 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 26 | 1.000 |
| 10 years (1 visit) | 9 | 100.0 | 6 | 100.0 | 15; 100.0 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 0 | 0.0 | 0 | 0.0 | 0; 0.0 | 15 | 1.000 |

Chi-square or Fisher's exact test with Monte Carlo simulation; *$p < 0.05$ considered statistically significant.

**Table 5:** Association and correlation between postoperative dietitian follow-up visits and weight regain

| Variable | Percentage weight regain (%), median (IQR)[¤] | Total postoperative dietitian visits (number), median (IQR)[¤] | Spearman's correlation $r$[¥] | $p$-value |
|---|---|---|---|---|
| Total sample ($N = 100$) | 23.3 (12.6–37.5) | 7 (5–11) | 0.122 | 0.225 |
| Sleeve gastrectomy ($n = 30$) | 32.3 (14.7–58.0) | 7 (5–12) | 0.284 | 0.128 |
| Roux-en-Y gastric bypass ($n = 70$) | 21.7 (12.0–34.1) | 7 (5–11) | 0.032 | 0.794 |
| $p$-value | $p = 0.032$[§*] | $p = 0.976$[§] | | |

[¤]IQR: interquartile range; [¥]Spearman's rank correlation describing the relationship between percentage weight regain and postoperative dietitian visits within each group; [§]Mann–Whitney $U$ test comparing SG vs. RYGBP; *$p < 0.05$, statistically significant.

there is currently no universally accepted definition or standardised measure of weight regain within the bariatric literature, making interstudy comparisons inherently variable and complex.[16]

In this study, WR commenced at a median of 2.3 years post-surgery and occurred earlier in the SG group (2.0 years vs. 3.0 years), aligning with most international studies. The typical trajectory of WL following BS has been well documented in a systematic review ($n = 2$ 458), demonstrating that the most substantial WL occurs within the first six months post-surgery.[8] Subsequently, the rate of weight reduction decelerates, typically reaching a plateau around two years post-surgery, after which WR commonly begins,[8] as seen in this study, where the overall median %WR was 23.3%, exceeding the threshold for excessive weight regain (> 15%). Furthermore, in the current study, the median %WR was lower in RYGBP than in SG. The median %WR for RYGBP in the current study (21.7%) was slightly lower than the 23.8% reported for the review's RYGBP at six years post-surgery.[8] However, only 60% of RYGBP patients in the current study had reached the six-year follow-up, which may limit direct comparability. Another systematic review[33] reported that the frequency of WR following SG increased from 5.7% at two years to 75.6% at six years; however, the definition of WR was heterogeneous and was missing in some studies. Nevertheless, a similar pattern was observed in the current study, where 70.8% of the SG patients experienced excessive WR at six years, and was slightly less frequent in the RYGBP at 66.7%.

Although RYGBP appears to provide more effective long-term weight management, both surgical groups demonstrated excess WR. These findings highlight the importance of sustained long-term follow-up and targeted intervention strategies to mitigate post-surgery weight recidivism and optimise long-term surgical outcomes. Furthermore, the South African clinical practice guidelines for the management of obesity recommend ongoing follow-up with the MDT. These include regular consultations with a dietitian to review the nutritional plan and micronutrient supplementation, psychological intervention when indicated and consideration of anti-obesity pharmacotherapy. If, despite these interventions, WR persists, the patient must be evaluated for potential surgical revision.[34]

A marked decline in dietitian follow-up attendance was observed in this study, with moderate-to-good adherence decreasing from 57.0% in the first year post-surgery to 8.0% in the second year. Low correlation was found between weight regain and the low total number of dietitian postoperative visits. This may reflect the multifactorial nature of weight outcomes after bariatric surgery, including differences in surgical procedure, timing and intensity of counselling, patient adherence and selective referral or extrinsic motivation of higher-risk patients for more intensive follow-up.

These findings are consistent with published literature showing declining follow-up adherence over time, although adherence rates are generally higher elsewhere. For example, a Canadian cohort ($n = 388$) reported a two-year adherence of 62.1% (> 50% of visits) (visits were at 1, 3, 6, and 12 months, then annually, attendance rates were 78.1% at 3 months, 68.0% at 6 months, 75.0% at 12 months, and 41.0% at 24 months).[35] Higher attendance was potentially due to coordinated multidisciplinary visits and telehealth availability,[35] while a large Miami cohort ($n = 2$ 658) reported lower adherence (41.1% attending > 50% of six scheduled visits).[36] Conversely, a study from Spain ($n = 385$) found 80% adherence over 5 years.[37] Those with better adherence had greater long-term %EWL,[37] were older than 25 years, part-time or full-time employed, experienced obstructive sleep apnoea before surgery[35] or had comorbidities,[36] whilst male sex was associated with poorer follow-up.[36]

