Original Article

Association between nutrient adequacy and psychosocial factors with overall rate of weight loss after bariatric surgery

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This was a cross-sectional study that investigated the relationship between nutrient intake and psychosocial factors with the overall rate of weight loss after bariatric surgery among patients who had undergone sleeve gastrectomy in University Kebangsaan Malaysia Medical Centre (UKMMC). Forty-three subjects (15 men and 28 women) were recruited for this study. Subjects completed assessment questionnaires including the Binge Eating Scale (BES), Beck Depression Inventory (BECK), Family Support Questionnaires, and the Index of Peer Relation (IPR). Results showed that the median overall rate of weight loss was 4.3±5.5 kg/month, which was lower when compared to the rate of weight loss at three months which was 5.0±5.6 kg/month. Pre-operative weight was the predictor of overall rate of weight loss ($p<0.05$, $R^2=0.52$). Binge eating disorder (BED) and depression were also closely associated with each other after bariatric surgery ($p<0.001$, $R^2=0.46$). Subjects with good compliance to dietary advice had lower scores on the binge eating scale. The mean caloric and protein intake was very low, only 562±310 kcal/day and 29.6±16.1 g/day. The intake of vitamin A, B-1, B-2, B-3, B-12, C, folate, and iron met the Malaysian Recommended Nutrient Intake (RNI). However, the RNI for calcium, zinc, selenium, vitamin D, and vitamin E was not met. In conclusion, although bariatric surgery had many health benefits, several factors hindered weight loss after bariatric surgery. Health care professionals should closely monitor patients after bariatric surgery.

Key Words: obesity, bariatric surgery, binge eating disorder, depression, rate of weight loss

INTRODUCTION

Obesity has become a serious condition and it has been estimated that the prevalence of obesity has tripled in developing countries due to unhealthy eating patterns and sedentary lifestyles.[1] Bariatric surgery has been gaining popularity due to the failure of diet, physical activity, and pharmacological treatment to promote long-term weight loss. Obesity is closely associated with many serious health consequences such as diabetes mellitus, obstructive sleep apnoea, musculoskeletal diseases, and certain cancers.[2] Lomanto et al (2012) has showed that 17 cases of bariatric surgery are reported in Malaysia from 2005 till 2009.[3] Bariatric surgery patients tend to experience drastic weight loss one year after surgery due to the anatomical restriction of the gastrointestinal tract, which contributes to poor appetite.[4]

Sleeve gastrectomy is a type of restrictive procedure that produces a small gastric tube with the shape of a sleeve by removing the greater curvature of the stomach. Sabbagh et al (2010) has compared the effectiveness of sleeve gastrectomy and gastric banding procedure.[5] The result shows that the long-term (two years after the operation) complication rate is 0% among patients who had undergone sleeve gastrectomy compared to 25% after a gastric banding procedure. Thus, sleeve gastrectomy is a better choice compared to gastric banding and sleeve gastrectomy could be performed when gastric banding failed. This is similar to the study done by Uglioni et al (2009) who has reported that there is no significant difference in excess weight loss and morbidity among those who has undergone sleeve gastrectomy alone or those after sleeve gastrectomy following the failure of gastric banding procedure.[6]

Bariatric surgery has been indicated for patients with Body Mass Index (BMI) 40 kg/m² without co-morbidities and those with BMI 35 kg/m² with co-morbidities.[7] Gruber and Haldeman (2009) emphasize the importance of weight loss treatment to include family members of patients to ensure success in achieving their targeted weight

loss.[8] Dupertius et al (2001) has reported that peers provide moral support which motivate an individual to lose weight.[9] Moreover, previous long-duration studies show the influence of psychosocial problems associated with weight loss after bariatric surgery. Binge eating disorder (BED) and depression after bariatric surgery greatly affect weight loss.[10,11] However, there have been very limited studies done to study the factors influencing the rate of weight loss in the short term (less than one year) after bariatric surgery.

In addition, a tremendous decrease in food consumption is also a major problem after bariatric surgery. Restricted energy intake experienced by patients after bariatric surgery is one of the factor causing protein malnutrition, food aversion, macronutrient, and micronutrient deficiency.[12,13] Therefore, two essential components to ensure nutrient adequacy after bariatric surgery are regular monitoring of nutrient intake especially protein, vitamin and minerals as well as screening of laboratory values.[14]

This present study aims to fill in the gap of knowledge of the previous studies by looking into comprehensive aspects of the short-term predictors that affect rate of weight loss after bariatric surgery. More specifically, the role of family and peer support, which have not been studied extensively in the previous literature, are emphasized in this current study. In addition, the dietary intake of the patients is analyzed to determine the adequacy of nutrient intake after bariatric surgery.

