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Weekend Variation in Ultra-Processed Food Intake of Patients after Metabolic and Bariatric Surgery: A Cross-Sectional Study

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Abstract: This study analyzed changes in ultra-processed food consumption patterns during weekends in patients in the post-metabolic and bariatric surgery periods. It is a cross-sectional study, which recruited and collected data via social media from adults who underwent metabolic and bariatric surgery. The Brazil Food and Nutritional Surveillance System markers of dietary consumption and the NOVA Ultra-Processed Food Screening tools were applied to evaluate dietary patterns and ultra-processed food consumption from the previous day. A total of 1525 participants were included, with a mean age of 38 ± 8 years and a mean body mass index of 29.9 ± 5.8 kg/m^2. From these, 766 (50.3%) individuals answered the questionnaire referring to a weekend day. After adjusting for confounders, ultra-processed food consumption was higher on weekends compared to weekdays (NOVA Score 3.07 vs. 2.42; $p < 0.01$). The consumption of fruits and vegetables was lower on weekends, whereas the consumption of hamburgers/sausages, sugar-sweetened beverages, boxed/canned juice, and frozen pizza increased on weekends. Instant noodles and sandwich cookies did not show differences between weekdays and weekend days. This pattern suggests the need to monitor eating habits on weekends in individuals after metabolic and bariatric surgery.

Keywords: bariatric surgery; dietary patterns; ultra-processed foods

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1. Introduction

Body weight reduction poses a challenge for individuals with obesity, as the difficulties faced extend beyond a single factor, impacting their daily routines, customs, and lifestyle habits. In this context, alcohol abuse, a sedentary lifestyle, and especially inadequate dietary habits are intrinsically associated with the persistence of overweight status experienced by these individuals [1]. Obesity is a major challenge in the global public health arena, being a risk factor for the emergence of non-communicable chronic diseases, with over 1 billion affected individuals reported in 2022. In the Brazilian context, approximately 863,086 people have been diagnosed with grade III obesity, characterized by a body mass index (BMI) exceeding 40 kg/m^2 [2].

In this context, metabolic and bariatric surgery (MBS) has been seen as a potential solution for individuals with obesity who have difficulty losing weight [3]. However, there are specific indications for surgical intervention in people with obesity but with a BMI between 30 and 35 kg/m^2 [4]. However, MBS does not constitute a definitive solution, requiring patient commitment to lifestyle modifications in the perioperative period. These adjustments include adopting a balanced and healthy diet, regular physical exercise, and strict adherence to postoperative medical guidelines [5,6]. MBS effectively provides an opportunity to reinvigorate the weight loss trajectory; however, achieving sustained long-

term success depends on sustained nutritional monitoring and further weight loss before surgery [7].

However, maintaining healthy lifestyle habits, particularly regarding nutrition, often proves challenging to adhere to. Currently, the food chain is filled with ultra-processed foods (UPFs), known for their high caloric content and widespread presence in modern diets [8]. These foods are widely prevalent in the diets of populations in developed countries. They are increasingly present in developing nations as well [9], causing negative impacts on both health and the ability of obese individuals to lose weight [10]. However, the consumption of more natural and minimally processed foods, along with reduced energy intake, is associated with significant improvements in health and weight loss [11,12].

Despite evidence pointing to the detrimental health effects of UPFs, avoiding their consumption proves to be a challenging task. In the general population, these foods appear to be the primary dietary choice on weekends, with higher consumption of sugar-sweetened beverages and pasta, along with other additives such as salt and fats, compared to weekdays [13]. Weekend habits directly influence weight gain or unsuccessful weight loss, primarily due to inadequate dietary choices and a low frequency of physical activity [14]. Foods characterized by ultra-processed traits, such as those high in sugar and fat, an increased consumption of sugar-sweetened and alcoholic beverages, the higher prevalence of fast foods, and a lower intake of fiber-rich foods like fruits and vegetables are the primary contributors to energy imbalance during this period [14–16]. Moreover, total energy intake on weekends is positively associated with BMI, with greater energy intake on these days being more pronounced in individuals with higher body weight [16].