Evidence on the impact of dietetic follow-up on outcomes remains mixed. An Abu Dhabi study ($n = 220$) found that attending at least three dietitian visits in the first year was associated with improved weight loss (7.4% higher WL) and fewer micronutrient deficiencies, despite suboptimal compliance (< 50%).[38] Each visit included assessment of weight, gastrointestinal symptoms, laboratory results and tolerance of dietary progression.[38] Conversely, broader evidence suggests that insufficient multidisciplinary follow-up, along with behavioural and lifestyle factors, contributes to weight regain after bariatric surgery.[39]

In summary, regular attendance at scheduled follow-up visits is essential for sustaining weight loss. It reinforces long-term behavioural changes, enables early detection and management of nutritional deficiencies, provides psychological support, prevents patient disengagement and enhances accountability – all essential for preventing WR.[9,32] No universally established guideline specifies the exact number of dietitian or MDT visits required for BS patients. However, various bariatric centres and expert groups recommend structured follow-up schedules, taking into account the diet stages postoperatively.

The main reasons participants in the current study did not attend scheduled dietitian visits post-surgery included work commitments (48.0%), lack of time (39.0%), financial constraints (38.0%) and embarrassment over inadequate weight loss or WR (26.0%). Similarly, an Israeli study ($n = 178$) reported comparable reasons for not consulting the dietitian, primarily work

commitments (43.3%), long waiting times at the clinic (37.6%), perceived lack of contribution (19.1%), lack of funding by the Health Maintenance Organization (17.9%), forgetting appointments (10.7%), weight regain or dissatisfaction (7.3%) and unawareness of the need for follow-up (9.0%).[40]

## Limitations

Variable participant retention over the 10-year follow-up period limited the ability to formally determine whether weight trajectories differed significantly between the surgery groups over time. This incomplete longitudinal data reduced the suitability of repeated-measures modelling and could have resulted in biased or unstable estimates. Consequently, the analysis focused on descriptive presentation of weight trajectories and point-wise comparisons of median weights between groups at each annual follow-up using the Mann–Whitney *U* test. The findings should therefore be interpreted as descriptive comparisons rather than a formal assessment of differences in longitudinal weight change between the surgery groups.

Poor attendance at scheduled follow-ups resulted in incomplete anthropometry in files. The self-reported weight loss progress collected retrospectively from the participants (when post-surgery weight was not available in the MDT files) using different scales may have introduced reporting and recall biases. In addition, body composition measurements were not available. Other factors that could have unduly affected bodyweight measurements were participants' psychological well-being, due to the uncertainty surrounding the COVID-19 lockdown, the isolation from friends and family, which could have influenced their eating behaviour (potentially leading to emotional or stress eating) and their physical activity levels (some individuals may have exercised more, while others may have exercised less). All the factors mentioned may contribute to the observed changes in weight.

Currently, no standardised protocol in SA or globally establishes a specific number of scheduled visits to a dietitian, making it challenging to compare attendance compliance with other studies.

## Conclusions and recommendations

Almost two-thirds were good responders (≥ 50% EWL), and the RYGBP group showed a significantly better weight-loss outcome. However, overall, 67.0% of participants experienced excessive weight regain (> 15%), which typically began around 2.3 years post-surgery. Low adherence to dietitian follow-ups from year two postoperatively was observed.

Several mechanisms may contribute to weight regain and challenge sustained long-term weight loss, emphasising the need for multidisciplinary ongoing interventions, including dietary modifications, physical activity, behavioural strategies and, where appropriate, adjunct pharmacotherapy or surgical interventions to optimise weight maintenance outcomes.

The routine referral to dietitians and highlighting the importance of regular follow-ups post-surgery may offer continuous support and possibly decrease unwanted excessive WR. As work obligations were frequently reported as a barrier to follow-up engagement, dietitians could consider implementing novel approaches, such as flexible scheduling options, incorporating technology for virtual meetings, and automated reminders, which might improve attendance as obesity is a chronic disease and entails long-term treatment.

*Acknowledgement* — Approval was obtained from the Health Sciences Research Ethics Committee of the Faculty of Health Sciences (HSREC) at the UFS (HSD2020/0023/2403) and MDT. Participants gave voluntary verbal informed consent. On behalf of all authors, the corresponding author states that there is no conflict of interest. No funds, grants or other support were received.

*Disclosure statement* — No potential conflict of interest was reported by the authors.

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**Received: 28-11-2025 Accepted: 23-07-2026**