STUDY DESIGN AND METHODLOGY
This was a cross-sectional study that involved 43 patients and consisted of 15 men and 28 women who had undergone sleeve gastrectomy at University Kebangsaan Malaysia Medical Centre (UKMMC), Malaysia since January 2012. The list of post bariatric surgery patients was obtained using the surgeon's database. Based on the database, there were a total of 58 patients who underwent bariatric surgery in UKMMC since bariatric surgery was established in January 2012. All the post bariatric surgery patients who visited the Obesity Outpatient Clinic in UKMMC were recruited as subjects for the study. However, of the 58 patients, only 43 patients managed to come for their regular appointment at the clinic. The remaining 15 patients who did not come for their appointment were contacted via phone calls. They were unable to make it due to work trips overseas, busy schedules, pregnancy, staying in different states in Malaysia, and were receiving treatment from other hospitals nearby their homes. Five patients, who were originally selected for the pilot test, were not chosen for subjects of this study. The number of post bariatric surgery patients in UKMMC was very low because bariatric surgery was recently introduced in UKMMC.

The mean duration from the onset of bariatric surgery and the point of recruitment was 9.8 months. Patients were selected as participants of this study if they had undergone bariatric surgery procedure at least three months ago. This study obtained the ethical approval with code of NN-112-2013 from the Research and Ethical Committee of Medical Research of University Kebangsaan Malaysia. Prior to participating in this study, respondents were given explanations regarding the aims of the current study. If they were willing to participate, signed informed consent was obtained. Subjects were recruited during their regular appointment at the Obesity and Metabolic Clinic in UKMMC. Inclusion criteria were patients aged from 18 to 65 years old, had undergone bariatric surgery at least three months ago, and had no severe mental disturbances (from medical folder). The exclusion criteria were patients who had not undergone bariatric surgery, pregnant, those with genetic disorders or patients who had joined other weight loss treatment.

Data collection
Subjects were identified through the bariatric surgeon's database. Demographic variables, pre-surgical weight, current medication and supplementation information were obtained from the medical folder. Before undergoing bariatric surgery, patients had frequent visits to the Obesity Clinic and during each visit, patients' weight, height and waist circumference were recorded. After surgery, patients were required to visit the clinic once every two weeks for the first three months for monitoring of weight loss and complications following surgery. After the third month, patients would meet the surgeon once a month until the sixth month. During every visit, weight, height, waist circumference, diet, and medication history were taken. All the information was recorded in the patient's medical folder. Consent was obtained from the patients before recruiting them officially into this study.

Socio-demography, lifestyle, anthropometry, body composition, dietary intakes, depression, binge eating, family and peer support data were obtained during the patient's visit to the Obesity Clinic at least three months after surgery. Pre-operative weight, medical and medication history were attained from the patient's medical folder. The questions included in the socio-demography and lifestyle category were name, sex, age, ethnicity, education level, monthly salary, total household income, marital status, living arrangement, smoking, alcohol intake and frequency of exercise. The item that focused on exercise required the patients to choose their exercise frequency based upon the options given: not at all, once or twice per week, and at least three days per week.

Meanwhile, anthropometry and body composition of the subjects were measured using standard procedures. Current weight and height was measured using SECA 769 electronic column (SECA GmbH & Co, Hamburg, Germany). Weight and height were measured to the nearest 0.1 kilogram (kg) and 0.1 cm respectively. BMI was calculated using the standard formula of weight divided by the square of the height and further classified using the standard World Health Organization (WHO) classifications.[15] Waist and neck circumference were also measured to the nearest 0.1 cm using the standard plastic measuring tape. Waist circumference was classified using the standard WHO formula.[16] Percentage of lean and fat body mass were assessed via Bioelectrical Impedance Analysis using Maltron 906 Body Fat Analyser (BF-906, Maltron International Ltd, England)

Dietary intake of the subjects was obtained using a combination of 24-hour dietary recall and a two-day food record method. A total of three days (two weekdays and one weekend) food intake was attained from the subjects.