Therefore, it is important to monitor weekend food consumption in population groups requiring strict weight control, such as individuals undergoing MBS. Given the invasive nature of the surgical procedures these individuals have undergone and the necessity of adhering to nutritional recommendations to prevent weight regain, these individuals may exhibit significant variations in their habits compared to the general population [17]. In this context, this article aims to investigate and analyze potential changes in UPF consumption patterns during weekends among post-MBS patients.

2. Materials and Methods

2.1. Ethical Aspects

This study was approved by the Research Ethics Committee of the Universidade Federal de Alagoas (protocol number: 60233722.7.0000.5013). All participants were presented with the Online Informed Consent Form through the Google Forms® platform. Upon accessing the survey link, participants were shown the Informed Consent Form, which appeared on the first page of the online questionnaire. Their acceptance of the terms was required to access the questionnaire and initiate data collection. If a participant declined to participate, they were redirected to a page displaying the message: "Thank you for your interest. You may close this page". The page included information about the research, the Informed Consent Form, the details of Ethics Committee approval (including the protocol number for study identification in the Research Ethics Committee), and contact information for the Research Ethics Committee of the Universidade Federal de Alagoas and the project coordinator.

2.2. Study Design

This is a cross-sectional study, reported according to the Strengthening the Reporting of Observational Studies in Epidemiology-Nutritional Epidemiology (STROBE-nut) guidelines [18].

2.3. Local and Sample

The study was conducted using a digital platform (Google Forms®). Brazilian individuals of both sexes, aged between 18 and 59, who had undergone any surgical technique

of MBS were included. Pregnant and lactating women and individuals who did not fully complete the questionnaires were excluded.

2.4. Recruitment

Participant recruitment was conducted in August 2022, following Research Ethics Committee approval. Official profiles on social media platforms (Instagram® and Facebook®) were used to disseminate information about the study and the link to access the data collection form. Additionally, participants were encouraged to share the research with potential participants within their social circles.

2.5. Variables

2.5.1. Social, Demographic, and Clinical Variables

All participants were asked to provide their age (in years), date of birth, education level, state, sex, and race/skin color. Additionally, participants were asked about medical diagnoses of hypertension and diabetes. Information regarding bariatric surgery, including surgical technique and date of surgery, was also collected.

2.5.2. Economic Class

The Brazilian Economic Classification Criteria (BECC) was used to establish the socioeconomic profile of participants. BECC consists of a list of 12 questions regarding the ownership of assets, the number of bathrooms in the residence, the number of full-time employees, the education level of the head of the household (the primary breadwinner), and details about the water supply and the street segment where the residence is located. BECC generates a score ranging from 0 to 100 points, where higher scores indicate higher monthly family income. Participants are classified into one of six possible economic classes: "A" (45–100 points), "B1" (38–44), "B2" (29–37), "C1" (23–28), "C2" (17–22), and "D-E" (0–16) [19].

2.5.3. Anthropometry

Anthropometric data were self-reported and included current weight (kg) and height (m). BMI was then calculated and categorized according to World Health Organization standards, classifying participants as underweight (BMI < 18.5 kg/m^2), normal weight (BMI between 18.5 and 24.9 kg/m^2), overweight (BMI between 25.0 and 29.9 kg/m^2), and obesity (BMI $\geq$ 30 kg/m^2) [20].

2.5.4. Determining the Days of the Week

To determine the day of the week, we observed the completion of the food questionnaire, which always referred to the previous day. In the response spreadsheet, the recorded date was checked and classified according to the days of the week. If the response date fell between Tuesday and Saturday, it was considered a weekday response (Monday to Friday). If the date corresponded to Sunday or Monday, it was considered a weekend response.

2.5.5. Food Consumption

The food consumption markers of the Food and Nutritional Surveillance System (SISVAN), based on the Dietary Guidelines for the Brazilian population [21], were applied to measure the food consumption of the sample. The questionnaire consists of 7 food items and records the food consumption frequency on the previous day. This includes healthy foods such as fresh fruits; vegetables; beans; hamburgers and/or sausages; sugar-sweetened beverages; instant noodles, packaged snacks and/or salty cookies; sandwich cookies, sweets, and/or treats [22].

