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ORIGINAL ARTICLE

Food Consumption and Health Outcomes in Women During the COVID-19 Pandemic

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Abstract

Background: The COVID-19 pandemic has changed food consumption. Objective: Evaluate the association between metabolic phenotypes, changes in food consumption during the pandemic, and health outcomes in obese women.

Methods: Cross-sectional observational study including 491 women without previous diagnosis of chronic diseases, evaluated according to metabolic phenotype. During the pandemic, a subsample was re-evaluated by online questionnaires via Google Forms. Analyzed anthropometric, biochemical, and dietary data as well as health outcomes (coronary artery disease, type 2 diabetes, hypertension, dyslipidemia or death). Information on mortality was collected from the Internal Affairs Office of the State of Rio de Janeiro and the Health Department of the State of Rio de Janeiro. Statistical analysis was performed using the statistical program SPSS 21, with Mann-Whitney test, Pearson's chi-squared, Spearman correlation, and binary logistic regression, at a significance level of 5%.

Results: The anthropometric, glucose, and lipid profiles showed significant differences between the metabolically healthy and metabolically unhealthy groups ($p = 0.00$). Before the pandemic, women in the metabolically unhealthy group had higher dietary intakes of lipids ($p = 0.01$), saturated fat ($p = 0.01$) and sodium ($p = 0.04$), during the pandemic, they consumed more energy ($p = 0.04$), lipids ($p = 0.02$), saturated fat ($p = 0.02$), proteins ($p = 0.03$) and sodium from ultra-processed foods ($p = 0.03$). Consequently, health outcomes were more prevalent in the metabolically unhealthy group ($p = 0.00$).

Conclusion: Observed that metabolically healthy women had qualitatively better food intake and fewer health outcomes throughout the study.

Keywords: Metabolic Syndrome; Inflammation; Eating; Obesity.

Introduction

Faced with the severity of the COVID-19 pandemic, different countries worldwide have adopted measures to contain the spread of the highly transmissible virus.[1]

With respect to the behavioral practices implemented, social distancing has had a direct impact on food consumption and mental health. The scientific literature emphasizes that, in these situations, individuals tend to regulate their negative moods, caused by anxiety, stress and fear, through consumption of unhealthy foods, in a phenomenon known as "emotional eating".[2-4]

It is also known that the pandemic has caused financial instability with a direct impact on purchasing power, thus promoting increased consumption of ultra-processed foods, due to lower price and high availability. These factors have significantly contributed to food insecurity, leading to negative effects on quality of life. Accordingly, ultra-processed food consumption leads to the production of new inflammatory compounds, which are associated with negative health impacts.[5-7] These impacts include weight gain, sedentarism, reduced sleep quality, development of chronic diseases, and mortality.[8,9] Recent studies have revealed that obesity, type 2 diabetes, and arterial hypertension have a direct relation with the worsening of COVID-19, favoring acute respiratory syndrome, severe viral pneumonia, organ failure, and mortality.[10,11]

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In contrast, few studies in the scientific literature have simultaneously evaluated the impacts of changes in eating habits, taking into consideration body composition analysis and changes in food consumption, both quantitatively by means of dietary adequacy and qualitatively by means of the NOVA classification criteria, in addition to considering possible health outcomes during the COVID-19 pandemic.

Accordingly, the objective of this study was to evaluate the influence of dietary intake of processed and ultra-processed foods on dietary adequacy and body composition in women with different metabolic phenotypes, associating them with possible health outcomes and mortality during the COVID-19 pandemic.

Methods

Study group

This was a cross-sectional observational study, characterized, at an initial moment, by evaluation of a series of patients during a period before the pandemic, with socioeconomic, dietary, biochemical, and anthropometric data collected in person by trained professionals from 554 individuals who voluntarily registered at the Center for Research and Extension in Clinical Nutrition of the Clementino Fraga Filho University Hospital, referring to the period before the COVID-19 pandemic. At a second moment, in March 2021, during the second period of social isolation of the COVID-19 pandemic, the volunteers were reevaluated via Google Forms online questionnaires. Inclusion criteria for the study were women with body mass index (BMI) ≥ 30 kg/m^2, from 18 years to 59 years and 11 months of age. Exclusion criteria were the following: individuals ≥ 60 years of age, individuals with history or diagnosis of chronic diseases or under previous nutritional monitoring, normal weight or overweight individuals, and male individuals. Given that this was a convenience sample, there was no justification for using sample size calculation to estimate the sample population. After analyzing the inclusion criteria, 491 women were selected for the study, between the years of 2011 and 2019 (Supplementary figure 1).

The research project received approval from the Research Ethics Committee of the Clementino Fraga Filho University Hospital, under CAE number 89033118.1.0000.5257, approved on 07 July 2018. During the pandemic, an amendment was made to the approved project, asking the CEP for an authorization for the online reassessment, approved on July 22, 2020.Voluntary participation was authorized following verbal and written clarification, by means of a free and informed consent form, in accordance with resolution 466/2012.

