



# Predictors for Adherence to Multidisciplinary Follow-Up Care after Sleeve Gastrectomy

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## Abstract

**Introduction** A considerable proportion of patients who undergo bariatric surgeries (BS) do not attend routine postoperative follow-up despite recommendations for such. Data are sparse regarding the various aspects of patient adherence to consultations following sleeve gastrectomy (SG).

**Objectives** To examine predictors of adherence to SG follow-up, reasons for attrition from follow-up, and the relationship between adherence to follow-up and weight loss results.

**Methods** A retrospective cohort study was performed with a mean follow-up of 3 years. Data were collected from electronic medical records and telephone questionnaires. Adherence was defined both as a numerical variable (ranking 0–9 according to the number of pre-scheduled postoperative visits) and as a dichotomous variable (adherent and non-adherent groups).

**Results** Of 178 patients, 46.63% were defined as “adherent,” according to the dichotomous definition. Compared to the “non-adherent group,” patients in the “adherent group” more regularly used vitamin D after the surgery, had fewer rehospitalizations, and reported a lower intake of sweetened beverages. The main reasons for attrition were work-related and difficulties in mobility. Adherence to postoperative follow-up was not found to be correlated to weight loss. Older age (OR = 1.04;  $p = 0.026$ ) and postoperative side effects (OR = 2.33;  $p = 0.035$ ) were found to be positive predictors for adherence, whereas rehospitalizations (OR = 0.08;  $p = 0.028$ ) and ethnical minority status were negative predictors (OR = 0.42;  $p = 0.019$ ).

**Conclusion** Adherence to postoperative follow-up was found to be associated with positive lifestyle behaviors; however, no correlation was found to mid-term weight loss outcomes.

**Keywords** Sleeve gastrectomy · Bariatric surgery · Adherence · Follow-up · Predictors of adherence · Reasons for attrition

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## Introduction

Bariatric surgery (BS) requires pre- and postoperative multidisciplinary evaluation and follow-up. Medical, psychological, and nutritional counseling is available in many bariatric centers [1–5]. Surgeons generally determine the frequency of follow-up visits according to clinical considerations [6]; three to four visits during the first postoperative year are commonly recommended [3]. The nutritional postoperative follow-up generally entails five to six visits during the first postoperative year and at least once annually in subsequent years [3, 7]. Despite the recommendations, a considerable proportion of patients do not attend routine post-BS visits. In the BS adult population, attrition rates from follow-up vary substantially, from 3.7 to 63% [8–13]. A number of definitions have been used for positive adherence to follow-up, such as at least one meeting in 3 or 12 months [14–16]; the attendance at 50% or

more of pre-scheduled postoperative meetings [17]; the attendance at the majority of scheduled follow-up meetings (3 or 4 of a total of 4) [18]; or as a continuous variable indicated by the percentage of total meetings attended [19, 20] or according to the total number of meetings [21]. The wide variance in the definition of “adherence” contributes to the broad range of reported attrition rates.

To date, reasons for attrition have not been extensively examined. High proportions of patients who are lost to follow-up contribute to potential bias in the analysis of surgery results [10].

The correlation between attendance to meetings following BS and weight loss is still controversial; most studies examined the 1–2-year period following Roux-en-Y gastric bypass surgery (RYGB) [10, 15, 17, 22–28]. Adherence to follow-up after RYGB was found to be associated with greater weight reduction at 12 months postoperative, according to a meta-analysis of prospective cohort studies [27], as well as at 24 months postoperative [15]. On the other hand, a retrospective study did not find a correlation between adherence to follow-up and weight loss at 2–3 years after RYGB [29]. Further, two additional studies found positive correlations between compliance to follow-up after adjustable gastric banding (AGB) but not after RYGB [17, 22]. Data are sparse regarding the possible association of adherence to follow-up and weight reduction following sleeve gastrectomy (SG), with one study reporting a positive effect [30]. An Israeli retrospective cohort study of individuals who underwent AGB, SG, and RYGB reported that those who attended diet counseling were more likely to reduce their body mass index (BMI) by 5 units or more [25].

