Original Research Article

ULTRA-PROCESSED FOODS ARE ASSOCIATED WITH OVERWEIGHT AND POOR EATING PRACTICES IN NUTRITION STUDENTS

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ABSTRACT

Aim: The consumption of ultra-processed foods(UPF) has been associated with increased disease risk.The COVID-19 pandemic affected eating practices, favouring university students' consumption of these foods. Nutrition students could have been less influenced. Therefore, we evaluated associations between the consumption of UPFitems and markers of health status in nutrition students one year after the beginning of the COVID-19 pandemic.

Methods: It was a cross-sectional study with nutrition students from a public university. Socio-demographic, anthropometric, physical activity, sleep quality,eating practices, and body image data were collected through a self-answered questionnaire using an online platform. According to the NOVA classification, food items consumed on the previous day wereobtained through individual interviews on two days of the same week.

Results: Almost 50% of the foods reported were *in natura*/minimally processed (37 items of all 80); 40% of the participants consumed less than half of these food items.Almost 15% of all food items were UPF; the number of fooditems for more than 85% was up to 4.5. The consumption was higher in students with poor eating practices and overweighted males, younger and at the first half of the major. The greater UPF

items consumption, the greater the prevalence ratios of overweight (≥1 = 35%; ≥2=44%; ≥3=66%)or inadequate eating practices (≥1 = 32%; ≥2=40%; ≥3=52%).

Conclusion: The participation of one UPF item in the diet was associated with the prevalence of overweight or poor eating practices; the higher the UPFitem participation, the higher the prevalence.

Keywords: Ultra-processed foods. Students. Nutrition. Overweight.Eating practices. COVID-19.

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1 INTRODUCTION

Human diets progressively incorporate higher quantities of highly processed foods. These foods have been associated with poor health outcomes in children, adolescents, adults, and older people. These associations contributed to developing food classification systems according to food processing.[1] Currently, NOVA is, by far, the most known food classification system worldwide. NOVA classifies foods according to their extent and purposes of industrial processes as (1) *in natura* or minimally processed (IN/MP); (2) processed culinary ingredients (PCI); (3) processed (P); and (4) ultra-processed foods (UPF). UPF are industrial formulations made entirely or partially from substances extracted from foods (such as oils, fats, and sugar), derived from food constituents (such as hydrogenated fats and modified starch), or artificially synthesised from food substrates or organic sources (flavour enhancers, colours, and several food additives).[2] Furthermore, UPF have an unbalanced nutritional composition and are deficient in micronutrients compared to IN/MP, which should be the basis for a healthy diet.[3]UPFis also associated with poor diet quality and poor health outcomes.[4]

UPFmay comprise half or moreof the total dietary energy consumed in some high-income countries such as the U.S., Canada, UnitedKingdom, and Australia,

~~and~~between one-fifth and one-third in middle-income countries. In Brazil, a change in the dietary pattern has been recently observed, including replacing IN/MP foods and culinary preparations with UPF. Household food acquisition surveys have shown that the contribution of UPF to total energy intake increased from 14.3% in 2002/2003 to 19.4% in 2017/2018.[5] In addition, different countries have shown the association of increased consumption of UPF with a higher risk of type 2 diabetes, obesity, coronary artery disease, overweight, metabolic syndrome, depression, inflammatory bowel diseases, frailty~~,~~ and all-cause mortality.[6] It has also been shown that the consumption of UPF is increasing among adolescents, adults, and older people of both sexes, and it is more expressive among adolescents and adults compared to older people.[7]

In studies evaluating the quality of diets and their impact on health employing NOVA classification, the most frequently metric used is the dietary share, in calories or grams, of UPF.[6, 8] It has been shown that the energy density of UPF ranges from 2.5 (bread) to 5.0 (packed snacks) Kcal/gram, which is from 2 to 5 times higher than a rice and bean mixture (2:1). Conversely, the *Dietary Guide for the Brazilian Population* (DGBP) does not emphasise food nutrients or calories in its recommendations, but food quality based on the extent and purposes of industrial processes.[7] The DGBP is the first dietary guide to explore qualitative recommendations expressed by the terms "prefer," "avoid," or "limit." The golden rule is to "*always prefer natural or minimally processed foods and freshly made dishes and meals to UPF*." However, studies evaluating whether markers of health status are associated with the simple presence of one, two, three, or more UPF items in the diet need to be included in the literature.