Metabolic groups, anthropometry, blood pressure, and physical activity

The scientific literature suggests that obesity represents a heterogeneous condition, with differentiated risks related to metabolic alterations. The characterization of metabolic groups was performed according to the NCEP-ATP III classification, based on the metabolically healthy obese (MHO) phenotype with BMI greater than 30 kg/m^2 and without hyperglycemia, dyslipidemia, hypertension, and/or inflammatory processes; and the metabolically unhealthy obese (MUHO) phenotype with the presence of at least 3 of the following criteria: waist circumference ≥ 88 cm; triglycerides ≥ 150 mg/dL; HDL < 50 mg/dL; blood glucose > 110 mg/dL; blood pressure: ≥ 130/85 mmHg.[5,12-15] Anthropometric evaluation considered data on body weight, height, waist circumference in cm, and BMI in kg/m^2. Classification of systemic blood pressure followed the cutoff points established by the NCEP-ATP III in 2002.[15]

Degree of physical activity was evaluated by applying the short version of the International Physical Activity Questionnaire (IPAQ), with only 2 categories: sedentary (including women who were irregularly active and sedentary) and active (including women who were active and very active).[16]

Biochemical evaluation

Blood collection was carried out before the pandemic, following the protocol of a 14-hour fast for analysis of blood glucose and plasma insulin; evaluation of blood lipid profile followed the cut-off point established by the NCEP-ATP III in 2002. Insulin resistance was estimated using the HOMA-IR method.[15]

Biochemical analyses were performed in duplicate by means of an automated method (Automatic Analyzer A25, BioSystems), using commercial BioSystems kits. Serum concentrations of glucose, triglycerides, total cholesterol, and HDL were evaluated. LDL values were calculated following the formula by Friedewald et al (1972), which is valid only if the triglyceride concentration is less than 400 mg/dL. Insulin was obtained from blood samples and analyzed by the ELISA method (Ultra Sensitive Insulin ELISA Kit, DRG) on a BRIO 2 Radim device.[17]

Evaluation of dietary adequacy and food consumption

Dietary adequacy was evaluated by analyzing the mean values of food consumption from 3-day food records, which were self-completed by the study volunteers, referring to 2 weekdays and 1 weekend day. Volunteers were instructed to fill in food records based on food consumption; when the records were complete, they were delivered in person before the pandemic and sent via email during the pandemic.

The calculation for the analysis of dietary adequacy was performed using the software Food Processor, version 7.2. Evaluation of dietary adequacy was based on the estimated average requirement (EAR) to meet the nutritional needs of a group and the recommended acceptable macronutrient distribution range (AMDR) from the Institute of Medicine (IOM).[18-20]

Qualitative evaluation of food consumption followed the NOVA classification criteria, which subdivides foods into the following 4 categories: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods.[21]

Evaluation of health outcomes during the COVID-19 pandemic and death

Evaluation of health outcomes was carried out by trained professionals, by telephone, with a standardized approach and online questionnaires that were self-filled via Google Forms by volunteers during the pandemic, during the period corresponding to the second lockdown in the city of Rio de Janeiro, evaluating whether they showed any changes in body weight or waist circumference during the pandemic as well as the presence of occurrences such as hospitalization and surgical procedures. New diagnoses were confirmed by analysis of medications taken by the volunteers; the most commonly reported were rosuvastatin, enalapril, atorvastatin, and captopril. We also evaluated whether the volunteers had health complications during the last 2 years.

During reevaluation, volunteers were virtually instructed to measure body weight on a home scale and waist circumference by passing the measuring tape at the height of the narrowest waist.[21] On the online questionnaire, volunteers were also asked about COVID-19 diagnosis by PCR, presence of symptoms, and hospitalization due to COVID-19; these data were self-reported.

Data on all-cause mortality were collected from the website of the Judicial Internal Affairs Office of the State of Rio de Janeiro, and multiple-cause mortality data were collected from death certificates made available on the Mortality Information System (SIM, acronym in Portuguese) of the Health Department of the State of Rio de Janeiro. [22-24]

Statistical analysis

Statistical analyses were conducted using IBM® SPSS® Statistics software, version 21. Categorical variables were expressed as percentages and analyzed using the chi-square test. The normality of continuous variables was evaluated using the Kolmogorov-Smirnov method. The continuous variables did not present a normal distribution and, therefore, were expressed as median and interquartile range. Mann-Whitney test, Spearman correlation, and binary logistic regression were also used (with the aim of predicting the values taken during reevaluation of volunteers as a function of the independent variables related to the beginning of the study). P values < 0.05 were considered significant.

Results

We evaluated 491 women without any disease diagnosis or previous nutritional follow-up. Their characteristics are shown in Table 1. The MHO group accounted for 51.73% of the sample (n = 254), with a median age of 38 years (20 to 59), and the MUHO group accounted for 48.27% of the sample (n = 237), with a median age of 46 years (20 to 59). The MHO group had higher level of education, lower per capita income, and higher level of physical activity.

Reevaluation was carried out in March 2021, during the second period of social isolation. Less than 30% of contacts from the initial sample were retrieved (n = 120). Among the volunteers contacted, only 24.16% (n = 29) completed the reevaluation questionnaires. The other volunteers did not respond to contact attempts via e-mail and/or changed their telephone numbers. It was thus necessary to perform a re-characterization of this subsample of the study population, in order to assess its representativeness in relation to the other volunteers in the study. Of the volunteers who completed the reevaluation (n = 29), 51.73% belonged to the MUHO group (n = 15). Subsequently, binary logistic regression was carried out in order to observe whether the women who were reevaluated (n = 29) had any similarity in relation to the rest of the sample that was not reevaluated (n = 462). We were able to conclude that there was no evidence that the women who completed the reevaluation were different from the women who did not, and they were good representatives of the study population (Table 1).