2.5.6. Consumption of Ultra-Processed Foods (UPFs)

For the analysis of UPF consumption, the Ultra-Processed Food Consumption Screening [23] tool was used. This instrument assesses the consumption of 23 UPF groups that con-

tributed the most to the estimated daily energy intake in the National Food Consumption Survey conducted by the Brazilian Institute of Geography and Statistics in the Household Budget Survey of 2008–2009. The NOVA Score for each participant was calculated by summing scores from the 23 listed groups, ranging from 0 to 23 points. The UPF groups were divided into six subgroups as follows: (a) NOVA Score subgroup 1—beverages: soda, boxed or canned fruit juice, powdered drink mix, chocolate drink, tea-based drink, flavored yogurt; (b) NOVA Score subgroup 2—processed meats: sausage, hamburger or nuggets, ham, salami or bologna; (c) NOVA Score subgroup 3—savory snacks: sandwich bread, hot dog or hamburger buns, frozen French fries, instant noodles or soup packets, frozen pizza, lasagna or other frozen ready meals, packaged snacks, potato sticks or salty biscuits; (d) NOVA Score subgroup 4—sweets: sweet biscuits with or without filling, packaged cake, cereal bars, branded ice cream or popsicles, chocolate bars or bonbons, sweetened breakfast cereals; (e) NOVA Score subgroup 5—sauces: mayonnaise, ketchup, mustard, ready-made salad dressing; (f) NOVA Score subgroup 6—margarine: margarine [13].

2.6. Statistical Analysis

Continuous and categorical variables were presented as means, standard deviation, and frequencies, respectively. Multivariable Poisson regression models with robust variance adjustment were conducted to assess the association between the prevalence of UPF consumption and the day of questionnaire responses (weekday or weekend; independent variable), adjusted for sex, socioeconomic status, BMI (continuous), surgical technique, and time since surgery (in months). NOVA Score was compared using independent samples *t*-tests. All analyses were conducted using JAMOVI v. 2.3.21 (Sydney, Australia).

3. Results

In total, 1924 questionnaires were completed. After data verification, the removal of duplicates, and the application of inclusion and exclusion criteria, 399 were excluded, leaving 1525 individuals in the final sample of this study (Figure 1).

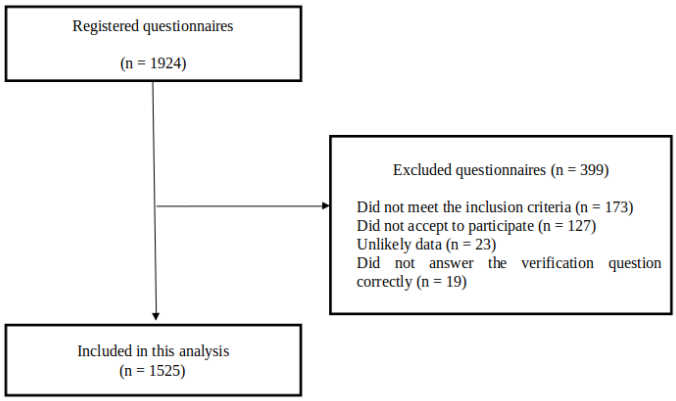

Figure 1. Flowchart of recruitment, inclusion, and analysis of eligible participants.

The mean age of the participants was 38 ± 8 years, and 1458 (95.6%) were female. The average BMI was 29.9 ± 5.8 kg/m^2. The individuals had a median of 12 months since surgery, with 70.2% (n = 1070) having undergone surgery less than two years ago, 7.5% (n = 115) between 2 and 5 years ago, and 22.3% (n = 340) 5 years ago or more. Table 1 presents the additional characteristics of the population, categorized by the day of questionnaire completion (whether a weekend or a weekday).

Table 1. Description of the sample according to demographic, social, economic, clinical, and anthropometric variables.

