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Original article

The Influence of Health Literacy and Health Numeracy on Weight Loss Outcomes Following Bariatric Surgery

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Abstract

Background: Although cognitive functioning and health literacy are related to weight loss 1 year following bariatric surgery, the influence of health numeracy (i.e., health-related mathematical abilities) is unknown. In addition, further research is needed to examine the impact of all these factors on longer-term weight loss outcomes to determine if they influence the ability to maintain weight loss.

Setting: Single bariatric center.

Methods: Patients (N = 567) who underwent bariatric surgery from 2014–2017 completed a brief survey including current weight. Retrospective chart reviews were conducted to gather information from the presurgical evaluation including weight, body mass index (BMI), health literacy, health numeracy and score on a cognitive screener.

Results: Among participants in the weight loss period (< 2 years postsurgery), health literacy, health numeracy and cognitive functioning were not related to change in BMI (Δ BMI), percent total weight loss (%TWL) or percent excess weight loss (%EWL). However, for participants in the weight maintenance period (2–4 years postsurgery), higher health literacy scores were related to greater change in Δ BMI, and higher health numeracy scores were related to greater Δ BMI, %TWL, and %EWL.

Discussion: Although health literacy and health numeracy did not predict weight loss outcomes for those in the initial weight loss period, they were related to weight outcomes for participants in the weight maintenance period. This suggests that health literacy and health numeracy may play a role in facilitating longer-term weight maintenance among patients who undergo bariatric surgery. Clinicians conducting presurgical psychosocial evaluations should consider routinely screening for health literacy and health numeracy. (Surg Obes Relat Dis 2021;17:384–389.) © 2020 American Society for Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

Key words:

Bariatric Surgery; Weight Loss; Health Literacy; Health Numeracy; Cognitive Functioning

Bariatric surgery is the most effective method to assist patients with severe obesity in achieving and maintaining significant weight loss [1]. Despite the ability to lose a

considerable amount of weight with these procedures, there is variability in the amount of weight loss and 50%–80% of patients experience weight regain [2–4]. As such, it is vital to identify factors influencing weight loss to assist patients in achieving maximum weight loss and maintenance.

One means of identifying factors associated with postsurgical weight loss is the presurgical psychosocial evaluation. Before undergoing bariatric surgery, it is routine for patients

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to complete a psychosocial evaluation, which typically assesses weight history, eating disorder symptoms, current stressors, social support, and psychosocial history [5]. Another common area of assessment is cognitive functioning, which influences the capacity to provide informed consent, ability to sustain realistic expectations regarding potential improvement of medical co-morbidities and weight loss after surgery, and adherence to long-term lifestyle changes [5,6]. During the early postsurgical period (i.e., 1 year postsurgery), those with lower cognitive functioning scores are less likely to adhere to postsurgical guidelines [7]. Furthermore, the domains of attention/executive functioning and verbal memory before bariatric surgery are associated with body mass index (BMI) 1 year postsurgery [8]. Hence, global cognitive function is an important determinant of postsurgical outcomes.

Cognitive functioning is also associated with health literacy [9–13]. Health literacy is defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” [14]. Health literacy skills can specifically be categorized into those which involve speaking and listening (oral literacy), reading and writing (print literacy), and numeracy [15]. Health numeracy is defined as “the degree to which individuals have the capacity to assess, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions” [16].

Approximately 26% of Americans have limited health literacy [17]. Limitations in health literacy and health numeracy have been associated with increased emergency room visits and hospitalizations, decreased use of preventative services, improper use of medications, insufficient understanding of medication labels, poorer overall health status and higher all-cause mortality [18]. Because of the negative effects on health outcomes, research has begun to examine the prevalence of limited health literacy and health numeracy among bariatric surgical candidates. One study found that out of 314 patients undergoing bariatric surgery, 9.6% had limited health literacy, 24.2% had limited health numeracy, and 29.5% had probable cognitive impairment [19]. It could be expected that these variables will influence outcomes after bariatric surgery since they impact health outcomes in other patient populations [18]. Recent studies have found that those with better health literacy had better weight loss outcomes 1-year postsurgery [20,21]. However, the relationship between health numeracy and weight outcomes after bariatric surgery has not been studied. Furthermore, it is also important to examine how cognitive functioning, health literacy and health numeracy relate to outcomes further out from surgery. Patients are expected to lose their maximum weight at about 2 years following surgery [22], and because health literacy and health numeracy are necessary for the comprehension of nutrition