In comparative evaluation, the MUHO group had worse anthropometric and biochemical profile when compared to the MHO group. There were no statistically significant differences in the variables reevaluated throughout the pandemic (Table 1).

Among all women followed up in the study (n = 491), 2% died (n = 10), with 0.6% (n = 3) in the MHO group and 1.4% in the MUHO group (p = 0.10). Deaths were related to neoplasms (n = 4), cardiovascular diseases (n = 2, both in the MUHO group), unspecified respiratory failure (n = 1), pulmonary embolism (n = 1), and causes that were not identified in the databases (n = 2).

We observed that the MUHO group had more harmful health outcomes. This evaluation was confirmed by the medications used and self-reported by the volunteers. Diagnoses of other diseases were reported, such as polycystic ovary syndrome, endometriosis, and non-alcoholic steatohepatitis, which stood out to the extent that it affected approximately 31.3% of metabolically unhealthy women and 3.44% of metabolically healthy women. The other reported diseases affected less than 6% of the total sample. The percentage of hospital admissions due to aesthetic reasons and for cesarean section was higher in MHO (13.79% versus 6.25%) than in MUHO (p = 0.18) (Figure 1).

With respect to evaluation of health complications associated with COVID-19, 55.2% of MHO and 50% of MUHO reported positive PCR for COVID-19 (p = 0.09), and 51.7% of MHO and 75% of MUHO reported COVID-19 symptoms (p = 0.05). The most commonly reported was dyspnea on minor exertion, which was present in 44% of MHO and 31.3% of MUHO (p = 0.61). Additionally, 17.2% of MHO and 37.5% of MUHO reported that they sought nutritional counseling (with a professional nutritionist) to change their eating habits during the pandemic (p = 0.13).

Evaluation of adequacy of dietary composition during the pre-pandemic period showed a significant difference in relation to intake of lipids (p = 0.01), saturated fat (p = 0.01), and total dietary sodium (p = 0.04). Analysis of caloric intake from ultra-processed foods showed no significant differences between the groups (Table 2). However, during the pandemic period, there was a significant difference in intake of energy (p = 0.04), lipids (p = 0.02), saturated fat (p = 0.02), and proteins (p = 0.03). Evaluation of dietary composition and adequacy are displayed in Table 2. Quantitative analysis of caloric intake from ultra-processed foods showed a significant difference in sodium intake from ultra-processed foods between the groups during the pandemic period (p = 0.03) (Table 2).

Qualitative dietary evaluation was divided into 3 parts. The first part comprised comparative analysis between the groups, where the frequency of ultra-processed foods was higher in the MUHO group before (p = 0.10) and during the pandemic (p = 0.05). The second analysis evaluated the percentage of intake of ultra-processed foods in relation to total energy value (TEV), dividing the groups into 4 intake ranges. We observed that the MUHO group consumed more ultra-processed foods, especially in the ranges "30% to 45% of TEV" and "≥ 45% of TEV", before (p = 0.29) and during the pandemic (p = 0.12). Finally, the third analysis evaluated food consumption using the NOVA classification. We did not observe a significant difference in the consumption of ultra-processed foods (%) in relation to the total energy value during the pre-pandemic and pandemic periods and in the ranking of the 15 most consumed foods according to metabolic phenotypes. We observed that the food base of the population in both groups consisted mainly of processed and ultra-processed foods that were rich in simple carbohydrates and saturated fat (Figures 2 and 3).

The correlation test between health outcomes and food consumption during the pre-pandemic period demonstrated that dietary intake of ultra-processed foods between the groups was positively associated with the amount of total carbohydrates (ϱ = 0.878; p = 0.00), total lipids (ϱ = 0.766; p = 0.00), and saturated fat (ϱ = 0.670; p = 0.00) in the diet. In contrast, during the pandemic period, dietary intake of ultra-processed foods between the groups was positively associated with the amount of total carbohydrates (ϱ = 0.844; p = 0.00), total dietary sodium (ϱ = 0.511; p = 0.00), and saturated fat (ϱ = 0.520; p = 0.00) in the diet. The remaining variables did not show statistically significant results during either of study periods.

Table 1 – Anthropometric characteristics, blood pressure, and biochemical evaluation according to metabolic classification during the pre-pandemic and pandemic periods.