The primary aim of the current study was to assess sociodemographic and medical predictors of adherence to postoperative follow-up in patients who underwent SG. Additional aims were to evaluate the relationship of postoperative attendance to nutritional and medical appointments with weight loss, to evaluate characteristics of patients who adhere to follow-up and those who do not, and to identify reasons for attrition from follow-up visits. We hypothesized that adherence to follow-up would have a positive effect on surgery outcomes.

## Methods

A retrospective cohort study was performed to access data regarding patients who underwent SG between March 2011 and August 2012 in a large tertiary medical center in Israel, with an average follow-up of 3 years. The study was approved by the institutional review board of Hadassah Hebrew University Medical Center. Informed consent was attained verbally from all participants.

**Inclusion Criteria** The study included all adults ( $\geq 18$  years of age) who underwent a SG as a primary BS, who fulfilled the National Institutes of Health (NIH) Consensus Conference criteria for BS [31], and who were approved by our multidisciplinary team, which comprises a surgeon, registered dietitian, and a clinical psychologist. The primary cohort comprised 235 individuals, 15 (6.4%) were not approved by the preoperative evaluation; 18 (5.1%) were excluded due to having undergone a previous BS or having medical or mental contraindications for surgery; and one was under the age of 18 years. Of 201 individuals who were eligible to participate in the study, 178 (88.5%) completed a questionnaire at the end of the cohort period and their data were analyzed in this study. The remaining 23 were not reached or refused to take part in the study.

The schedule of the postoperative follow-up consisted of a total of nine visits to a surgeon and a registered dietitian within 2 weeks and 3, 6, and 12 months after surgery and an additional visit 6 weeks after surgery to the dietitian [3, 7]. The data collected during the follow-up meetings were extracted from electronic medical records. For statistical analyses, adherence was considered as both a continuous and a dichotomous variable. Adherence was calculated as a continuous variable according to nine pre-scheduled meetings to the surgeon and dietitian (0–9), both together and separately (surgeon 0–4 and dietitian 0–5), in the first postoperative year. This variable was expressed as an individual value for each participant, according to the total number of attended visits.

The dichotomous definition of adherence was defined as positive if a patient attended  $\geq 6$  meetings (more than the median and  $> 50\%$  of the recommended meetings in the first postoperative year) and non-adherent if attendance was for  $\leq 5$  meetings.

The percentage of total body weight loss (TWL%) was calculated by dividing postoperative weight loss (kg) by preoperative weight (kg) and multiplying the result by 100.

A detailed questionnaire was developed to collect current data on medical status, lifestyle behaviors, and overall satisfaction from the surgery. The questionnaire was developed by bariatric surgeons, dietitians, and an epidemiologist. A telephone interview was conducted by members of the bariatric team: nurses, a dietitian, and a resident in general surgery. All interviewers received relevant guidance prior to the interviews and ongoing supervision during the study period. The questionnaire included self-reported information regarding demographic and medical conditions, lifestyle behavior, and reasons for attrition. Reasons for attrition were examined according to 12 categories, including the option of “other.” The questionnaire was originally written in Hebrew, translated into Arabic, and then retranslated to Hebrew by a second translator to assure reliability. Questionnaires were administered in participants’ native language. Before conducting the main study, a pilot survey using this questionnaire was administered to ten

patients to obtain primary feedback on the clarity of the questions. As no particular problems arose, no alterations were introduced to the questionnaire.

To achieve validity, some questions were presented in different ways. Some of the self-reported data were compared to gold standard criteria in electronic medical records.

## Statistical Analysis

A statistical analysis was carried out using the SPSS version 23 (SPSS Inc., Chicago, IL, USA) software. Adherent and non-adherent groups were compared, using Student's *t* test for continuous variables. Categorical variables were compared, using the  $\chi^2$  test. Mean values of %TWL were compared between patients who were and were not adherent to follow-up visits with the surgeon and dietitian, considered separately and together, using the one-way ANOVA test. Pearson correlation coefficients were calculated to evaluate the correlation between adherence to follow-up and %TWL.