In this context, university students face new demands in their adult lives, endure long physical and mental hours of effort, and often eat incomplete meals with poor

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nutritional value.[8]In addition, from 2020 through 2022, the COVID-19 pandemic forced homeschooling, introducing additional challenges and requiring students to adapt their study habits quickly.[9] This new reality also has increased anxiety and depressive symptoms in these students.[10]Communication technology and social media contributed to sedentary behaviour and to spreading pseudo-science regarding eating habits. Therefore, this scenarioalso favouredpoor eating practices, contributing to restrictive and unbalanced diets,[11]increasing UPF consumption[8], and the risk of developing obesity, type 2 diabetes, cardiovascular diseases, and eating behaviour disorders, among others.[12]

Among university students, a group of interest in the context of dietary patterns, but still poorly explored, is the human nutrition students. In Brazil, the major in nutrition trains professionals to act in all fields in which food and nutrition are fundamental for promoting, maintaining, and recovering health and preventing diseases in individuals or population groups.[13]These students learn about food and healthy dietary patterns throughout their training. However, to the best of our knowledge, we did not find investigations of eating practices or food consumption according to NOVA classification in this group, especially during the COVID-19 pandemic.

Therefore, this study aimed to evaluate associations between the qualitative contributionof UPF items in the diet and the health outcomes of nutrition students from a public university in Brazil one year after the beginning of the COVID-19 pandemic. As a secondary aim, we described the participation of food items in the diet of these students, classified according to NOVA.

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2 METHODS

This study was conducted in March 2021, one year after social distancing and quarantine measures began.The lockdownmeasures weresuspending nonessential activities (closing restaurants, bars, shopping malls, and gyms), closing schools and universities, and implementing emergency remote education. Therefore, all data collection was completed in a virtual format.

It was a cross-sectional study based on probabilistic sampling, designed and completed following the Strengthening the Reporting of Observational Studies in Epidemiology(STROBE) tool.[14]We recruited participants from apublic university's nutrition major. All participants agreed to participate via virtual informed consentthrough the Google form platform. The university's Ethics Committee Board approved the protocol.

The sample size calculation was performed using the OpenEpi program, version 3.01. A proportional stratified probability sample was chosen. It was considered for the calculation: (a) population size: 198 Nutrition students regularly enrolled in March 2021; (b) frequency of primary outcome: 80% for the consumption of at least one UPF item in the previous day;[15](c) confidence limit: 5%; (d) design effect for random samples: 1; (e) the number of strata: 9 (semesters of the major); and (f) the number of students enrolled in each semester (elements/stratum). Thus, the sample size was 110 students witha 95% confidence interval. After an adjustment of 10% for losses, the total was 121.

After selecting the participants, an electronic correspondence was sent with a link to the consent form. The study was carried out in two phases.

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Phase one: Which involved socio-demographic and health information, was acquired through self-answered questionnaires using the Google Forms platform. The economic class was evaluated usingan Economic Classification Criteria 2020 (CCEB). Individuals were categorised in A, B1, B2, C1, C2, and DE.[16]

Anthropometric measurements (body mass and height) were self-reported by the participants. The Body Mass Index (BMI: weight(kg)/height(m^2)) was evaluated according to the World Health Organization in< 18 = underweight, between 18 e 25.9 = healthy weight, ≥ 25 = overweight. Physical activity was evaluated by the International Physical Activity Questionnaire – IPQA (short version), and all participants were categorisedassedentary, active, or very active.[17]Sleep quality was evaluated as "good," "bad," or "sleep disorder" by using thePittsburgh Sleep Quality Index – PSQI.[18] Body image (dis)satisfaction and perception were investigated through a body silhouette scale.[19]In the analysis, a difference between perceived silhouette (perceived BMI) and desired silhouette (desired BMI) equals zero implied satisfaction with the body image. When this difference was higher or lower than zero, it implied dissatisfaction due to being overweight or thin. When the difference between perceived silhouette (perceived BMI) and actual silhouette (actual BMI) was equal to zero, there was no body image distortion. When this difference was higher or lower than zero, they underestimated or overestimated their body weight respectively.