	Pre-pandemic period						
Variables	Total (n = 491)	Metabolically healthy (n = 254)	Metabolically unhealthy (n = 237)	P value	Reevaluated (n = 29)	Not reevaluated (n = 462)	P value
Age (years)	43 (20 – 59)	38 (20 – 59)	46 (20 – 59)	0.00	40 (24 – 53)	43 (20 – 59)	0.231
Weight (kg)	88 (57.4 – 165)	82.62 (57.4 – 145.2)	92.50 (59.3 – 165)	0.01	93.65 (70.2 – 145.2)	87.5 (67.4 – 165)	0.408
BMI (kg/m^2)	34.52 (26 – 64.65)	32.80 (27.11 – 51.72)	35.85 (26 – 64.65)	0.00	36.78 (26.01 – 51.45)	33.44 (26.84 – 49.61)	0.148
Waist circumference (cm)	103.0 (84.5 – 160)	99.1 (84.5 -146)	106.5 (89 – 160)	0.00	108.5 (83 – 131.7)	102.5 (84.5 – 160)	0.276
SBP (mmHg)	120 (90 – 200)	115 (90 – 200)	127 (90 – 200)	0.00	120 (90 – 160)	120 (90 – 200)	0.132
DBP (mmHg)	80 (50 – 130)	80 (50 – 120)	80 (50 – 130)	0.00	80 (50 – 100)	80 (50 – 130)	0.132
Blood glucose (mg/dL)	92 (57 – 406)	88 (57 – 228)	98 (63 – 406)	0.000	95 (65 – 189)	92 (57 – 406)	0.461
Total cholesterol (mg/dL)	201 (118 – 362)	195.5 (122 – 335)	207 (118 – 362)	0.009	202 (149 – 291)	201 (118 – 362)	0.306
LDL cholesterol (mg/dL)	122 (42 – 291)	121 (48 – 150)	126 (42 – 291)	0.185	122 (72 – 227)	122.5 (42 – 291)	0.583
HDL cholesterol (mg/dL)	46 (18 – 119)	51 (26 – 119)	42 (18 – 105)	0.000	47 (34 – 83)	46 (18 – 119)	0.480
Triglycerides (mg/dL)	126 (34 – 1463)	99 (34 – 635)	180.8 (63 – 1463)	0.000	114 (34 – 275)	126.5 (36 – 1463)	0.291
HOMA-IR	1.90 (0.17 – 31.37)	2.00 (0.17 – 15)	2.85 (0.19 – 31.37)	0.000	0.83 (0.18 – 3.00)	1.91 (0.17 – 3.38)	0.340
Insulin	8.27 (1 – 95.48)	7.98 (1 – 63)	8.37 (1 – 95.48)	0.000	4.49 (1 – 20)	8.38 (1 – 95)	0.744

Level of education	Completed primary = 31.05% Completed secondary = 48.75 % Tertiary or higher = 20.2%	Completed primary = 27.9 % Completed secondary = 51.2 % Tertiary or higher = 20.9 %	Completed primary = 34.2% Completed secondary = 46.3 % Tertiary or higher = 19.5 %	0.01	Completed primary = 34.5% Completed secondary = 41.4 % Tertiary or higher = 24.1%	Completed primary = 32 % Completed secondary = 49.4% Tertiary or higher = 18.6%	0.880
Skin color	White = 26.2% Non-white = 73.8%	White = 28.3 % Non-white = 71.7%	White = 24.1% Non-white = 75.9%	0.35	White = 20.7% Non-white =79.3 %	White = 29.6% Non-white =70.4 %	0.555
Tobacco use	Non-smokers = 95.15% Smokers = 0.8% Ex-smokers = 4.05%	Non-smokers = 94.5% Smokers = 0.8% Ex-smokers = 4.7%	Non-smokers = 95.8% Smokers = 0.8% Ex-smokers = 3.4%	0.75	Non-smokers = 96.6 % Smokers = 0% Ex-smokers = 3.4%	Non-smokers = 95 % Smokers = 0.8% Ex-smokers = 4.2%	0.920
Physical activity (pre-pandemic)	Sedentary = 71.1% Active = 28.9%	Sedentary = 65.5% Active = 34.5 %	Sedentary = 81.3% Active = 18.7 %	0.22	Sedentary = 96.6% Active =3.4 %	Sedentary = 72.7 % Active =27.3 %	0.124
Physical activity (pandemic)	Sedentary = 59.2% Active = 40.8%	Sedentary = 62.1 Active = 37.9%	Sedentary = 56.3% Active = 43.8%	0.03			
Marital status	Single = 44.3 % In a relationship = 55.7 %	Single = 46.2 % In a relationship = 53.8 %	Single = 42.2% In a relationship = 57.8 %	0.75	Single = 48.3% In a relationship = 51.7%	Single = 44.4% In a relationship = 55.6%	0.667
Per capita income (Brazilian reals)	979 (110 – 15180)	742.50 (110 – 7150)	1210 (231 – 15180)	0.02	759 (220 – 7150)	1001 (110 – 15180)	0.590
			Pandemic period				
Variables	**Total (n = 29)**	**Metabolically healthy (n = 14)**	**Metabolically unhealthy (n = 15)**	**P value**			
Current weight (kg)	87 (62 – 135)	84 (62 – 127)	90 (74 – 135)	0.17			
BMI (kg/m²)	33.29 (29.44 – 49.61)	31.46 (29.44 – 49.61)	33.66 (30.12 – 45.61)	0.29			
Waist circumference (cm)	104.50 (76 – 146)	103 (76 – 146)	109 (85 – 130)	0.63			

Results are expressed as percentages, median, and interquartile range. Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure. Statistical analysis: For the variables of age and per capita income, Mann Whitney test independent samples t test. For other variables from the pre-pandemic period, Pearson's chi-squared test. For comparative analysis during the pandemic period, Mann Whitney test was used. Significant values correspond to $p < 0.05$.