A multivariate linear regression model using the Enter method was executed to evaluate the relationship between the dependent variable %TWL and the independent variable of adherence to follow-up. Adjustment to possible confounders was based on the univariate analysis or on previous knowledge (age, gender, religion, years of education). Statistical tests were performed for detecting multicollinearity in the multivariate linear regressions. Multicollinearity was considered as a value of VIF  $\geq 5$ .

A multivariable logistic regression model using the Enter method was performed to identify predictors of adherence, adjusted for universal confounders (age, gender, family status, and population group) and potential confounders according to previous knowledge (BMI, employment situation, travel distance) and according to the univariate analysis (age, population group, rehospitalization, and the presence of postoperative side effects) (Table 4). All statistical analyses were two-sided with a significance of  $p < 0.05$ .

## Results

The study comprised 178 patients (121 females and 57 males). Their baseline characteristics are described in Table 1; Most of the patients had at least one comorbidity: 54.49% had hyperlipidemia, 21.34% hypertension, 16.29% type 2 diabetes mellitus, and 15.73% gastroesophageal reflux disease. The most common medications prescribed were antilipidemic (15.18%), followed by antihypertensive (14.04%) agents. Only 8.43% of the patients regularly used vitamins before surgery.

The maximal length of the follow-up period was 4.1 years, and the mean was 3.02 ( $\pm 0.85$ ) years. Eighty-three patients (46.63%) were defined as “adherent” (attended six or more

**Table 1** Baseline characteristics of post-bariatric surgery patients

Data	Study participants ( $n = 178$ )
<i>Socioeconomic data</i>	
Age, mean (SD*), years	39.9 (11.2)
Female, no. (%)	121 (68)
Country of birth—Israel, no. (%)	156 (86)
Family status	
Married, no. (%)	116 (65.2)
Single, no. (%)	48 (27)
Divorced, no. (%)	12 (6.7)
Widowed, no. (%)	2 (1.1)
Number of children, mean (SD*)	2.4 (2.4)
Population group	
Jewish, no. (%)	115 (64.6)
Muslim, no. (%)	58 (32.6)
Other, no. (%)	5 (2.8)
Years of education, mean (SD*)	13.2 (2.8)
<i>Preoperative medical data</i>	
Weight before surgery, mean (SD*), kg	118.6 (17.1)
Excess weight**, mean (SD*), kg	49.4 (13.3)
BMI, mean (SD*)	42.9 (4.5)
Presence of $\geq 1$ comorbidity***, no. (%)	137 (76.9)

\*SD standard deviation

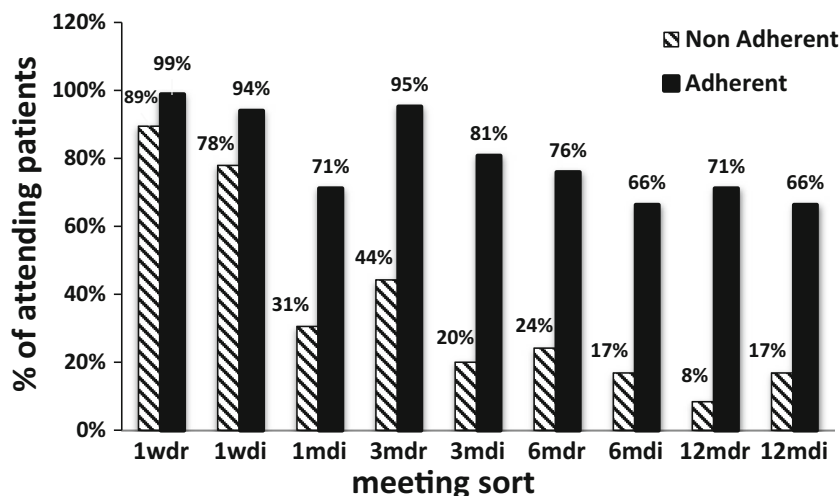
\*\*Excess weight = weight before surgery – maximum normal weight (calculated as weight at BMI = 25)

\*\*\*Comorbidity = obesity-related comorbidity refers to any of the following: diabetes mellitus, hypertension, dyslipidemia, obstructive sleep apnea, gastroesophageal reflux, or orthopedic disease related to excess weight

visits) and 95 (53.37%) were defined as “non-adherent.” The mean TWL% was 30.31% ( $\pm 9.90$ ), with no significant difference between the adherent (TWL% mean 29.18%,  $\pm 9.25$ ) and the non-adherent (TWL% mean 31.28%,  $\pm 10.43$ ,  $p = 0.160$ ) groups.

