Original Investigation | Nutrition, Obesity, and Exercise

Assessment of Physical Activity and Healthy Eating Behaviors Among US Adults Receiving Bariatric Surgery

Young-Rock Hong, PhD, MPH; Sandhya Yadav, PhD, MHA, BDS; Ryan Suk, PhD, MS; Alexandra M. Lee, PhD; Faith A. Newsome, BA; Crystal N. Johnson-Mann, MD; Michelle I. Cardel, PhD, MS, RD; Kathryn M. Ross, PhD, MPH

Abstract

IMPORTANCE Bariatric surgery effectively treats severe obesity and metabolic diseases. However, individual outcomes vary depending on sustainable lifestyle change. Little is known about lifestyle patterns after bariatric surgery among the US population.

OBJECTIVE To compare the level of physical activity and eating behavior among postbariatric surgery patients, individuals eligible for surgery, and those with normal weight.

DESIGN, SETTING, AND PARTICIPANTS A cross-sectional study using nationally representative survey data from National Health and Nutrition Examination Survey 2015-2018. Respondents included for analysis were age 18 years or older, and categorized by individuals with normal weight, individuals who received bariatric surgery, and individuals clinically eligible for bariatric surgery. Analyses were performed from February to October 2021.

MAIN OUTCOMES AND MEASURES Self-reported measures were used to assess physical activity (moderate-to-vigorous physical activity [MVPA], sedentary activity, and whether PA guidelines were met) and eating behaviors (total energy intake and Healthy Eating Index [HEI]–2015 diet quality scores).

RESULTS 0f04659 study1.pn 7nores).c191.9(intatn 7normintatn 70(8)-191.9(y4uals)6.5(s)9.7-191.9.)6.3601intatn 7n.7(e)-4.7(3.36061.9mintatn 7-191.9(old;in

Abstract (continued)

improvements seemed suboptimal based on the current guidelines. Efforts are needed to incorporate benefits of physical activity and a healthy, balanced diet in postbariatric care.

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Introduction

Obesity is a well-established risk factor for multiple chronic conditions, including metabolic exempt from review by the University of Florida institutional review board because we used deidentified and publicly available data. To report our findings, we followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Study Population

Our initial sample included 11 848 participants aged 18 years or older. We categorized the individuals into 3 mutually exclusive groups: (1) individuals with normal weight (BMI range, 18.5-24.9), (2) individuals who received bariatric surgery (self-reported to have received bariatric surgery), and (3) individuals clinically eligible for bariatric surgery but reporting no receipt of bariatric surgery. Eligibility for bariatric surgery was identified according to the ASMBS recommendation of having a BMI of 40 or higher (severe obesity) or a BMI of 35 or higher with at least 1 obesity-related comorbidity (including hypertension, diabetes, chronic obstructive pulmonary disease [COPD], liver disease, hyperlipidemia, and any CVD).[21] Those who did not fall in these groups (those with underweight BMI below 18.5, 188 respondents; did not meet the surgery eligibility, 6339 respondents) or with missing data on key study variables (662 respondents) were excluded (**Table 1**). The final study sample included 4659 participants.

Outcome Variables

participants in the analysis.[29,30] Covariates used in adjustments included participants' age, self-reported race and ethnicity (non-Hispanic Black, non-Hispanic White, or other [Asian, Hispanic, and multiple races]), education (high school or less, some college, college 4 years or more), family income (low, below 100% of federal poverty level [FPL]; middle, 100%-200% of FPL; high, above 200% of FPL), health insurance (private, public, uninsured), general health status (excellent or good, fair or poor), current smoking status, mobility limitation (difficulty walking), diagnosis of cardiovascular disease (CVD), cancer, diabetes, hypertension, hyperlipidemia, and COPD. We aggregated self-identified Hispanic, Asian, or multiracial participants into other race and ethnicity group because of small sample size. To create a propensity score for receiving bariatric surgery, we used a survey design–adjusted logistic regression procedure.