Eating practices were evaluated through a self-administered scale validated for individuals aged between 18 and 60 years, with 24 four-point Likert-type items ("strongly agree," "agree," "disagree," and "strongly disagree"). The scale comprises the four dimensions of adequate and healthy eating addressed in the DGBP: food choice, modes of eating, planning, and household organisation. The sum of the individual

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scores attributed to the answers of each sentence resulted in a score classified as "inadequate" when the sum of the points was less than 31, "risk" when it was between 31 and 41 points, and "adequate" when it exceeded 41 points.[11,20]

Phase two: In this phase, a qualitative description of all food items consumed by each participant on the previous day was accessed. The food consumed was obtained from two days of the same week (one typical and one atypical day).[21]The interviews were scheduled and conducted by trained interviewers using the multiple-pass method and by video calls through the Google Meet platform. Basic information on all food items and drinks consumed was asked over 24 hours before each interview. In addition, participants were also asked about food preparation (fried, cooked, roasted, for example), food brands, presence or absence of ingredients (salt, sugar, olive oil, for example) in the culinary preparations and meal settings (time and place). All culinary preparations reported were dismembered, and each food or one culinary ingredient corresponded to one food item. At last, all reported food items were classified according to the NOVA into: (1) in natura/minimally processed IN/MP, (2) processed culinary ingredients - PCI, (3) processed – P, and (4) ultra-processed foods - UPF. The food items' organisation, evaluation, and classification followed the best practices for applying the NOVA food classification.[22]

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All analyses were performed with theSPSS® v.26 (IBM Corporation 2019) software. A descriptive analysis was performed using frequencies, tertiles, minimum and maximum. TheMann-Whitney or Kruskal-Wallis test was used in the association analysisfor an asymmetrical numeric outcome. The variables were expressed as median and Interquartile (IQ) ranges.The Poison regression with robust variance was used to construct an adjusted model. For that, the exposition variables were BMI ≥25

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kg/m^2(overweight) and eating practicescores ≤ 41 (bad/at risk), and the outcome was the consumption of UPFitems.In this model, a forward adjustment was performed for possible confounding variables and those that, in association with exposure and outcome, presented a p-value in the Wald test ≤ 0.25 were included. In addition, variables with p-values<0.05 remained in the final model. Variables were described as prevalence ratios (PR) at a 95% confidence interval. A value of 5% ($p < 0.05$) was significant in all analyses.

3 RESULTS

This study included 111 students who were regularly enrolled in the Nutrition major program at a public university, one year after the beginning of the COVID-19 pandemic measurements of social distancing and quarantine. The general characteristics of these students are in Table 1. Most were female, aged between 19 and 24 years, categorised in the B economic class, and under remote teaching (Table 1). At most, they were sedentary, had poor sleep quality or a sleep disorder, were dissatisfied with their body image, and had distorted body image perception. In contrast, most had healthy body weight and good eating practices (Table 1).

Table 2 describes the analysis of the participation in the diet of food items from each NOVA group consumed on the day before the interview (two interviews). Up to 80 food items were reported, 46.9% of IN/MP, 32.5% of PCI, 5.6 of P, and 15% of UPF. Almost 40% of the participants ingested up to 12.5 IN/MP items. Less than 7% reported the highest consumption of those foods (26.00 – 37.50). The highest number of PCI was 26, but in the lowest tertile. P items were reported a few times. About 15% of the participants consumed 5 to 12 items for UPF, and the maximum consumption for almost

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85% was 4.5 (Table 2). In the IN/MP group, the most reported food items were bananas, beans, carrots, coffee, eggs, meat, milk, onion, rice, and tomato. The PCI items most reported were baking powder, butter, honey, lard, olive oil, salt, sour cream, sugar, and vegetable oil. The most reported P foods were natural colouring, beer, corn, dried meat, French bread, granola, non-processed cheeses, olives, sweet bread, and tomato extract. At last, UPF items most reported were chocolate, cocoa powder, cookies, ham, loaf bread, margarine, sausage, soft drinks, tomato sauce, and yogurt.

The UPFitems consumed were associated with gender, age, semester, eating practices, and BMI (Table 3). The consumption of the UPFitem was higher for male students, younger students, and those from the first to fifth semesters. In addition, students with inadequate/at-risk eating practices and overweight reported more UPFitems ($p<0.05$, Table 3).