Figure 1 describes the distributions of follow-up visits for the adherent and the non-adherent groups. In both groups, most patients attended the first two postoperative appointments to the surgeon and dietitian (99, 94% and 89, 78%, respectively). However, starting from the second postoperative visit, differences between the groups were much more pronounced (e.g., 71 vs. 8% for the visit to the surgeon at 12 months after surgery, for the adherent and non-adherent groups, respectively).

Comparing characteristics of the two groups showed that the adherent group included higher proportions of Hebrew speakers ( $p = 0.026$ ) and individuals with greater adherence to vitamin D intake ( $p = 0.011$ ); a lower proportion of individuals who consumed sweetened beverages ( $p = 0.023$ ); and a lower rate of rehospitalizations due to surgical complications ( $p = 0.046$ ) (Table 2). No differences were found between the



**Fig. 1** Proportions of post-bariatric surgery patients that attended scheduled surgeon and dietitian meetings in the adherent and non-adherent groups. 1wdr = Dr. appointment after 1 postoperative week; 1wdi = dietitian appointment after 1 postoperative week; 1mdi = dietitian

appointment after 1 postoperative month; 3mdr = 3 postoperative months Dr. appointment; 3mdi = 3 postoperative months dietitian appointment; 6mdr/6mdi/12mdr/12mdi = 6 or 12 postoperative months Dr. and dietitian appointments, respectively

groups in sociodemographic parameters, transportation mode, travel time to clinics, preoperative medical conditions, and physical activity habits.

The main self-reported reasons for attrition from follow-up with the surgeon and dietitian were related to work issues (scheduling and taking days off for appointments) (20.79 and 43.26%, respectively) and mobility issues (residence far from the clinic or difficulties in mobility) (16.85 and 40.45%, respectively) (Table 3). Adherence to postoperative follow-up meetings was not found to be correlated to TWL% (Pearson’s rho = -0.72, *p* = 0.337), during a follow-up period that averaged 3 years. This was true for overall postoperative attendance (0 to 9 appointments, *p* = 0.189), dietitian follow-up visits (0 to 5 meetings, *p* = 0.359), and surgeon follow-up (0 to 4 meetings) *p* = 0.390.

In multivariable logistic regression, older age (OR = 1.04; CI 1.005–1.074; *p* = 0.026) and postoperative side effects (gastrointestinal symptoms and alopecia) (OR = 2.34; CI 1.063–5.154; *p* = 0.035) were found to be positive predictors of adherence to follow-up (Table 4). Rehospitalization due to surgery complications (OR = 0.08; CI 0.009–0.764; *p* = 0.028) and population group (Arabs vs. Jews) (OR = 0.42; CI 0.204–0.867; *p* = 0.019) were identified as negative

predictors of adherence to follow-up. One hundred and fifty-one (84.83%) patients stated they would recommend the surgery to others.

**Discussion**

This study aimed to identify predictors of adherence to postoperative follow-up, principal reasons for attrition from follow-up visits, and the association between adherence and weight loss results. Older age and postoperative side effects were found to be positive predictors of adherence, while rehospitalization was a negative predictor. A possible explanation for these findings is that patients who had side effects (mainly gastrointestinal) came to the clinic seeking help, whereas hospitalization may have interrupted the follow-up appointment schedule.