The 24-hour dietary recall method was done via face-to-face interview during the patient's first visit to the clinic. Food albums, cups, plates, various sizes of spoons and bowls were used as tools to obtain more precise dietary information. Open-ended questions were asked to reduce bias and facilitate the process of collecting further dietary information from subjects. Upon completion of the 24-hour dietary recall process, participants were advised to keep a food record for one weekday and one weekend in that week and this information was obtained via a phone call. The proper ways of recording food intake in a diary were taught to each subject. Nutritionist Pro software was used to analyze the nutrient intake of the subjects. The intake of multi-vitamin supplementations such as folic acid, calcium carbonate, vitamin B-complex, vitamin D, iron tablets, and zinc were recorded and included in the nutrient analysis. Dietary intake of respondents was compared with the standard Recommended Nutrient Intake (RNI).[17]

Materials

This study used four self-administered questionnaires. All the questionnaires used in this study were validated among the population of this study. The original version of the questionnaires was in English. However, since majority of the subjects were proficient in Malay language, the English version was translated to the Malay language with the assistance of a linguist. Back to back translation method had been applied to ensure that the translated version of the questionnaires was easily understood by the subjects of this study. Pilot testing of the Malay questionnaires was done among five post bariatric surgery patients who were not respondents of this study. These patients were asked to give comments after answering the Malay version of the questionnaires. Final corrections were made based on the comments given. Reliability analysis was done using the Statistical Package for Social Sciences (SPSS) version 21.0.

The Binge eating scale (BES) was a 16-item self-reported questionnaire used to assess binge eating disorder. The Cronbach's alpha was 0.85 and the score of BES was divided into three main categories namely no binge eating (0 to 17), moderate binge eating (18 to 26), and severe binge eating (27 to 46).[18] On the other hand, depression was assessed using BECK Depression Inventory, which had high internal consistency with coefficient alpha of more than 0.90. Score of 0 to 13 indicated no or minimal depression, 14 to 19 represented mild depression, 20 to 28 indicated moderate depression, and 29 to 63 indicated severe depression.[19]

The family support questionnaire consisted of questions which assessed the role of family members in motivating patients to lose weight. This two-section questionnaire was adapted from La Greca (2002) and was validated for the population of this study.[20] The Cronbach's alpha of this questionnaire for the current bariatric surgery population was calculated. Family members of the post-bariatric surgery patients were defined as spouse, parents, children, siblings, or relatives of the subjects. The questionnaire was divided into two sections; the first section was regarding the frequency of occurrence of certain positive behaviour among family members of subjects which

had Cronbach's alpha 0.83. Meanwhile, the second part was the feelings of respondents toward the positive attitude of their family members. The Cronbach's alpha for the second part was 0.82. The score for each item was obtained by multiplying the score from the first and second section. The total score for the family support questionnaire was divided into three categories, namely poor family support (0-85), moderate family support (86-171), and good family support (172-255).[20]

Furthermore, peer support was determined using the Index of Peer Relation (IPR). Peers refer to classmates, officemates, schoolmates, roommates, neighbours, or friends in mosque, temple, church, or park during regular exercise. IPR was a 25-item questionnaire used to assess the quality of peer relationship. The Cronbach's alpha value obtained after validation among the current bariatric surgery population is 0.90. Subjects were asked to rate their level of agreement on a five point Likert scale ranging from 1 (most or all of the time) to 5 (rarely or none of the time).[21] The score was calculated using the reverse scoring method. Score below 30 indicated positive peer relationship, while score of 30 and above represented poor rapport among peers.

Weight loss was reported as the percentage of excess weight loss, overall rate of weight loss, and rate of weight loss at three months. The percentage of excess weight loss was calculated using the formula: (pre-operative weight – post-operative weight) / (pre-operative weight – ideal weight).[22] Meanwhile, overall rate of weight loss was obtained using the formula: (pre-operative weight – post-operative weight) / months after bariatric surgery.[23] Overall rate of weight loss was the dependent variable and was reported in kilograms/month. The formula for rate of weight loss at three months was: (pre-operative weight – weight at three months) / 3.

Statistical analysis

All analysis was conducted using SPSS version 21 and p less than 0.05 was set as the level of statistical significance. Assumptions of normality were checked using the Shapiro-Wilk test before employing the statistical test. Parametric test was employed when the data were normally distributed and a non-parametric test was specified for non-normal distribution. Chi-Square test was used to determine the association between categorical variables. When the expected frequencies of less than five were more than 20%, the Fisher exact test was used. The relationship between gender and the presence of co-morbidities was studied using the chi-square test. The relationship between gender, employment status, marital status, and education level with the overall rate of weight loss were determined using Mann Whitney-U-test. Kruskal-Wallis one-way between group ANOVA was a non-parametric test used when there were three categorical variables which were mutually exclusive. For example, the relationship between rate of weight loss and exercise regimen was studied using Kruskal-Wallis test. Pearson's correlation was used when the two continuous variables were normally distributed and there was a linear as well as homoscedastic relationship between the continuous variables. Multiple Linear Regression (MLR) was employed to examine the relationship between one depend-

ent variable and two or more independent variables. The standard MLR was used to identify the best predictors of overall rate of weight loss, binge eating, and depression.