Variables	Sample (n = 1525)		Weekday (n = 759)		Weekend (n = 766)		*p*
	n	%	n	%	n	%	
Sex							
Female	1458	95.6	723 [a]	95.3	735 [a]	96.0	0.53
Male	67	4.4	36 [a]	4.7	31 [a]	4.0	
Race/skincolor							
White (Caucasian)	984	64.5	480 [a]	63.2	504 [a]	65.8	0.45
Black (Afro-descent)	102	6.7	47 [a]	6.2	55 [a]	7.2	
Brown	416	27.3	220 [a]	29.0	196 [a]	25.6	
Yellow (Asian)	23	1.5	12 [a]	1.6	11 [a]	1.4	
Economic class							
A	138	9.0	75 a	9.9	63 [a]	8.2	0.29
B1	282	18.5	134 [a]	17.7	148 [a]	19.3	
B2	633	41.5	313 [a]	41.2	320 [a]	41.8	
C1	340	22.3	180 [a]	23.7	160 [a]	20.9	
C2	117	7.7	49 [a]	6.5	68 [a]	8.9	
D-E	15	1.0	8 [a]	1.1	7 [a]	0.9	
Hypertension							
Yes	219	14.4	121 [a]	15.9	98 [a]	12.8	0.08
No	1306	85.6	638 [a]	84.1	668 [a]	87.2	
Diabetes mellitus							
Yes	112	7.3	64 [a]	8.4	48 [a]	6.3	0.11
No	1413	92.7	695 [a]	91.6	718 [a]	93.7	
Surgical technique							
RYGB	1206	79.1	575 [a]	75.8	631 b	82.4	<0.01
Sleeve	319	20.9	184 [a]	24.2	135 b	17.6	
Current BMI class							
Normal weight	311	20.4	141 [a]	18.6	170 [a]	22.2	0.01
Overweight	544	35.7	256 [a]	33.7	288 [a]	37.6	
Obesity	670	43.9	362 [a]	47.7	308 b	40.2	
Time since surgery							
Up to 2 years	1070	70.2	557 [a]	73.4	513 b	67.0	0.01
>2 years <5 years	115	7.5	47 [a]	6.2	68 b	8.9	
≥5 years	340	22.3	155 [a]	20.4	185 [a]	24.2	

Different letters in the columns indicate significant differences. RYGB: Roux-en-Y gastric bypass; Sleeve: sleeve gastrectomy; BMI: body mass index.

Table 2 presents the prevalence of food consumption compared between weekdays and weekends, according to the dietary intake markers and NOVA Score subgroups. In comparing the NOVA Score means, the average consumption on weekdays was 2.42 (2.09) compared to 3.07 (2.23) on weekends ($p < 0.01$). Fruit and vegetable consumption was higher on weekdays compared to weekends ($p < 0.01$). Conversely, the consumption of hamburgers and sausages was 10% higher on weekends, as was the intake of sugar-sweetened beverages and sodas overall. Additionally, boxed or canned juice consumption doubled on weekends, increasing from 5.9% to 9.9%, and there was a considerable rise in frozen pizza consumption, nearly three times higher on weekends compared to weekdays (13.5%).

Table 2. Prevalence of food consumption markers and dietary patterns in the sample and NOVA Score subgroups.

Variables	Sample (1525)		Weekday (n = 759)		Weekend (n = 766)		*p* [a]
	n	%	n	%	n	%	
Food Consumption Markers							
Fresh fruits	1001	65.6	523	68.9	478	62.4	<0.01
Vegetables	1123	73.6	583	76.8	540	70.5	<0.01
Beans	823	54.0	448	59.0	375	49.0	<0.01
Hamburger and/or sausages	358	23.5	137	18.1	221	28.9	<0.01
Sugar-sweetened beverages	423	27.7	165	21.7	258	33.7	<0.01
Instant noodles, packaged snacks, and/or salty cookies	228	15.0	110	14.5	118	15.4	0.61
Sandwich cookies, sweets, and/or treats	438	28.7	198	26.1	240	31.3	0.02
NOVAScore Subgroups							
Drinks	792	51.9	343	45.2	449	58.6	<0.01
Processed meats	416	27.3	173	22.8	243	31.7	<0.01
Savory snacks	756	49.6	338	44.5	418	54.6	<0.01
Sweets	776	50.9	355	46.8	421	55.0	<0.01
Sauces	294	19.3	117	15.4	177	23.1	<0.01
Margarine	308	20.2	151	19.9	157	20.5	0.77

[a] *p*-value for the chi-square test.