The main self-reported causes of attrition identified in this study were related to logistic issues such as occupation-related reasons, followed by difficulties in mobility or in travel to the clinic. Similar findings were reported by Vidal et al. [10], who identified work-related issues as the main reason for missing follow-up appointments. Another reason for attrition was the

**Table 2** Differences in characteristics between patients who were “adherent” and “non-adherent” to follow-up meetings

Parameter	Adherent, no. (%)	Non-adherent, no. (%)	<i>p</i> value
Hebrew speakers	73 (41.0)	71 (39.9)	0.026
Rehospitalizations related to surgery	1 (0.5)	7 (3.9)	0.046
HTN therapy post-surgery (dichotomous variable)	9 (5.0)	3 (1.6)	0.041
Vitamin D intake post-surgery	22 (12.3)	11 (6.2)	0.011
Sweetened beverages drinking habits post-surgery	33 (18.5)	54 (30.3)	0.023
Population group (Jewish)	62 (34.8)	53 (29.8)	0.008

**Table 3** Reasons patients stated for non-attendance to one or more scheduled appointments following bariatric surgery

Reasons for non-attendance to scheduled postoperative visits*	Dietitian, no. (%)	Dr., no. (%)
Work	77 (43.3)	37 (20.8)
Distance to the clinic/mobility difficulties	72 (40.4)	30 (16.8)
Prolonged waiting time in the clinic or for the appointment	67 (37.6)	33 (18.5)
The meetings did not contribute	34 (19.1)	14 (7.9)
Lack of funding by the Health Maintenance Organization	32 (17.9)	14 (7.9)
Forgot to come to the appointment	19 (10.7)	16 (9.0)
Family	19 (10.7)	11 (6.2)
Economic	18 (10.1)	9 (5.0)
Language difficulties	15 (8.4)	4 (2.2)
Weight regain/dissatisfaction with results	13 (7.3)	6 (3.4)
Health-related	9 (5.1)	5 (2.9)
Other	63 (35.4)	79 (44.4)
Other: not aware of the need of follow-up	16 (9.0)	35 (19.7)

*N* = 178

\*Each patient could choose more than one reason

lack of awareness of patients to the importance of the postoperative follow-up. This is despite our efforts to clearly explain, prior to the surgery, the significance of the postoperative follow-up and the importance of adhering to it. Patients' difficulties in attending follow-up visits rarely receive attention during clinical appointments. Evaluating this aspect of treatment [32], as well as providing complimentary use of online communication services, may improve adherence [33].

According to the literature, the most frequently reported reasons for attrition from BS follow-up are family-related personal problems, difficulties related to work, and lack of motivation [10, 32]. Characteristics that were previously identified

as positive predictors for adherence were single relationship status [16, 34], active employment [16, 35], Caucasian race [34, 35], low anxiety level, and greater weight loss [34]. Characteristics that have been identified as negative predictors are higher preoperative BMI [16], higher baseline weight [8], and self-payment for meetings [16]. Inconsistent results have been reported regarding the predictive value of the following factors: the need to travel a long distance to the bariatric clinic [8, 34–36], older age [16, 34, 35], and the presence of diabetes mellitus type 2, hypertension, and hyperlipidemia [20]. No associations were found between adherence to postoperative follow-up and socioeconomic status or gender [29, 34, 35, 37].

**Table 4** Multivariate analysis for predictors of adherence to postoperative follow-up meetings with a dietitian and surgeon

Parameter	OR for adherence*	<i>p</i>	95% confidence interval	
			Lower bound	Upper bound
Constant	0.65	0.811	–	–
Age, years (continuous)	1.04	0.026	1.005	1.074
Gender (ref: male)	0.84	0.649	0.396	1.782
F.S. (ref: not married)**	0.69	0.354	0.323	1.497
Population group (ref: Jew)	0.42	0.019	0.204	0.867
BMI, kg/m <sup>2</sup> (continuous)	0.99	0.730	0.918	1.062
Rehospitalization*** (ref: no)	0.08	0.028	0.009	0.764
Adverse symptoms post surg. (ref: no)	2.34	0.035	1.063	5.154
Travel time, minutes (continuous)	1.00	0.198	0.997	1.013
Occupational situation (ref: no full-time job)****	0.73	0.404	0.346	1.533

*R* square (Nagelkerke's  $R^2$ ) = 0.191

\*OR for adherence = > 50% of visits

\*\*F.S. family status

\*\*\*Rehospitalization—surgery-related

\*\*\*\*Full time job: 40 or more weekly hours



Contrary to our hypothesis, no correlation was found between adherence to follow-up and weight loss during the 3-year study period. This supports the notion that in the postoperative midterm period, the surgery has a certain physiologic effect that is independent of lifestyle behavior. Another possible explanation is that some patients were more adherent to postoperative visits than others because they initially sought professional help for their difficulties in losing weight. On the other hand, the 3-year duration of the follow-up must be considered in the interpretation of the findings. Longer follow-up time may have yielded different results.