RESULTS

Socio-demographic, lifestyle and health profile

The mean age of the subjects was 43.4±9.1 years old with mean age of men, 42.1±9.6 years old and women, 44.1±8.9 years old. Almost 81.4% of the participants were Malays, 11.6% were Chinese, and the least, 7.0%, were Indians. Majority of the subjects in this study were employed (81.4%), married (74.4%), and received tertiary education (69.8%) as shown in Table 1. The range of the follow-up interval between the point of recruitment and the time of operation ranged between 3 to 18 months. Almost half of the subjects (51.2%) were recruited after three months from the surgery. About 69.8% of the subjects of this study reported that they had chosen bariatric surgery to achieve weight loss after dieting and physical activity failed to produce the desired effect. There were 23.2% of the respondents who were encouraged by the doctors to undergo bariatric surgery to manage their co-morbid conditions. The percentages of men and women respondents suffering from several co-morbidities were as follows; knee osteoarthritis (23.3% versus 44.2%), diabetes mellitus (18.6% versus 34.9%), cardiovascular disease (23.3% versus 32.6%), and hypertension (23.3% versus 41.9%). All the subjects included in this study were non-smokers and non-alcoholic.

Psychosocial profile

As shown in Table 2, majority of the subjects (69.8%) had no binge eating problems and 74.5% had very minimal, or no, depression. Binge eating and depression were seen in 7.0% and 2.3% of women participants, respectively. Most of the subjects in this study reported that they had very good family support (48.8%) and positive peer relationships (95.3%).

Anthropometric and body composition profile

The pre-operative and post-operative weights of the subjects ranged from 78 to 226 kg and 64.3 to 170 kg, respectively. The median pre and post-operative weights of men and women respondents were 141±40.0 kg vs 110±28.0 kg and 107±38.9 kg vs 91.8±32.7 kg, respectively. The median rate of weight loss was higher at three months (5.0±5.6 kg/month) compared to the overall rate of weight loss (4.3±5.5 kg/month). The median total body fat and lean body mass between men and women were (34.5±15.2)% vs (38.7±10.6)%, respectively, and (65.5±15.2)% vs (61.3±10.6)%, respectively (Table 3).

Table 1. Socio-demographic characteristic and frequency of exercise

Characteristics	Total (N=43)	Men (n=15)	Women (n=28)	p-value
Age, years (mean±SD)[*]	43.4±9.1	42.1±9.6	44.1±8.9	0.48
Gender, n (%)				
Men	15 (34.9)			
Women	28 (65.1)			
Ethnic, n (%)[**]				0.46
Malay	35 (81.4)	11 (25.6)	24 (55.8)	
Chinese	5 (11.6)	5 (11.6)	2 (4.7)	
Indian	3 (7.0)	3 (7.0)	2 (4.7)	
Marital status, n (%)[**]				0.76
Single	8 (18.6)	2 (4.7)	6 (14.0)	
Married	32 (74.4)	12 (27.9)	20 (46.5)	
Divorcee	1 (2.3)	0 (0.0)	1 (2.3)	
Widow/widower	2 (4.7)	1 (2.3)	1 (2.3)	
Education level[**]				0.43
Primary education	2 (4.7)	0 (0.0)	2 (4.7)	
Secondary education	11 (25.6)	3 (7.0)	8 (18.6)	
Tertiary education	30 (69.8)	12 (27.9)	18 (41.9)	
Living with[**]				0.53
Parents	6 (14.0)	3 (7.0)	3 (7.0)	
Husband/wife and children	31 (72.1)	11 (25.6)	20 (46.5)	
Children	3 (7.0)	1 (2.3)	2 (4.7)	
Relatives	3 (7.0)	0 (0.0)	3 (7.0)	
Employment status[**]				0.69
Housewife/unemployed	8 (18.6)	2 (4.7)	6 (11.6)	
Employed	35 (81.4)	13 (30.2)	22 (51.2)	
Monthly salary, RM (mean±SD)[***]	3349±1987	4000±1927	3000±1963	0.11
Household income, RM (mean±SD)[***]	6663±2954	6567±2329	6714±3279	0.82
Frequency of exercise				0.81
Not at all	14 (32.5)	9 (20.9)	5 (11.6)	
Once or twice per week	14 (32.6)	10 (23.3)	4 (9.3)	
At least three times per week	15 (34.9)	9 (20.9)	6 (14.0)	