In Table 3, the multivariable model associating food consumption across different days of the week shows that individuals were still more likely to consume UPFs on weekends compared to weekdays, even after adjusting for confounders.

Table 3. Prevalence ratio of univariable and multivariable analyses for food consumption in Brazilian bariatric patients according to the day of the week.

Food Consumption Markers	Univariable Analysis			Multivariable Analysis *		
	PR	95%CI	*p*	PR	95%CI	*p*
Fresh fruits	0.90	0.84; 097	<0.01	0.89	0.83; 0.96	<0.01
Vegetables	0.91	0.86; 0.97	<0.01	0.91	0.85; 0.96	<0.01
Beans	0.82	0.75; 0.91	<0.01	0.80	0.73; 0.88	<0.01
Hamburger/sausages	1.59	1.32; 1.92	<0.01	1.50	1.24; 1.82	<0.01
Sweetened beverages	1.54	1.31; 1.83	<0.01	1.45	1.22; 1.71	<0.01
Instant noodles, packaged snacks, and/or salty cookies	1.06	0.83; 1.35	0.61	1.02	0.80; 1.30	0.84
Sandwich cookies, sweets, and/or treats	1.20	1.02; 1.40	0.02	1.12	0.96; 1.31	0.14
NOVA Score Subgroups						
Drinks	1.29	1.17; 1.43	<0.01	1.28	1.16; 1.42	<0.01
Processed meats	1.39	1.17; 1.64	<0.01	1.33	1.13; 1.58	<0.01
Savory snacks	1.22	1.10; 1.35	<0.01	1.20	1.08; 1.33	<0.01
Sweets	1.17	1.06; 1.29	<0.01	1.13	1.02; 1.24	0.01
Sauces	1.49	1.21; 1.85	<0.01	1.44	1.17; 1.79	<0.01
Margarine	1.03	0.84; 1.25	0.77	0.99	0.81; 1.21	0.99

* Adjusted for age (years), sex, socioeconomic status, BMI (continuous), surgical technique, time since surgery (in months), PR: Prevalence ratio and 95%CI: 95% confidence interval.

4. Discussion

4.1. Summary of Findings

This study aimed to investigate and analyze potential changes in dietary patterns during weekends among post-MBS patients. We found that the average consumption of UPFs was higher on weekends compared to weekdays, whereas the average consumption

of healthy foods was lower on weekends. These findings partially corroborate those of Monteiro et al. [13], as their study concluded that the consumption of unhealthy foods among the Brazilian population generally increases on weekends. Specifically, our research observed that this trend persists among patients undergoing MBS. Almost all subgroups of the UPFs showed a significant difference in consumption prevalence between weekdays and weekends, except for the margarine subgroup. Subgroups such as sauces, processed meats, beverages, sweets, and savory snacks had higher odds of being consumed on weekends.

4.2. Dietary Patterns and UPF Subgroup Consumption Analysis

Surprisingly, regarding the beverage subgroup, our findings contradict the results previously obtained by Silva et al. [24] in adults overall, which indicate that individuals with greater dissatisfaction with body weight tend to consume fewer sugar-sweetened beverages. However, among post-MBS individuals, there is a trend towards increased consumption of these beverages during weekends. Another aspect is the reduction in fruit and vegetable consumption during this same period, supporting the assertion of increased UPF consumption. A study conducted with adults in the United States by Kant and Graubard [15] observed that food consumption patterns change between weekends and weekdays, characterized by a greater choice of more energy-dense foods and drinks and a later time for the first meal on weekends.