labels [23], health literacy and health numeracy may play a larger role in weight loss outcomes once patients reach the weight maintenance period. The purpose of this study was to examine the effects of cognitive functioning, health literacy and health numeracy on weight loss outcomes in those in the weight loss period versus those in the weight maintenance period.

Methods

Participants

All patients who underwent a bariatric surgery procedure (i.e., Roux-en-Y gastric bypass or sleeve gastrectomy) from 2014–2017 at a single institution were invited to complete an online survey between March and April 2018.

Measures

Current weight

As a part of the survey, participants reported their current weight. Self-reported weight yields high concordance with objective weight in this population [24].

Retrospective chart reviews: A chart review was conducted to obtain presurgical data. All patients pursuing bariatric surgery undergo a required presurgical surgical consultation, which records their height, weight and BMI, as well as a required psychosocial evaluation. Data gathered from the psychosocial evaluation included the following routinely used measures:

Health literacy

The Rapid Estimate of Adult Literacy in Medicine (REALM) is a validated measure that asks patients to read words verbally and estimates a patient’s reading grade level [25]. Participants were determined to have an adequate reading ability if they had at least a ninth grade reading level or limited ability if they scored below a ninth grade level.

Health numeracy

Health numeracy was measured by the Brief Medical Numbers Test in which participants respond to 4 mathematical problems [26]. This measure was validated in a presurgical sample and participants were considered to have limited health numeracy level if they responded to fewer than all 4 mathematical questions correctly [26].

Cognitive functioning

The Montreal Cognitive Assessment (MoCA) was utilized to screen for cognitive difficulties [27]. Scores range from 0 to 30 and participants were categorized as having lower cognitive functioning if they scored below the validated cutoff score of 26.

Table 1
Demographic characteristics of participants

	Total sample		Weight loss period		Weight maintenance period		<i>t</i>	<i>P</i> value
	M	SD	M	SD	M	SD		
Age at time of surgery	45.7	10.3	45.9	10.5	45.5	10.1	.44	.66
Baseline BMI	48.1	7.8	47.6	7.7	48.6	7.9	-1.53	.13
	n	%	n	%	n	%	χ^2	<i>P</i>
Gender								
Female	476	84.1	260	84.7	215	83.7	.11	.74
Male	90	15.9	47	15.3	42	16.3		
Race								
White	303	53.4	163	61.3	140	64.8	.91 ^a	.34
Black	182	32.1	106	38.7	76	35.2		
Other/Missing	82	14.4						
Surgery type								
Sleeve gastrectomy	378	67.0	211	68.7	167	65.0	.89	.35
RYGB	186	33.0	96	31.3	90	35.0		

SD = standard deviation; BMI = body mass index; RYGB = Roux-en-Y gastric bypass.

^a Chi-square analysis is only comparing White and Black patients.

Procedures

This project was approved by the health system's IRB and consent was obtained from all participants. This study was part of a larger project in which participants completed a brief online survey, which requested that participants report their current weight. There were 567 patients who responded to the survey (response rate 39.2%). Based on the time elapsed since undergoing surgery, participants were categorized into the weight loss period (i.e., < 2 years postsurgery) or the weight maintenance period (i.e., 2–4 years postsurgery). We calculated the recommended standardized weight loss outcomes based on height/weight/BMI measurements taken at the presurgical consultation and the self-reported weight at the time of the survey, including change in BMI (Δ BMI), percent total weight loss (%TWL), and percent excess weight loss (%EWL).