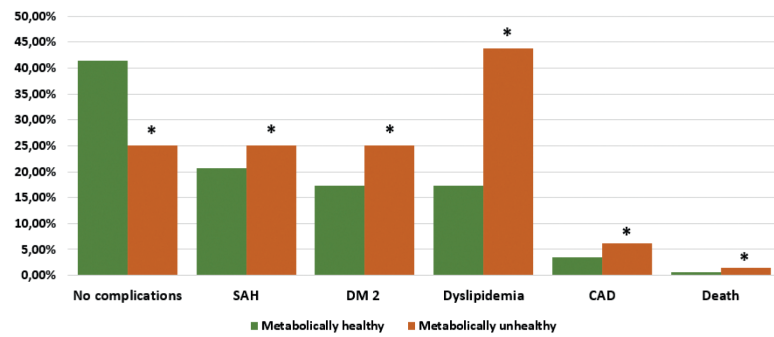

Figure 1 – Characterization of health outcomes in the sample.
Health outcomes: *death, CAD, DM2, SAH, and dyslipidemia. Diagnosis of CAD was confirmed by evaluating the medications used by the study volunteers, the most reported being: rosuvastatin, enalapril, atorvastatin, and captopril ($p = 0.00$). Results are displayed in percentages. Data were self-reported via questionnaire. Abbreviations: CAD: coronary artery disease; DM2: diabetes mellitus type 2; SAH: systemic arterial hypertension. Statistical analysis: Pearson's chi-square test, where significant values correspond to $p < 0.05$, represented by the asterisk (*).*

Table 2 – Evaluation of dietary adequacy and composition in the sample during the pre-pandemic and pandemic periods

Pre-pandemic period					
Dietary intake	**EAR/AMDR**	**Total (n=491)**	**Metabolically healthy (n=254)**	**Metabolically unhealthy (n=237)**	**P value**
Energy (kcal/day)	-	1670.79 (137.40 – 7468.96)	1594.93 (137.40 –5216.91)	1721.94 (372.10 –7468.94)	0.10
Lipids (g)	**37.13 g – 64.97 g (20 – 35% of TEV)**	48.80 (0.92 – 322.93)	44 (0.92 – 169.72)	52.41 (3.36 – 322.93)	0.01
Saturated fat (g)	**≤ 13 g (≤ 7% of TEV)**	16.32 (0.10 – 104.96)	13.87 (0.10 – 71.19)	17.16 (0.75 – 104.96)	0.01
MUFA (g)	**5.57 g (3% of TEV)**	9.49 (0 – 86.91)	8.70 (0 – 57.97)	10.14 (0.13 – 86.91)	0.18
PUFA (g)	**7.42 g (4% of TEV)**	4.29 (0 – 85.64)	4.2 (0 – 50.23)	4.46 (0.11 – 85.64)	0.14
Carbohydrates (g/day)	**188 g – 271.50 g (45 – 65% of TEV)**	223.88 (8.86 – 1501)	215.83 (8.86 – 1210.85)	232.24 (43 – 1501)	0.26
Fibers (g/day)	**25 – 30**	16 (0.5 – 79.18)	16 (1.5 – 79.18)	15.94 (0.5 – 70.57)	0.75
Proteins (g/kg/day)	**42 g – 146 g 10 – 35% of TEV**	75.10 (7.13 - 219.37)	72.65 (11.22 – 219.37)	79 (7.13 – 213.17)	0.07
Total sodium (mg/day)	**2000**	1887.35 (0 – 13342.45)	1983.00 (0 – 12158.84)	1731.52 (123.54 – 13342.45)	0.04
Vitamin E (mg/day)	**12**	1.53 (0 – 22.35)	1.35 (0 – 19.32)	1.68 (0.02 – 22.35)	0.14
Vitamin C (mg/day)	**60**	58.57 (0 – 7875.81)	64.06 (0 – 7875.81)	54.43 (0 – 4096.43)	0.43
Zinc (mg/day)	**6.8**	6.15 (0 – 38.28)	6.67 (0.23 – 38.28)	5.71 (0 – 26.56)	0.15
Selenium (mcg/day)	**45**	45.37 (0 – 375.15)	47.38 (0.06 – 296.35)	44.94 (0 – 375.15)	0.38