Table 1. Characteristics of Study Participants

	Re de , N . (eigh ed %)[a]				P e i - c e eigh ed e de , N . (eigh ed %)[b]				
Cha ac e i ic	N a eigh (= 2906)	Had ba ia ic ge (= 132)	E igib e b ge (= 1621)	*P* a e	N a eigh (= 2403)	Had ba ia ic ge (= 121)	E igib e b ge (= 1496)	*P* a e	*P* a e ba ia ic e igib e g
BMI, mean (SD)	22.4 (2)	35.6 (7)	41.9 (6)	<.001	NA	NA	NA	NA	NA
Mean (SD) age, y	43.8 (20)	52.2 (12)	49.6 (16)	<.001	51.8 (19)	52.8 (12)	53.9 (16)	.18	.45
Sex									
Women	1536 (57.2)	105 (78.5)	997 (59.8)	<.001	1266 (78.4)	96 (77.5)	915 (76.5)	.95	.85
Men	1370 (42.8)	27 (21.5)	624 (40.2)		1137 (21.6)	25 (22.5)	581 (23.5)		
Race									
Non-Hispanic Black	576 (10.3)	40 (12.7)	498 (16.2)	<.001	472 (8.9)	36 (12.7)	456 (18.1)	.17	.32
Non-Hispanic White	969 (64.7)	51 (69.3)	550 (62.2)		860 (71.5)	48 (69.6)	525 (66.3)		
Other[c]	1361 (25.0)	41 (18.0)	573 (21.5)		1071 (19.6)	37 (17.7)	515 (15.6)		
Education									
High school or less	1106 (32.8)	40 (25.2)	704 (37.9)	<.001	990 (21.9)	37 (26.2)	664 (31.1)	.09	.30
Some college	721 (28.2)	53 (28.2)	601 (38.0)		661 (23.9)	48 (29.1)	573 (34.9)		
College ≥4 y	831 (39.0)	39 (46.6)	282 (24.1)		752 (54.2)	36 (44.7)	259 (34.0)		
Family income[d]									
Low	866 (22.9)	29 (15.1)	529 (23.8)	.08	683 (14.3)	27 (16.7)	472 (19.3)	.85	.85
Middle	680 (18.3)	26 (11.7)	422 (20.0)		568 (10.8)	23 (11.5)	391 (12.4)		
High	1340 (58.8)	77 (73.2)	670 (56.2)		1152 (74.9)	71 (71.8)	633 (68.2)		
Health insurance									
Private	1196 (51.0)	65 (55.6)	557 (44.6)	.006	977 (53.6)	57 (51.4)	532 (48.9)	.98	.95
Public	1247 (35.0)	58 (35.7)	829 (43.2)		1050 (37.1)	56 (39.2)	751 (41.5)		
Uninsured	457 (14.0)	9 (8.7)	232 (12.2)		376 (9.3)	8 (9.4)	213 (9.4.3(61Sel59 1 gs q 1 0 0 92410.5(48)-215.9((69.6)		

Statistical Analysis

To compare baseline characteristics across surgery and BMI groups, we used first-order Rao-Scott χ^2 tests. We fit multiple general linear models to examine the mean of physical activity levels (minutes per week of MVPA, minutes per day of sedentary activity, and proportion of meeting physical activity guidelines), HEI scores, and total energy intake between the 3 study groups. Each study outcome was examined in a separate model. SAS PROCSURVEY procedures were used for population

Table 2. Comparison of PA Levels Between Normal Weight, Bariatric Surgery, and Surgery-Eligible Groups

	E i a e (95% CI)	
O c e		

and had lower total energy intake (294 kcal/d lower) than those who were surgery-eligible but did not receive surgery. However, further analysis showed that receipt of bariatric surgery was not associated with meeting PA guidelines or higher dietary quality (as measured by HEI). Taken together, our findings suggest that long-term weight loss achieved through bariatric surgery is unlikely to result in individuals meeting the current minimum recommended levels of MVPA (over 150 min/wk) or diet quality recommendations and likely reflect significant physiological changes and reductions in energy intake. Further intervention from health care professionals may be needed to support higher levels of physical activity and diet quality in postoperative bariatric patients.

Change in physical activity and sedentary behavior after bariatric surgery is a growing area of interest.[31-33] Although earlier studies focused on postsurgery physical activity in the short-term,[32-35] a novelty and strength of our study was that it captured physical activity in varying time frames (median 7 years) after bariatric surgery in the general population. More in-depth understanding of these lifestyle behaviors seems to be needed to maximize the long-term health benefits of surgical weight reduction. Our findings appear to concur with previous studies that show improvements in active time following bariatric surgery, given that the surgery group had a higher mean MVPA than the surgery-eligible group.[31,36] However, it is important to consider the activity intensity and postsurgery time frame, as these may affect the interpretation of our results. For example, a 2016 study by Afshar and colleagues[36] found no significant change in physical activity before and 6 months after bariatric surgery using subjective and device-based measures of physical activity.