Results

Demographic characteristics of participants are located in Table 1. There were 307 (54.4%) participants who were categorized in the weight loss period and 257 (45.6%) in the weight maintenance period. There were no significant differences in age, presurgical BMI, gender, race or type of surgery between those in the weight loss and weight maintenance periods (Table 1).

There were 5.2% ($n = 27$) of patients with limited health literacy, 18.8% ($n = 98$) with limited health numeracy and 31.6% ($n = 165$) with lower cognitive functioning (MoCA; $M = 26.7$, $SD = 11.5$). Those with lower cognitive functioning were more likely to have limited health literacy ($\chi^2 = 18.30$, $P < .001$; $\phi = .20$, $P < .001$) and limited health numeracy ($\chi^2 = 10.95$, $P = .001$; $\phi = .13$, $P = .001$); however, there was not a significant finding for those with

limited health literacy and health numeracy ($\chi^2 = .11$, $P = .74$). There were only 4 participants (.8%) who had limited abilities in all 3 areas. Because age is often related to cognitive functioning and weight loss outcomes postsurgery, we explored how age was related to these variables. Age was not related to cognitive functioning ($t = .68$, $P = .50$), health literacy ($t = -1.42$, $P = .16$), or health numeracy ($t = .02$, $P = .95$), nor was age correlated with Δ BMI ($r = -.06$, $P = .16$), %EWL ($r = .05$, $P = .23$), or %TWL ($r = -.01$, $P = .90$). Thus, we did not include age as a factor in additional analyses.

For participants in the weight loss period, health literacy, health numeracy and cognitive functioning were not related to Δ BMI, %EWL or %TWL (Table 2). For participants who were in the weight maintenance period, higher scores on health literacy were related to greater %EWL and higher scores on health numeracy were related to greater Δ BMI, %EWL and %TWL (Table 2). Cognitive functioning was not related to weight loss outcomes among those in the weight maintenance period. When examining the independent prediction of health literacy and health numeracy on %EWL, health numeracy remained statistically significant ($\beta = .29$, $P = .02$), while health literacy was no longer a significant predictor ($\beta = .11$, $P = .38$).

Discussion

The findings from this study suggest that health literacy and health numeracy may not influence weight loss outcomes within the first 2 years following surgery; however, they may impact weight loss outcomes once patients reach the weight maintenance phase. Specifically, health numeracy had small to medium effect sizes on weight loss outcomes and health literacy had a medium effect size in

Table 2
Relationships between cognitive abilities and weight loss outcomes

	Weight loss period						Weight maintenance period					
	Δ BMI		%EWL		%TWL		Δ BMI		%EWL		%TWL	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Health literacy	.03	.85	.17	.28	.07	.66	.09	.44	.23	.047	.16	.18
Health numeracy	-.02	.82	.02	.77	.01	.94	.16	.01	.13	.047	.17	.01
Cognitive functioning	.04	.54	.004	.95	.05	.44	.02	.79	-.02	.76	.002	.98

Δ BMI = change in BMI; %EWL = percent excess weight loss; %TWL = percent total weight loss.

predicting %EWL, although when also accounting for health numeracy, the effect was small. These results demonstrate that deficits in these domains may impair weight maintenance more than initial postsurgical weight loss. There are several potential explanations for these findings. Weight recidivism, which occurs during the weight maintenance period, is multifactorial and thought to be related to poor nutritional compliance, hormonal imbalances, mental health factors, lack of physical activity and surgical factors [28]. Poor follow-up with nutritional services, overall increased caloric intake and poor adherence to the postsurgical diet are thought to be responsible for weight regain [28]. Therefore, it is possible that those with lower levels of health numeracy and health literacy may have difficulty adhering to the dietary and lifestyle changes necessary to maintain weight loss. This aligns with existing research that cognitive functioning and health literacy are positively correlated with adherence [7,29]. This may also extend to individuals with lower health numeracy, who may have more difficulty interpreting numerical information (i.e., understanding nutrition labels and tracking nutrition), which could contribute to poorer weight loss following bariatric surgery [23].