	Evaluation of ultra-procesed food consumption				
	Dietary intake from ultra-processed foods	**Total (n=435)**	**Metabolically healthy (n=227)**	**Metabolically unhealthy (n=208)**	**P value**
	Energy (kcal)	382.21 (0 – 5046.98)	363.38 (28.57 – 2845.87)	387.20 (0 – 5046.98)	0.33
	Total fats (g)	16.42 (0 – 338.53)	16.30 (0 – 338.53)	17 (0 – 147.17)	0.77
	Saturated fat (g)	4.60 (0 – 82.30)	4.32 (0 – 82.30)	5.0 (0 – 50.44)	0.38
	Carbohydrates (g)	43.85 (0 – 1161. 11)	40.74 (0 – 564.80)	46.72 (0 – 1161. 11)	0.37
	Sugars (g)	18.81 (0 – 1074.50)	18.32 (0 – 492.33)	19.44 (0 – 1074.50)	0.89
	Sodium (mg)	474.66 (0 – 5214.50)	471.76 (0.68-3775.25)	489.56 (0 – 5214.50)	0.05
Pandemic period					
Dietary intake	**EAR/AMDR**	**Total (n=29)**	**Metabolically healthy (n=14)**	**Metabolically unhealthy (n=15)**	**P value**
Energy (kcal/day)	-	1441.80 (733 – 4239.40)	1325.06 (856.32 – 1918.42)	1721.65 (733.00 – 4239.40)	0.04
Lipids (g)	**32 g – 56 g (20 – 35% of TEV)**	32 (5.6 – 98.85)	23.75 (7.23 – 56.81)	35.09 (5.6 – 98.85)	0.02
Saturated fat (g)	**≤ 11.1 g (≤ 7% of TEV)**	9.52 (1.51 – 43.81)	8.52 (1.61 – 19.02)	13.22 (1.51 – 43.81)	0.02
MUFA (g)	**4.8g (3% of TEV)**	8.32 (0.16 – 40.05)	5.57 (0.16 – 16.30)	9.65 (0.65 – 40.05)	0.05
PUFA (g)	**6.4 g (4% of TEV)**	2.63 (0.70 – 10.19)	2.60 (0.70 -10.19)	2.71 (1.39 – 8.89)	0.88
Carbohydrates (g/day)	**162.20 g – 234.29 g (45 – 65% of TEV)**	218.67 (93.25 – 914.50)	202.7 (129.83 – 312.20)	237.04 (93.25 – 914.50)	0.19
Fibers (g/day)	**25 – 30**	20.40 (5.86 – 61.10)	18.18 (5.86 -42.26)	23.26 (9.20 – 61.10)	0.12
Proteins (g/kg/day)	**36 g – 126.16 g (10 – 35% of TEV)**	74.02 (22.40 – 139.60)	73.16 (22.40 – 109.60)	89.27 (43 – 139.60)	0.03
Total sodium (mg/day)	**2000**	1365.80 (115.20 – 3269.90)	1139.36 (64.70 – 2563.47)	1446.63 (115.20 – 3269.90)	0.15
Vitamin E (mg/day)	**12**	1.75 (0 – 6.81)	2.0 (0.13 – 6.81)	1.66 (0 – 4.62)	0.76
Vitamin C (mg/day)	**60**	193.23 (3.64 – 552.10)	162.09 (11.70 – 407.10)	293.99 (3.64 – 552.10)	0.28
Zinc (mg/day)	**6.8**	5.0 (1.72 – 25)	3.99 (1.72 – 11.21)	5.91 (2.70 – 25)	0.06

Evaluation of ultra-procesed food consumption				
Dietary intake from ultra-processed foods	Total (n=29)	Metabolically healthy (n=14)	Metabolically unhealthy (n=15)	P value
Energy (kcal)	225.70 (0 – 1043.80)	208.82 (0 – 1043.80)	265.85 (0 – 861.33)	0.41
Total fats (g)	10.20 (0 – 45.51)	10.18 (0 – 45.51)	11.57 (0 – 42.53)	0.35
Saturated fat (g)	2.68 (0 – 24.49)	2.68 (0 – 13.22)	3.1 (0 – 24.49)	0.26
Carbohydrates (g)	29.70 (0 – 137.90)	27.90 (0 – 137.90)	35.64 (0 – 107.97)	0.44
Sugars (g)	12.45 (0 – 85.05)	12.45 (0 – 53.89)	13.95 (0 – 85.05)	0.49
Sodium (mg)	618.40 (59.41 – 1278.44)	346.22 (64.70 – 1278.44)	769.67 (59.41 – 1148)	0.03

Calculations were performed using Food-Processor and SPSS version 21 software. Results are expressed as median and minimum and maximum values. Abbreviations: AMDR, macronutrient distribution range; EAR, estimated average requirement; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. Statistical analysis: Mann Whitney test was used where significant values correspond to p <0.05.

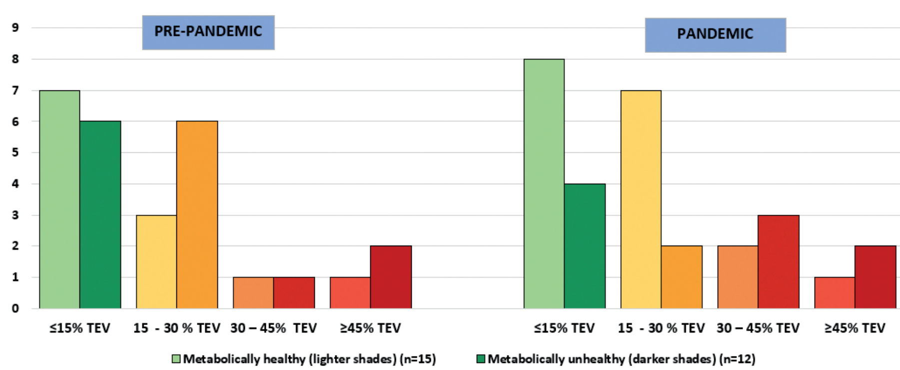

Figure 2 – Ultra-processed food consumption (%) in relation to total energy value during the pre-pandemic (p = 0.29) and pandemic (p = 0.12) periods per person according to classification of metabolic phenotypes.
The lighter shades represent the percentage intake in the MHO group, and the darker shades represent percentage intake in the MUHO group. Data are expressed as percentage of intake per person. Calculations were performed using Food-Processor and SPSS version 21. Abbreviations: MHO: metabolically healthy obese; MUHO: metabolically unhealthy obese; TEV: total energy value. Statistical analysis: chi-square test, where significant values correspond to p <0.05.