Surgical recovery may impede engagement in MVPA while the body is healing and the patient is adjusting to new eating patterns. A longitudinal study[37] conducted in bariatric surgery patients found that 47% of postoperative bariatric patients were sedentary or somewhat active, while 14% were active and 6% were highly active. In those studies, participants mainly reported participating in physical activity through activities in daily living (eg, playing with children, gardening) rather than structured physical activity regimens, suggesting the importance of assessing daily activities as a proxy for physical activities in patients who have undergone bariatric surgery. For example, measuring total physical activity volume throughout the day, like step counts, may be a more useful indicator of activity in this patient population given the focus of recent physical activity guidelines.[38]

There are a few factors that may explain lower physical activity rates in bariatric surgery patients compared with patients with normal weight. First and foremost, patients with obesity are more likely to be stigmatized while participating in physical activity.[39,40] Second, a recent study suggested that physical activity recommendations applicable to the general population may not be realizable for postbariatric surgery patients because of persistent physical and mental health challenges that remain after bariatric surgery.[36,41] Additional support for setting realistic goals and achieving behavioral change within the domain of physical activity (eg, incorporating lessons on SMART [Specific, Measurable, Achievable, Relevant, and Time-bound] goals) may be beneficial components for both preoperative and postoperative education programs.[42] More substantive, direct, intentional work is necessary to promote dietary and lifestyle behaviors among postbariatric patients.

Although not statistically significant, we showed a potentially meaningful difference in sedentary behavior between those who underwent surgery and those who were eligible but did not, which may show a decrease in sedentary behavior (36 minutes less per day) and a corresponding increase in light intensity physical activity for those who underwent surgery. Vatier and colleagues[43] also found a decrease in sedentary behavior after bariatric surgery independent of differences in physical activity, and suggested that this may be a result of favorable changes in body composition. The latest PA guidelines suggest "a strong relationship between time in sedentary behavior and the risk of all-cause mortality and cardiovascular disease mortality in adults."[38] Because the risk related to sedentary behavior is not dependent on the duration of MVPA, a decrease in prolonged periods of

Strengths and Limitations

The primary strength of this study was that we used data from a recent nationally representative sample from the NHANES (representing 100 million US adults), which included validated measures of diet and physical activity-related assessments. Nevertheless, this study has several limitations. First, we were not able to run analyses that incorporated time since the surgery date due to the manner in which this would limit the sample size and generate unreliable estimates.[51] Given that most weight regain occurs between 2 and 5 years after surgery,[13,14] additional studies with a greater sample size are needed to further understand lifestyle patterns during early postsurgery period and long-term health outcomes.[15,16] Second, information on the type of surgery (eg, gastric sleeve, gastric bypass, duodenal switch) was not available in the NHANES data. Third, since we used self-reported data, our findings may be subject to recall bias. For example, self-reported MVPA data often have a right-skewed distribution, resulting in overreporting of MVPA. Thus, average minutes of physical activity reported should be interpreted with caution. Moreover, we relied on self-reported 24-hour dietary recall data to assess energy intake. Although NHANES dietary data are validated and considered reliable,[23,24] it may be inadequate to assess total usual energy intake because of the timeframe of measure (eg, seasonal variation) and variations in individual intake.[52] Fourth, this was a cross-sectional study, which limited causal inference of study findings. Lastly, we used the propensity score-weighting approach to minimize the selection bias of receipt of bariatric surgery[29,30]; however, this was based on available data, and we could not adjust for unobserved factors (eg, insurance coverage, provider information). Future studies with longitudinal data are warranted to confirm findings in this study.

Conclusions

The current study examined physical activity and eating behavior in a representative sample of US adults who either were normal weight with no history of bariatric surgery, underwent bariatric surgery, or were eligible for bariatric surgery but had not undergone the procedure. Results demonstrated that individuals who underwent bariatric surgery showed higher engagement in physical activity and lower total energy intake compared with those eligible for the surgery. However, these improvements were not aligned with the current physical activity recommendations. By incorporating behavior change strategies that focus on reducing sedentary behavior and increasing

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