A Poison model analysis (Table 4) was performed to estimate the PR for BMI ≥ 25 and inadequate/at-risk eating practices (scores <41). We found a PR of 34% for being overweight (BMI ≥ 25) among participants consuming ≥ 1 UPF item compared to those consuming no UPF item. This prevalence increased by 44% among participants consuming ≥ 2 UPF items and 66% among those consuming ≥ 3 UPF items. In addition, there was a PR of 32% of inadequate/at-risk eating practices (scores <41) among participants consuming ≥ 1 UPF item (PR 1.32; 95% CI 1.10 – 1.58) compared to participants consuming no UPF items. When the consumption of UPF items increased to ≥ 2, the PR was 40%; when it was ≥ 3, it was 52%. (Table 4).

4 DISCUSSION

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Recent meta-analyses showed significant dose-response associations between the dietary share of UPF and increased risk of noncommunicable diseases (NCDs), such as obesity, cancer, cardiovascular diseases, diabetes, and all-cause mortality in several groups of individuals.[23]In addition, most research worldwide has shown that the estimated energy intake from UPFconsumption has consistently increased among adolescents and youths, accounting for a high proportion of the daily energy intake and contributing to poor health outcomes.[24] In our study, we investigated possible relationships between UPFitems consumption (number of items in the previous day) and health outcomes in nutrition students from a public university one year after the beginning of the social distancing measures due to the COVID-19 pandemic.

The pandemic has contributed to changes in people's lifestyles, changing food trends and habits.The purchase of certain products for an unpredictable period, the stressful and uncertain situation during periods of confinement resulting in higher levels of anxiety and depression, or the implementation of remote work are just some of the causes that have influenced differences in food habits, resulting in non-healthy diets.[8] Therefore, we first described the food items consumed by the participants, according to the NOVA classification, on the previous day, in two days of the same week. Overall, 15% of all food items reported were UPF. The number of UPF items eaten by more than 85% of the participants was up to 4.5. Also, the consumption of those items was higher for males, younger, enrolled from the first to fifth semesters of the major, with at-risk/inadequate eating practices, and overweighted. Conversely, although almost 50% of the food items reported were IN/MP, 40% of the participants consumed less than half of those food items (12.5 of all 37 food items).

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Similar data also showed the participation of UPF in the diet for young adults and males.[24]Bonalume et al.[25] showed that mostuniversity students (~90%, 66.2% from nutrition majors) did not consume UPF; they also were 18 to 51 years old and between their majors' sixth and eighth semesters. Monteiro et al. showed an eating frequency of 18.2% of UPF by youths from 27 capitals in Brazil.[24] In agreement with our findings, it also wassignificantly lower in females, decreased linearly with age, and increased from the lower level to the intermediate level of education, corroborating our findings. Being in the first half of the nutrition course could have been a determinant because, during this time, biological and health sciences and social, human, and economic sciences were the focus of the human nutrition major.[13, 26]

The ten most consumed food items from each NOVA group were also presented in our study. The most reported items in the UPF were margarine, loaf bread, and soft drinks. Costa et al.[24] also found those items with the highest frequency of consumption on the previous day by adults from 27 Brazilian state capitals. In the IN/MP, beef, rice, beans, coffee, eggs, tomatoes, milk, onions, bananas, and carrots were the most cited. These findings partially agree with the last *Brazilian Household Budget Survey* carried out in 2017-2018, in which rice, beef, beans, and poultry were also the most cited.[5]

The most relevant finding of our investigation was that the prevalence of overweight or poor eating practices was associated with only one UPFitem in the diet.In addition, the prevalence of overweight or inadequate eating practices increased as the UPFitems increased in the diet. Duran-Aguero et al. (2021) showed that Chinese university students consuming at least one serving of sugary drinks per day were associated with higher odds of obesity.[27] In our study, soft drinks were amongthe UPFitemsmost cited. Recently, Fondevila-Gascón (2022)[3] showed that university

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students with higher BMI had more unhealthy diets containing UPthan those with lower BMI.