[*]p>0.05 non-significant using independent-t-test
[**]p>0.05 non-significant using the Pearson chi square test
[***]p>0.05 non-significant using Mann-Whitney U test
N: Total number of subjects; n: number of subjects who represent certain characteristic; SD: standard deviation; RM: Ringgit Malaysia (Malaysian currency)

Table 2. Psychosocial profile of the subjects

Psychosocial profile	Total (n=43)	Men (n=15)	Women (n=28)
Binge eating scale, n (%)[*]			
Little or no binge rating	30 (69.8)	10 (66.7)	20 (71.4)
Moderate binge eating	10 (23.3)	5 (33.3)	5 (17.9)
Severe binge eating	3 (7.0)	0 (0.0)	3 (10.7)
BECK depression inventory, n (%)[*]			
Minimal or no depression	32 (74.5)	10 (66.7)	22 (78.6)
Mild depression	7 (16.3)	4 (26.7)	3 (10.7)
Moderate depression	3 (7.0)	1 (6.6)	2 (7.1)
Severe depression	1 (2.3)	0 (0.0)	1 (3.6)
Family support, n (%)[*]			
Poor family support	7 (16.3)	3 (20.0)	4 (14.3)
Moderate family support	15 (34.9)	5 (33.3)	10 (35.7)
Good family support	21 (48.8)	7 (46.7)	14 (50.0)
Index of peer relation, n (%)[*]			
Positive peer relationship	41 (95.3)	14 (93.3)	27 (96.4)
Negative peer relationship	2 (4.7)	1 (6.7)	1 (3.6)

[*]not significant using cross tabulation

Table 3. Anthropometric and body composition profile

Variables	Total (N=43)	Men (n=15)	Women (n=28)	p-value
Pre-Op weight, kg (median±IQR)[**]	120±29.0	141±40.0	110±28.0	<0.001
Post-Op weight, kg (median±IQR)[**]	96.0±33.3	107±38.9	91.8±32.7	<0.001
Pre-Op BMI, kg/m² (median±IQR)	45.5±7.5	46.6±20.3	45.5±6.6	0.490
Post-Op BMI, kg/m² (mean±SD)	38.2±8.4	39.8±9.3	37.3±7.9	0.360
Ideal body weight, kg (mean±SD)[**]	62.1±92	71.0±7.6	57.4±5.8	<0.001
Excess weight loss, % (mean±SD)	43.7±18.8	46.5±12.9	42.2±21.4	0.410
Excess weight loss at 3 months, % (mean±SD)	31.5±13.4	32.5±12.5	31.0±2.7	0.730
Overall RWL, kg/month (median±IQR)[*]	4.3±5.5	6.5±5.7	3.6±5.3	0.050
RWL 3 months, kg/month (median±IQR)[**]	5.0±5.6	8.0±5.0	4.3±4.7	0.010
Neck circumference, cm (mean±SD)[***]	37.0±3.7	39.6±3.7	35.6±2.9	<0.001
Waist circumference, cm (mean±SD)[***]	102±21.4	114±18.8	95.0±20.1	<0.001
Total body fat, % (median±IQR)	38.4±11.5	34.5±15.2	38.7±10.6	0.100
Lean body mass, % (median±IQR)	54.5±11.5	65.5±15.2	61.3±10.6	0.100

[*]p=0.05 was marginally significant using Mann Whitney U test.
[**]p<0.05 was significant using Mann Whitney U test.
[***]p<0.05 was significant using independent t test.
RWL: rate of weight loss; IQR: interquartile range; SD: standard deviation

Nutrient intake

The mean caloric and protein intake of the subjects in this study were very low. The overall mean caloric and protein intake between men and women were 746±347 kilocalorie (kcal) vs 464±220 kcal, respectively, and 38.0±16.6 gram vs 25.2±14.1 gram, respectively. The mean fluid intake of men and women were 1123±258 mL and 1038±290 mL, respectively. As shown in Table 4, the intake of vitamin D, vitamin E, zinc, selenium and calcium did not meet the RNI of Malaysia. The RNI for vitamin A, B-1, B-2, folate, B-12, C and iron was achieved through supplementation in addition to diet.