Interestingly, weight loss outcomes in the present study were not related to cognitive functioning, despite existing research showing that presurgical cognitive functioning predicted weight loss outcomes at 1 year postsurgery [8]. One potential explanation for this is that this study used a screening measure of cognitive functioning whereas previous research used more extensive measures. Alternatively, the lack of significant findings could be because many patients experience improvement in cognitive functioning during the 3 years following bariatric surgery [30]. Thus, presurgical cognitive functioning may not be as useful a predictor as current cognitive functioning. In addition, cognitive functioning was related to health literacy and health numeracy in this sample as well as among bariatric surgery candidates [19]. It is possible the variance in postsurgical weight loss is better explained by health numeracy and health literacy which may be less impacted by postsurgical weight loss and improvements in medical co-morbidities (e.g., sleep apnea, hypertension) than cognitive functioning. In addition, it is also possible that those with limited abilities in all areas may have the poorest outcomes; however, we

were unable to examine this in the present study given that only 4 participants were identified to have lower cognitive functioning, limited health literacy and limited health numeracy.

Results from the present study illustrate the importance of assessing health literacy and health numeracy before patients undergoing bariatric surgery. Although it is recommended that cognitive functioning be assessed presurgically [5], there are no recommendations regarding the assessment of health literacy and health numeracy. If patients with low health literacy and/or health numeracy are identified, additional support could be provided which may optimize patient outcomes. For example, providers in bariatric programs could ensure that patients have social support and/or provide additional instruction to assist with tasks related to these areas. This may also encourage providers to routinely follow up with patients postsurgery, including in the weight maintenance phase, to assess whether patients understand diet and exercise recommendations and provide further education, if needed. A meta-analysis [29] and systematic review [31] illustrated the benefits of health literacy interventions on several health-related outcomes, highlighting the potential for these types of interventions to be helpful in promoting postsurgical weight loss among those with low health literacy. Future research should evaluate whether these interventions improve weight loss outcomes.

One limitation of the present study is the potential for response bias given those with limited health literacy or cognitive functioning may be less likely to complete an online survey. Indeed, the prevalence rates of low health literacy (5.2%), health numeracy (18.8%), and cognitive functioning (31.6%) of participants in this study are somewhat lower or comparable to the rates (9.6%, 24.2%, and 29.5%, respectively) we found among all patients undergoing a presurgical bariatric psychosocial evaluation at our center [19]. However, in that study, patients with lower levels of health literacy, health numeracy and cognitive impairment were less likely to undergo surgery, suggesting that rates in this study may be similar to all of those who undergo surgery. Additionally, because there was a relatively small prevalence of individuals with low health literacy in this study, there is the potential that we would have found significant differences for other weight loss outcomes if

the sample were larger and more varied. Replication of this study with a larger sample of individuals would be valuable. As mentioned, participants self-reported their current weight. Although self-reported weight is highly correlated with objectively measured weight [24], an objective measure of weight would be useful. Finally, we did not have data on co-morbid medical conditions, which could potentially be related to cognitive functioning and weight loss outcomes.

Conclusions

This study highlights the importance of examining presurgical health literacy and health numeracy as they have a small to medium effect on weight loss outcomes for patients, especially those who are 2–4 years postsurgery. Better health literacy and health numeracy may assist with weight maintenance and potentially guard against weight regain following bariatric surgery. Future research should evaluate which factors are responsible for this phenomenon (i.e., whether adherence mediates the relationship between lower levels and weight loss outcomes) and whether interventions targeting health literacy and health numeracy improve weight loss outcomes. It would also be important to ascertain whether health literacy and health numeracy improve postsurgically, as has been documented with cognitive functioning [30]. Given these findings, providers should consider evaluating health literacy and health numeracy during the presurgical psychosocial assessment for bariatric surgery.

Disclosures

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