However, although the food items reported by the participants refer to just two days in the same week, food practices are long-term information that generally reflects food habits. To minimise that, we used a multidimensional scale that measures adherence to the four dimensions of adequate and healthy eating practices addressed in theDGBP[7]: food choices, modes of eating, planning and household organisation.[20]In the concurrent validation study of this scale, the score was positively associated with higher consumption of fresh and MP foods and inversely associated with UPF consumption. Therefore, our data align with its observed correlations: people with a higher degree of adherence to food guidelines consume more IN/MP and less UPF.[28]Therefore, we can speculate that UPF items in the participants' diets are a long-term practice, regardless of the number of items.

To the best of our knowledge, there is a gap in the literature demonstrating the "cause-effect" relationships between the consumption of UPF and adverse health effects. Nevertheless, some mechanisms have been postulated, such as poor nutritional profile and displacement of IN/MP foods in the diet,[1]low satiety potential, highglycemic loads, reduced gut-brain satiety signalling, inflammatory responses linked to industrial food additives, gut microflora dysbiosis, and increased intestinal permeability. In addition, some properties of UPF may promote overconsumption,including their often-ubiquitous availability and convenience, palatability and quasi-addictiveness,and intensive marketing practices used to promote purchasing and consumption, especially among children and adolescents. [29]

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Lastly, it is essential to point out that we did not find any association between the consumption of UPF items (or another NOVA group) and physical activity, sleep quality, or body image (dis)satisfaction and perception. Conversely, more than half of the participants reported being sedentary, having bad sleep quality or sleep disturbance, being dissatisfied, or having a distorted perception of their body image, which are considered poor markers of health status, contributing to rising disease risks. In addition, although we did not investigate mental health, numerous studies have shown that the pandemic favoured the increase of anxiety and depression in youth. They also show their strong influences on food habits, sleep quality, sedentary behaviour, and body image, favouringadverse health outcomes. [30]

Some potential limitations of this study deserve mention. We could not assess body composition; the BMI was the only nutritional indicator. BMI does not access body fat; therefore, the overweight prevalence may be overestimated. However, we believe it may be correct because more than half of the participants were sedentary, often associated with excess body fat. Another limitation involves the self-reported data, which depends on the memory. However, the interviewer was previously trained in using the multiple-pass method, helping the participants describe food items and other information more appropriately, avoiding possible bias. Despite these limitations, this research contributes to a better understanding of associations betweenUPF itemconsumption and the health status of youth.

The main strength of our study is that poor eating practices or being overweight are associated with consuming just one UPF fooditem. Although nutrition students supposedly know healthy food choices, there are UPF items in their diets. This finding

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reinforces the "gold rule" of the DGBP: make unprocessed/minimally processed foods the basis of the diet, reduce processed foods, and avoidUPF. [2, 7]

5 CONCLUSION

Nutrition students with poor eating practices and overweighted males, younger and in the first half of the major, consumed more UPF items in their diets. The prevalence of overweight or poor eating practices was associated with just one UPF item in their diets.The higher the prevalence, the higher the consumption of UPFitems.

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Table 1. Distribution according togeneral characteristics of nutrition students at a public university (n=111).

Variables		**n**	**%**
Gender	Male	16	14.41
	Female	95	85.59
Age	19 – 24 years	77	69.37
	25 – 44 years	34	30.63
Semester	1 to 5	57	51.35
	6 to 9	54	48.65
Routine	Remote teaching and job out of home	25	22.52
	Just remote teaching	86	77.48
Socioeconomic class	B or higher	67	60.36
	C or lower	44	39.64
Physical activity	Sedentary	54	55.67
	Active	22	22.68
	Very active	21	21.65
Sleep quality	Good	31	31.31
	Bad/sleep disturbance	68	68.69
Body image (dis)satisfaction	Dissatisfaction	90	81.08
	Satisfaction	21	18.92
Body image perception	Distorted perception	88	79.28
	Non-distorted perception	23	20.72
Body mass index	Underweight	9	8.33
	Healthy weight	69	63.89

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	Overweight	30	27.78
Eating practices	Inadequate / at-risk	47	42.34
	Adequate	64	57.66

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Table 2. Descriptive analysis of the participation in the diet of food items, according to NOVA classification, of nutrition students at a public university (n=111).