Predictors of overall rate of weight loss, binge eating and depression

Employment status was significantly associated with overall rate of weight loss of which the non-working group had a higher median overall rate of weight loss (7.9 kg/month) compared to the working group (4.2 kg/month) (not shown in Table). Multiple linear regression analysis reported that pre-operative weight was the only predictor for overall rate of weight loss, R^2=0.52, β=0.56, and p=0.01. Binge eating and depression were closely related to each other with R^2=0.47, β=0.43 and p=0.01, as shown in Table 5.

DISCUSSION

Pre-operative weight has been found to be a short-term predictor of overall rate of weight loss. The is contradictory with the study done by Kinzl et al (2006), which shows that pre-operative weight has no significant association with weight loss 30 days after bariatric surgery.[24] Furthermore, current study reveals that subjects who are still working has lower rate of weight loss compared to the unemployed group. Those who are working are most likely to rely on food in the restaurants which are high in calories and fat. It is timely for a total change in the eating pattern among those who are working, since evidence has confirmed that Malaysian adults who have been residing in urban areas often rely on food sold in shops and convenience stores due to insufficient time to cook.[25] Since the dietary pattern of Malaysians needs improvement, the role of nutritionists and dieticians in educating the adult population on improving their dietary intake has become very important for attainment of better quality of

Table 4. Comparison of mean micronutrient intake with the RNI

Micronutrients, unit	Total[†] (n=43)	Men[†] (n=15)	Women[†] (n=28)	RNI
Vitamin A, µg/d	727±405	698±428	743±399	Men: 600 µg/d Women: 500 µg/d
Vitamin D, µg/d	1.7±0.7	19-50: 2.0±0.7 51-59: 2.0±0.7	19-50: 2.0±0.7 51-59: 1.9±0.7	19-50: 5 µg/d 51-59: 10 µg/d
Vitamin E, mg/d	1.0±1.1	1.1±1.2	1.0±1.0	Men: 10 mg/d Women: 7.5 mg/d
Vitamin B-1, mg/d	13.3±28.9	10.4±25.0	14.9±31.2	Men: 1.2 mg/d Women: 1.1 mg/d
Vitamin B-2, mg/d	1.3±0.8	1.1±0.7	1.5±0.8	Men: 1.3 mg/d Women: 1.1 mg/d
Vitamin B-3, mg/d	25.1±7.6	24.3±7.5	25.6±7.8	Men: 16 mg/d Women: 14 mg/d
Folate, µg/d	3075±2470	1723±2430	3800±2206	400 µg/d
Vitamin B-12, µg/d	63.7±151	49.5±135	71.3±161	>19 years: 2.4 µg/d
Vitamin C, mg/d	140±90.0	96.2±54.0	164±97.1	70 mg/d

Iron, mg/d	53.1±31.4	49.0±31.4	19-50: 54.1±28.5
			51-59: 44.4±31.6
				Men: 14 mg/d
				Women:
				  19-50: 29 mg/d
				  51-59: 11 mg/d

Calcium, mg/d	526±254	553±237	19-50: 499±218
			51-59: 680±241
				Men: 800 mg
				Women:
				  19-50: 800 mg/d
				  51-59: 1000 mg/d

Zinc, mg/d	1.9±1.5	2.5±2.1	1.6±1.1	Men: 6.7 mg/d Women: 4.9 mg/d
Selenium, µg/day	15.8±11.0	23.1±13.0	11.8±7.4	Men: 33 µg/d Women: 25 µg/d

[†]Data were presented as mean±SD.
RNI: Recommended Nutrient Intake; µg/d: microgram per day; mg/d: milligram per day.

Table 5. Multivariable analysis of the predictors affecting overall rate of weight loss, binge eating and depression after bariatric surgery