Much of the research regarding attendance to postoperative visits refers to RYGB or AGB. Studies performed on patients after AGB showed mainly positive associations between adherence and weight loss [17, 22, 25], whereas studies that examined adherence rates after RYGB have shown controversial results [15, 17, 22, 29, 30]. The positive correlation between adherence and weight loss after AGB may be due to the need for band adjustment. Proper adjustment may affect weight loss and eating capacity, giving a clear advantage to patients who attend clinical visits, which is not relevant to other BS surgeries. Differences between studies in the content of the follow-up visits and in participants' perceptions of the value of such appointments may be additional reasons for the discrepancies observed regarding weight loss.

We explored the effect of postoperative follow-up on a number of important lifestyle behaviors such as vitamin intake and the avoidance of sweetened beverages. As far as we know, assessments of such effects of postoperative follow-up have not been published. We found that patients who attended the recommended meetings reported higher adherence to vitamin D supplementation and lower consumption of sweetened beverages compared to the non-adherent patients.

There is strong evidence that the majority (42–93%) of patients after BS will have some degree of vitamin D deficiency [38–40]; hence, lifetime vitamin D screening is a well-accepted recommendation [2, 3, 41]. Avoidance of sweetened beverages is one of the principal nutritional guidelines after BS [3, 42]. Drinking such beverages entails ingestion of high quantities of calories and sugar in a small volume [42, 43]. Sarwer et al. showed that adherence to a healthy postoperative diet was associated with greater postoperative weight loss [13]. Nevertheless, in the current study, lower consumption of sweetened beverages did not appear to affect weight loss outcomes. This may be explained by the fact that weight loss is affected by several factors and that drinking habits may influence body weight after a longer period.

This study has a number of limitations. First, the conduct of the study in a single medical center may reduce the generalizability of the findings. However, as BS is covered by the health services that are nationally provided in Israel, it is unlikely that the patients in our center differed greatly from other BS patients. A second limitation is a potential for information

bias, due to the use of self-reported data collected through telephone interviews. To mitigate this bias, interviewers were provided ongoing guidance, and a preliminary pilot survey was performed, with satisfactory results. Another limitation is the possibility of “recall bias,” due to the time lapse from the surgery to the interview. This is a common limitation in studies that examine reasons for follow-up dropout. Finally, sample size may be a limitation in the examination of the correlation between adherence and weight loss, especially in analyses that comprised a larger number of small groups, according to the number of follow-up visits.

This study has major strengths as well. It elucidates possible reasons for attrition after SG; these have been described only scarcely until now. The analysis of adherence included gastrointestinal adverse symptoms, rehospitalizations, the language spoken during follow-up visits, and ethnicity. The use of a relatively broad definition for the term “adherence” further adds to its credibility and universality.

As was demonstrated, the highest attendance in the postoperative regime was recorded in the initial meetings. Thus, it may be beneficial to use these meetings as an opportunity to increase future adherence and to address logistic constraints that may increase attrition.

## Conclusions

Adherence to postoperative follow-up was found to be associated with positive lifestyle behaviors; however, no correlation was found to mid-term weight loss outcomes. Further research may explore strategies to improve patients' awareness to the importance of postoperative nutritional and surgical counseling. In addition to weight loss results, other follow-up outcomes should be assessed, such as positive lifestyle behaviors and self-perception of success.

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## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Institutional Review Boards of the Hadassah-Hebrew University Medical Center, Jerusalem, and Tel-Aviv University, Israel.

For this type of study, formal consent is not required.

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