NOVA classification	**Students** % (n)	**n° of food items*** minimum – maximum
***In natura* and minimally processed**	100 (111)	0.00 – 37.50
1st tertile	40.54 (45)	0.00 – 12.50
2nd tertile	52.25 (58)	12.60 – 25.00
3rd tertile	7.21 (8)	26.00 – 37.50
Processed culinary ingredients	100 (111)	0.00 – 26.00
1st tertile	25.22 (28)	0.00 – 8.50
2nd tertile	59.45 (66)	9.00 – 17.50
3rd tertile	15.31 (17)	18.00 – 26.00
Processed	100 (111)	0.00 – 4.50
1st tertile	65.76 (73)	0.00 – 1.50
2nd tertile	26.13 (29)	2.00 – 3.00
3rd tertile	8.10 (9)	3.50 – 4.50
Ultra-processed	100 (111)	0.00 – 12.00
1st tertile	85.58 (95)	0.00 – 4.50
2nd tertile	12.61 (14)	5.00 – 8.00
3rd tertile	1.80 (2)	9.50 – 12.00

*n° of food items according to NOVA classification was evaluated by two individual and qualitative interviews regarding the food items consumedon the previous day: one typical and another atypical.

Table 3. Participationin the diet of UPF items, according to NOVA classificationof nutrition students at a public university (n=111).

Variables	N	UPF items*	p-value
Gender[a]			
Male	16	4.25 (2.37 – 6.00)	<0.001
Female	94	2.00 (1.00 – 3.00)	
Age[a]			
19 – 24 years	77	2.50 (1.50 – 3.50)	0.03
25 – 44 years	32	2.00 (1.00 – 2.50)	
Semester[a]			
1 to 5	52	3.00 (1.50 – 4.00)	<0.001
6 to 9	54	2.00 (1.00 – 3.00)	
Routine[a]			
Remote teaching and job out of home	24	2.50 (1.50 – 3.50)	0.24
Just remote teaching	86	2.00 (1.00 – 3.50)	
Socioeconomic class[a]			
B or higher	67	2.00 (1.00 – 3.50)	0.78
C or lower	44	2.25 (1.00 – 3.50)	
Physical activity[b]			
Sedentary	53	2.00 (1.00 – 3.00)	
Active	22	2.75 (1.50 – 3.75)	0.28
Very active	21	2.50 (1.00 - 5.50)	
Sleep quality[a]			
Good	30	2.50 (1.00 – 4.62)	0.59

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Bad / disturbance	80	2.00 (1.12 – 3.50)	
Body image (dis)satisfaction[a]			
Dissatisfaction	90	2.50 (1.00 – 3.50)	0.53
Satisfaction	21	2.00 (1.00 – 3.75)	
Body image perception[a]			
Distorted perception	88	2.00 (1.12 – 3.50)	0.84
Non-distorted perception	23	2.50 (1.00 – 3.50)	
Eating practices[a]			
Inadequate / at-risk	47	3.00 (1.50 – 3.50)	<0.001
Adequate	58	1.75 (1.00 – 2.50)	
Body mass index[b]			
Underweight	9	2.00 (1.00 – 2.25)	
Healthy weight	65	2.00 (1.00 – 3.00)	<0.001
Overweight	30	3.25 (1.50 – 6.00)	

*Ultra-processed food items. Data expressed as a median and interquartile range of 25% - 75%. [a] Mann-Whitney test. [b]Kruskal-Wallis test.

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Table 4 - Association between body mass index (BMI), eating practices, and the number of UPF items in the diet of nutrition students at a public university (n=111).

	BMI ≥ 25 *	
N°UPF items consumed	**PR (95% CI)**	**p-value****
≥ 1	1.34 (1.07 – 1.69)	0.01
≥ 2	1.44 (1.09 – 1.88)	<0.001
≥ 3	1.66 (1.26 – 2.17)	< 0.001
	Eating practice scores< 41*	
N°UPF items consumed	**PR (95% CI)**	**p-value****
≥ 1	1.32 (1.10 – 1.58)	0.003
≥ 2	1.40 (1.13 – 1.73)	0.002
≥ 3	1.52 (1.10 – 1.58)	0.003

*Adjusted for the semester of the nutrition major. ** Wald test.BMI: Body Mass Index;PR: Prevalence Ratio; 95%CI: 95% Confidence Interval.

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