Discussion

This was a pilot study that evaluated the dietary adequacy of Brazilian women with different metabolic phenotypes, using the NOVA classification to categorize food consumption before and during the COVID-19 pandemic, correlating it with anthropometric and biochemical data, as well as adverse health outcomes and mortality. [21]

It has already been well established in the scientific literature that individuals who have a diet with a higher proportion of fibers, fruits, vegetables, and legumes, as well as lower consumption of saturated fat, dietary

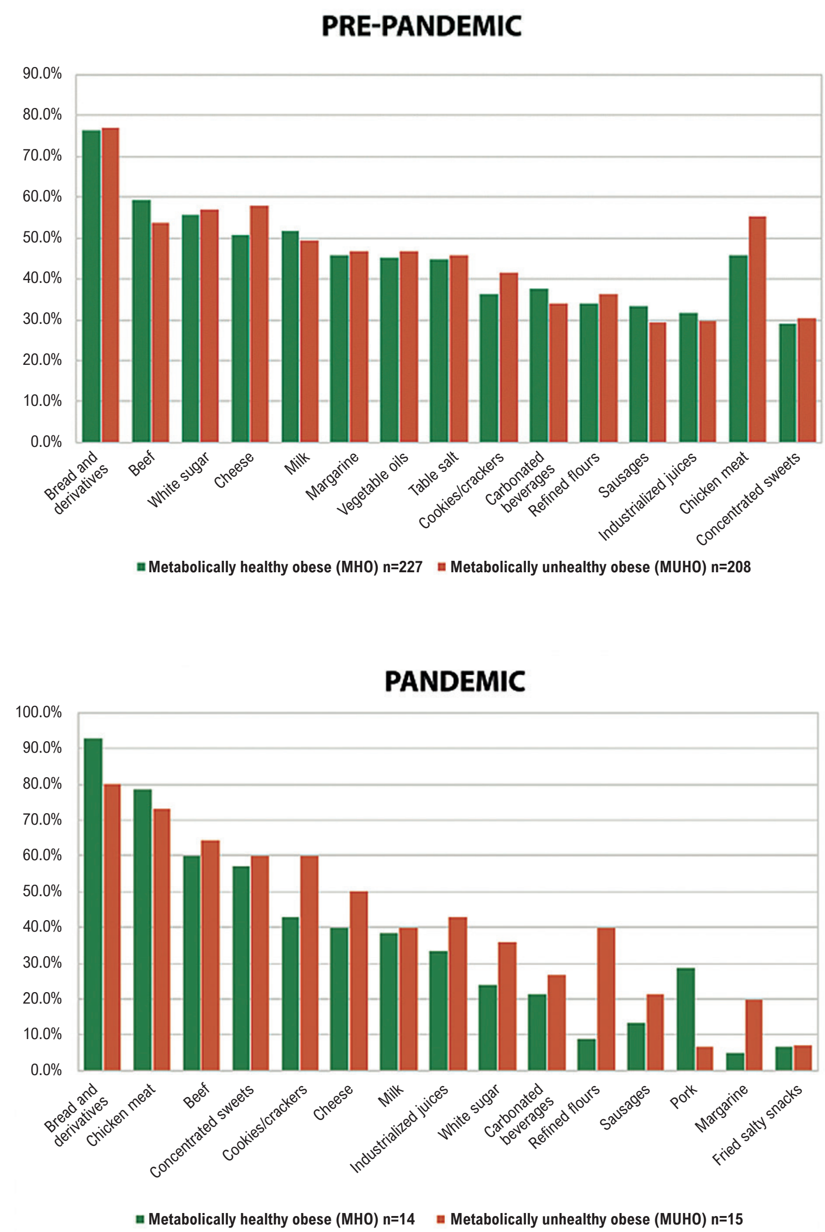

Figure 3 – Ranking of the 15 foods most consumed by the study sample according to metabolic phenotypes and NOVA classification. *Above shows the ranking of the most consumed foods during the pre-pandemic period, and below shows the ranking of the most consumed foods during the pandemic period, according to the NOVA classification (Monteiro, 2019). Results are displayed as percentages. Data were self-reported via questionnaire. Abbreviations: MHO: metabolically healthy obese; MUHO: metabolically unhealthy obese.*

cholesterol, and refined carbohydrates have lower levels of total cholesterol, triglycerides, and blood glucose, in addition to lower body weight, waist circumference, and blood pressure, thus presenting a better metabolic profile. On the other hand, it has been observed that the pandemic provoked risk behaviors and changes in dietary patterns, which increase risk factors for chronic non-communicable diseases, the worsening of COVID-19 and fatal outcomes associated with comorbidities.[22,23,25]