Variables	Adj β[¶]	95% CI	t-stat	p-value
Predictors of overall rate of weight loss[†]				
Age	-0.08	-0.19, 0.04	-1.38	0.18
Pre-op weight	0.06	0.02, 0.11	2.66	0.01[*]
Pre-op BMI	0.01	-0.01, 0.14	0.22	0.83
Binge eating score	-0.06	-0.22, 0.10	-0.71	0.48
BECK depression inventory	-0.04	-0.25, 0.05	-0.52	0.61
Family support score	0.10	0.00, 0.03	1.11	0.27
Peer support score	0.03	-0.07, 0.05	0.99	0.14
Predictors of binge eating disorder[‡]				
BECK depression inventory	0.44	0.12, 0.75	2.82	0.01[*]
Family support score	-0.02	-0.06, 0.02	-1.22	0.23
Peer support score	0.03	-0.08, 0.14	0.55	0.59
Mean calorie intake	0.00	-0.01, 0.02	0.42	0.67
Mean fat intake	0.03	-0.34, 0.40	0.18	0.86
Household income	0.00	0.00, 0.00	-0.53	0.60
Predictors of depression[§]				
Binge eating score	0.43	0.13, 0.73	2.88	0.01[*]
Family support score	-0.03	-0.07, 0.01	-1.76	0.09
Peer support score	0.03	-0.08, 0.14	0.61	0.55
Mean calorie intake	0.00	-0.01, 0.01	0.16	0.88
Household income	0.00	0.00, 0.00	-0.51	0.61

MLR: Multiple Linear Regression ([†]R^2=0.42, [‡]R^2=0.38, [§]R^2=0.39). The model fits reasonably well; Model assumptions were met; there was no interaction between the independent variables and no multicollinearity problem).
[¶]Adj β: adjusted regression coefficient.
[*]$p<0.01$.

life. Working adults should be essentially educated regarding healthier food choices when dining out, especially including more green leafy vegetables, reducing the amount of gravy eaten, and choosing low fat milk instead of full cream or condensed milk.

The levels of vitamin B-1, B-2, B-3, folic acid, vitamin A, vitamin B-12, vitamin C, and iron has been able to meet the RNI, partly due to prescription of various supplementations namely multivitamin, vitamin C, folic acid, B-complex, ferrous fumarate, and calcium carbonate. This is in agreement with the study done by Novais et al (2012) which reveals the importance of supplementations in enabling patients to achieve their vitamin and mineral requirements.[26] However, in this current study, the intake of certain vitamin and minerals such as calcium, selenium, zinc, and vitamin D fail to meet the RNI due to no or inadequate supplementation and poor dietary intake. As a result, it is recommended that dieticians encourage post bariatric surgery patients to practice healthy dietary patterns, which include adequate whole grains, legumes, lean meat, dairy products, and sufficient fruits and vegetables. Compliance to multivitamin supplementation could be monitored via laboratory tests (to monitor levels of calcium, vitamin B-12, vitamin D, electrolytes, folate, ferritin, albumin, pre-albumin, liver function and iron study), bone density measurement, urinalysis, and deficiency symptoms such as hair loss and paleness. Medications taken by the patients should be monitored at each follow-up and adjusted based on the biochemical parameters.[27-29] Since this study was a not a follow-up study, compliance to medications prescribed is not monitored.

Bariatric surgery patients are at high risk of vitamin and mineral deficiencies due to anatomical changes in the gastrointestinal tract.[30] Restrictive procedures such as sleeve gastrectomy tend to reduce the stomach's capacity to hold food and would lead to early satiety. Rapid stomach emptying is also common among sleeve gastrectomy patients and this has increased the risk of nutrient deficiencies, especially iron and vitamin B-12.[31] Future studies should consider the inclusion of biochemical data to identify the presence of vitamin and mineral deficiencies. Moreover, the effects of several gastrointestinal hormones, which interfere with appetite and metabolism, such as ghrelin, leptin, and neuropeptide Y-Y could be explored to determine its association with nutritional status.

Psychosocial variables such as binge eating, depression, family and peer support are not significantly associated with overall rate of weight loss. Majority of the subjects in this study are in the initial phase of which massive weight loss would occur and this may mask the influence of other variables. De Zwaan et al (2011) found that depression is associated with slower weight loss two years after surgery and not one year post-operation.[10] Legenbauer et al (2011) also reported similar findings in which binge eating and depression have no statistical significance on short-term weight loss after bariatric surgery.[32]

Bariatric surgery is able to produce dramatic weight loss. In this study, the rate of weight loss at three months is higher compared to the overall rate of weight loss. This was in agreement with the studies by Bock et al (2003)[33] and Collene et al (2003).[34] These studies have found that the fastest rate of weight loss occur within the first three months after bariatric surgery. Dietary intake analysis reports that the mean caloric intake of most of the participants are very low after bariatric surgery. Poor appetite, increased feeling of fullness, and vomiting after eating are the possible reasons for this. Zieglar et al (2009) has reported that post-bariatric surgery patients are required to eat slowly and chew solid food well to avoid gastrointestinal symptoms such as vomiting, nausea, and bloating.[35] The result of the current study also show that the mean protein intake between men and women, 38.0 ± 16.6 gram vs 25.2 ± 14.1 gram, are lower than the recommendation. Post bariatric surgery patients are required to consume at least 60 grams of protein per day for preservation of lean body mass and to avoid protein calorie malnutrition.[36]