Lifestyle changes are crucial for the success of MBS, with dietary habits being a significant social construct [25]. Our study revealed lower fruit and vegetable consumption on weekends compared to weekdays, supporting [26], who identified this trend since childhood, which may explain the challenge of altering these patterns in adulthood. The guidelines of the Brazilian Society of Bariatric and Metabolic Surgery [22] recommend pre-surgery care, such as weight reduction, as well as post-surgery medical and nutritional monitoring to ensure satisfactory progress. However, our results indicate that despite the surgery and significant weight loss, patients maintain unhealthy dietary patterns, particularly on weekends. This persistence of harmful dietary habits, even after surgical intervention, underscores the need to investigate the reasons for non-adherence to prescribed nutritional recommendations [23]

Few studies have investigated the food consumption of post-MBS individuals using the NOVA classification system. Evidence suggests that MBS can result in a reduction in UPF consumption, especially in the first three months after surgery [27]. However, over time, this effect tends to diminish. Farias et al. [28] reported that after 24 months of MBS, UPF consumption already corresponded to more than 50% of daily energy intake, similar to pre-surgery levels. Similarly, Lobão et al. [29] found a continuous increase in UPF intake over time, with consumption returning to preoperative levels five years post-MBS. In line with these findings, approximately half of our sample reported consuming UPF, such as beverages, savory snacks, and sweets, while 15% to 30% consumed processed meats, sauces, and margarine. Additionally, a study by Pinto, Silva, and Bressan [27] recorded a significant energy contribution of 19.7% from UPF in post-MBS individuals. Their research noted the greatest reduction in the consumption of sweets, soft drinks, and savory snacks, whereas our findings show a persistently high prevalence of sweets consumption. Both studies suggest a preference for unprocessed or minimally processed foods and an increase in fruit and vegetable consumption, with meat being the most consumed food during this period [27]. Although no studies have specifically examined the relationship between UPF consumption and weight gain in post-MBS individuals, there is evidence that consuming these foods can activate brain regions linked to reward, contributing to excessive energy intake and weight gain in adults [30–34]. Therefore, it is reasonable to hypothesize that UPF intake may contribute to weight regain in post-MBS patients.

4.3. Differences in the Food Consumption Assessment Tools

The difference in dietary consumption prevalence observed between the SISVAN tool and the NOVA Score in our study, such as the category “Sandwiches, biscuits, sweets,

and/or treats" at 28.7% by SISVAN versus 50.9% for the sweets subgroup by NOVA Score, may be attributed to methodological differences between the two approaches. SISVAN provides a broad view of population dietary patterns by encompassing broad food groups. In contrast, the NOVA Score is specifically designed to assess diet quality based on the NOVA classification, which categorizes foods by their degree of processing [23,35]. The greater specificity and detailed classification of UPF subgroups by the NOVA Score allow for a more comprehensive analysis of food consumption, resulting in higher prevalence rates compared to SISVAN.

4.4. Limitations

Our study has limitations. Firstly, anthropometric data were self-reported by participants and may not accurately represent their actual measurements. However, the use of self-reported weight and height data in epidemiological studies can be a valid option, as previous studies have provided significant data using this tool [21]. Secondly, dietary intake marker tools heavily rely on self-reported data, which may introduce memory bias and social desirability bias. Specifically, the NOVA Score focuses on processing and may overlook other relevant nutritional aspects such as ingredient quality and nutritional density. However, despite these limitations, both tools are important for monitoring dietary patterns and guiding public policies.

5. Conclusions

In conclusion, the dietary patterns of individuals undergoing MBS are different on the weekend when compared to weekdays, characterized by higher UPF consumption and lower fruit and vegetable consumption. Our observations reveal that the less healthy eating behavior on weekends in the general population is replicated by individuals undergoing MBS. In addition, eating patterns may influence long-term weight management after MBS. In future directions, it is necessary to conduct investigations that seek to identify the possible reasons why individuals undergoing MBS change their eating patterns at weekends and relate this change in eating pattern to quantitative measures of the impact of these changes on the loss and maintenance of weight loss after the procedure.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee of the Universidade Federal de Alagoas (protocol number: 60233722.7.0000.5013).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: Data are available upon request to the authors.

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