Our study stands out from others insofar as we carried out an evaluation that simultaneously encompassed quantitative and qualitative dietary characteristics, considering the processing steps of the foods consumed by the sample, in order to associate them with harmful health outcomes and mortality. In general, the studies present in the literature, such as the Brazilian studies by Malta (2020) and Moraes Lamounier (2021), evaluated dietary intake, taking into consideration analysis of dietary adequacy, exploring only the qualitative characteristics of ultra-processed food consumption, in comparison to daily energy intake. It is worth underscoring that both studies associated ultra-processed food consumption with greater risks of developing cancer, diabetes mellitus, and arterial hypertension.[26,27]

Similarly, studies carried out during the pandemic associated changes in food consumption with excess weight during isolation, reinforcing the impacts of social distancing on diet, body weight, and health outcomes.[28,29] We also observed the maintenance of excess weight in the women in our study, especially in the MUHO group. Other studies conducted in Italy and the United Kingdom have correlated ultra-processed food consumption with increased variety of unhealthy food consumption, as well as increased binge eating during social isolation, suggesting an increase in the practice of emotional eating during the pandemic.[30, 31]

Health outcomes and mortality were more recurrent in the MUHO group, which simultaneously presented higher ultra-processed food consumption and a clear deterioration in the quality of food consumption during the pandemic period.[21] When observing dietary intake, we found that the MUHO group had higher intake of total lipids, saturated fat, and monounsaturated fatty acids. These results were also associated with dietary inadequacy and higher ultra-processed food consumption in the same group. In the literature, other studies have associated the health impacts caused by confinement to feelings of boredom and stress, justifying the worse quality of food, bringing the concept of emotional eating and changes in eating patterns back into the debate.[29, 32]

Regarding the qualitative context of diet, we found that the pandemic intensified changes in food consumption in the study population, especially in the MUHO group. Malta et al found reduced consumption of healthy foods and increased consumption of ultra-processed foods during the pandemic. These behavioral changes were negatively correlated with diet quality and positively correlated with risk of chronic diseases.[26]

In our study, we observed that energy intake from ultra-processed foods in MUHO individuals intensified and oscillated between 30% and 45% of daily energy intake during the pandemic. This behavior differed from the characteristics shown by the MHO group, where ultra-processed food consumption was less than 15% and was limited to 30% of daily energy intake, suggesting that there was a difference in ultra-processed food consumption between the groups, especially during the pandemic period. In 2021, a study associated ultra-processed food consumption with increased risk of cardiovascular events and mortality in overweight individuals, regardless of factors such as sex and age, concluding that, for each additional daily serving of ultra-processed foods, there was a 9% increase in mortality.[33]

In the literature, it has not described cut-off points that establish a safe amount for the intake of ultra-processed foods. It has been observed that the higher the consumption of these products, the greater the negative impact on health.[34] The studies cited in this article have shown that consumption of these foods reached very wide intake ranges, oscillating between 15%, 20%, and 60% of daily energy intake It is becoming increasingly evident that behavioral factors can interfere with diet and cause increased inflammation and development of diseases in the long or short term. In our study, we observed that the MUHO group had higher intake of energy, lipids, and saturated fat in their diet, which is concerning, considering the characteristics of the sample and the worsening of the pandemic. Therefore, public health measures and actions that discourage the consumption of ultra-processed foods are necessary to minimize possible adverse effects of the pandemic.

The greatest limitation to our study was the loss of volunteers for reevaluation of food consumption. The vast majority of volunteers changed their telephone number or did not respond to attempts to contact them via e-mail and/or telephone. This is added to the fact that a large number of the participants in the MUHO group reported that, during the pandemic, they sought nutritional support in order to change their lifestyle. One of hypothesis for this was the wide dissemination of risk factors that associated excess weight with worse health outcomes in COVID-19. We believe that concerns regarding being overweight led these women to seek professional help. Nonetheless, we observed that the volunteers did not adhere to the changes in eating behavior, seeing that dietary inadequacy was maintained throughout the pandemic.

Our study's strengths include the analysis of the impacts of changes in food consumption in the context of the COVID-19 pandemic, considering metabolic phenotypes and the current NOVA classification of foods. Furthermore, this allowed thorough evaluation of the influence of dietary composition and food consumption during the pandemic on the occurrence of health outcomes and mortality.

Conclusion

We observed an increase in the frequency of consumption of processed and ultra-processed foods during the pandemic period, especially among MUHO women. Accordingly, increased consumption of these foods negatively influenced dietary quality and the worsening of behavioral risk factors during the COVID-19 pandemic. Therefore, the negative effects of social isolation may have medium- and long-term health consequences.

Author Contributions

Conception and design of the research: Lopes MB, Aranha LN, Pinto LR, De Oliveira GMM, Rosa G; acquisition of data: Lopes MB, Aranha LN, Pinto LR, Lino PCMS, De Oliveira GMM, Rosa G; analysis and interpretation of the data: Lopes MB, Aranha LN, Pinto LR, Luiz RR, De Oliveira GMM, Rosa G; statistical analysis: Lopes MB, Aranha LN, Luiz RR, De Oliveira GMM, Rosa G; writing of the manuscript: Lopes MB, Aranha LN, De Oliveira GMM, Rosa G; critical revision of the manuscript for intellectual content: Aranha LN, De Oliveira GMM, Rosa G.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Hospital Universitário Clementino Fraga Filho/ UFRJ under the protocol number 89033118.1.00005257. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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*Supplemental Materials

For the Supplemental Figure, please click here.