Findings of this current study demonstrates that binge eating and depression are closely related to each other. Subjects who are depressed are vulnerable to develop inappropriate eating behaviours, which might affect adherence to post-operative dietary regimens. Failure to manage binge eating may result in depression, weight gain, and poor quality of life. This is in agreement with the study by Hsu et al (2002)[37] and Azarbad et al (2010)[38] which have reported that binge-eating respondents have lower self-esteem, poorer sense of personal effectiveness, disturbed self-attitudes and higher levels of depression.

Since there are very limited studies done on the nutritional and psychosocial aspects of bariatric surgery in Malaysia, the results of this study would be very beneficial for future long-term research conducted in this field. Moreover, this is one of the first studies in Malaysia to explore the role of family and peer support after bariatric surgery. Although this study has managed to identify the short-term predictors of the overall rate of weight loss, the results of the current study must be interpreted in the context of several limitations. Firstly, this study is conducted as a cross-sectional study. The suggestion would be for a prospective study to be conducted to enable the study of several other factors which interfere with the overall rate of weight loss. Furthermore, this study has included a rather small sample size because bariatric surgery is recently initiated in UKMC (since January 2012).

Bariatric surgery candidates in UKMMC are from various states in Malaysia. Thus, some of the patients have failed to come for their regular check-ups due to far distances or busy working schedules. Only 43 patients who have visited the Obesity Clinic meet the inclusion criteria of the current study. Lee and Wang (2005) has reported that only 35 cases of bariatric surgery were reported from 1996 until 2004 in Malaysia.[39] Moreover, in 2004, only two cases of bariatric surgery have been reported in Malaysia. Since bariatric surgery has started to gain popularity in Malaysia, the sample size of 43 is representative of the bariatric surgery population in Malaysia. The body composition data collected in this study has been reported as descriptive statistics and not suitable to be compared among the respondents because they are at different points of time after surgery.

Conclusion

Most of the micronutrient intakes especially vitamin B_1, B_2, B_3, folic acid, iron and vitamin C met the RNI due to supplementations in addition to dietary intake. However,

calcium, selenium, zinc and vitamin D intakes were not able to meet the RNI. Thus, proper nutrition education and strict surveillance of eating patterns were very essential tasks of dieticians to ensure improvement in nutritional status of the post-bariatric surgery patients. Preoperative weight was found to be the most important short-term predictor affecting overall rate of weight loss. In addition, depression and binge eating were found to be inter-related in this study. Thus, further interventions were required from the psychiatrist to manage these problems in order to improve the quality of life of the post-bariatric surgery patients.

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Original Article

Association between nutrient adequacy and psychosocial factors with overall rate of weight loss after bariatric surgery

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减肥手术患者营养充足和心理社会因素与总失重率的关系

该研究是一项横断面研究，旨在探讨减肥手术患者营养摄入和社会心理因素与总失重率的关系。研究对象为来自马来西亚 Kebangsaan 大学医疗中心接受袖状胃切除术的患者（UKMMC）。共招募 43 名受试者（15 名男性和 28 名女性）参加了本研究，受试者完成的问卷中有暴饮暴食规模（BES）、Beck 抑郁问卷（Beck）、家庭支持和同伴关系指标（IPR）等。结果表明，总失重率的中位数为 4.3±5.5 千克/月，低于 3 个月时的 5.0±5.6 千克/月。术前体重是总失重率的预测因子（$p<0.05$，$R^2=0.52$）。减肥手术患者暴饮暴食和抑郁之间有密切相关（$p<0.001$，$R^2=0.46$）。对饮食建议有良好依从性的患者暴饮暴食得分较低。减肥手术患者平均热量和蛋白质的摄入量非常低，只有 562±310 千卡/天和 29.6±16.1 克/天，维生素 A、B-1、B-2、B-3、B-12、C、叶酸和铁的摄入量达到马来西亚的推荐摄入量（RNI）。然而，钙、锌、硒、维生素 D 和维生素 E 的摄入量未达到 RNI。总之，虽然减肥手术对健康有很多好处，有几个因素阻碍了减肥手术后减重，医护人员应密切监测减肥手术后患者。

关键词：肥胖、减肥手术、暴饮暴食、抑郁、失重率