

Food consumption and factors related to weight variation in patients with Non-Alcoholic Fatty Liver Disease during the COVID-19 pandemic

Consumo alimentar e fatores relacionados à variação do peso de pacientes com Doença Hepática Gordurosa não Alcoólica durante a pandemia da COVID-19

Consumo de alimentos y factores relacionados con la variación de peso en pacientes con Enfermedad Hepática Grasa no Alcohólica durante la pandemia de COVID-19

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Laís Spíndola Garcêz

ORCID: <https://orcid.org/0000-0001-5818-9502>
Universidade do Estado da Bahia, Brasil
E-mail: lsgarcez@uneb.br

Carla de Magalhães Cunha

ORCID: <https://orcid.org/0000-0002-9644-7194>
Universidade Federal da Bahia, Brasil
E-mail: cdcunha@ufba.br

André Castro Lyra

ORCID: <https://orcid.org/0000-0001-9010-8645>
Universidade Federal da Bahia, Brasil
E-mail: aclyra@live.com

Rosangela Passos de Jesus

ORCID: <https://orcid.org/0000-0002-2276-0452>
Universidade Federal da Bahia, Brasil
E-mail: rosangela.jpassos@gmail.com

Lucivalda Pereira Magalhães de Oliveira

ORCID: <https://orcid.org/0000-0003-4822-5930>
Universidade Federal da Bahia, Brasil
E-mail: valdapm@hotmail.com

Abstract

This study longitudinal investigated food consumption and factors related to weight variation in 81 adult patients with Non-Alcoholic Fatty Liver Disease (NAFLD) during the COVID-19 pandemic. Sociodemographic, anthropometric, physical activity and food intake data were collected during two periods: before and during the pandemic. For analysis, variations in weight were divided into two categories: weight gain less than or equal to two kilos and weight gain greater than two kilos. Mann Whitey test was used to verify the difference between the medians, while Spearman's correlation coefficient to calculate correlations, Fisher's exact test to assess associations. The significance level adopted in the decision of the tests was 5%. Results showed increases in the consumption of processed and ultra-processed foods among NAFLD patients alongside a reduction in the consumption of natural or minimally processed foods. Both findings were more frequent among patients demonstrating weight gain greater than two kilograms. However, analysis of the nutritional composition of patients' diets revealed increases in carbohydrate consumption to be the only factor significantly correlated with weight gain. There was a high percentage of individuals who did not practice physical exercise before the pandemic, and this number was exacerbated during home isolation. Thus, it is observed that NAFLD patients have difficulty maintaining a healthy lifestyle and these difficulties have worsened during the pandemic, as reflected by weight gain. Therefore, it is suggested that specialized nutritional assistance be aimed at NAFLD patients seeing as they are at an increased risk for progression to more severe forms of COVID-19.

Keywords: Non-alcoholic fatty liver disease; Diet; Energy intake; Weight gain; COVID-19.

Resumo

Este estudo longitudinal investigou o consumo alimentar longitudinal e fatores relacionados à variação de peso em 81 pacientes adultos com Doença Hepática Gordurosa Não Alcoólica (DHGNA) durante a pandemia COVID-19. Dados sociodemográficos, antropométricos, de atividade física e consumo alimentar foram coletados durante dois períodos: antes e durante a pandemia. Para análise, as variações de peso foram divididas em duas categorias: ganho de peso menor ou igual a dois quilos e ganho de peso maior que dois quilos. O teste de *Mann Whitey* foi utilizado para verificar a diferença entre as medianas, o coeficiente de correlação de *Spearman* para calcular correlações e teste exato de *Fisher* para avaliar associações. O nível de significância adotado na decisão dos testes foi de 5%. Os resultados mostraram aumento no consumo de alimentos processados e ultraprocessados entre pacientes com DHGNA, junto com a redução

no consumo de alimentos naturais ou minimamente processados. Ambos os achados foram mais frequentes entre pacientes que apresentaram ganho de peso superior a dois quilogramas. No entanto, a análise da composição nutricional das dietas dos pacientes revelou aumentos no consumo de carboidratos como o único fator significativamente correlacionado com o ganho de peso. Houve um alto percentual de indivíduos que não praticaram exercício físico antes da pandemia, e esse número foi exacerbado durante o isolamento domiciliar. Assim, observa-se que os pacientes com DHGNA têm dificuldade em manter um estilo de vida saudável e essas dificuldades pioraram durante a pandemia, refletindo no ganho de peso. Portanto, sugere-se que a assistência nutricional especializada seja direcionada aos pacientes com DHGNA, uma vez que eles têm um risco aumentado de progressão para formas mais graves de COVID-19.

Palavras-chave: Doença hepática gordurosa não alcoólica; Dieta; Consumo de energia; Ganho de peso; COVID-19.

Resumen

Este estudio longitudinal investigó el consumo de alimentos longitudinal y factores relacionados con la variación de peso en 81 pacientes adultos con Enfermedad Hepática Grasa no Alcohólica (EHGNA) durante la pandemia COVID-19. Datos sociodemográficos, antropométricos, de actividad física y consumo alimentario fueron recogidos durante dos períodos: antes y durante la pandemia. Para el análisis, las variaciones de peso se dividieron en dos categorías: aumento de peso menor o igual a dos kilos y aumento de peso mayor que dos kilos. La prueba de Mann Whitey fue utilizada para verificar la diferencia entre las medianas, el coeficiente de correlación de Spearman para calcular correlaciones y prueba exacta de Fisher para evaluar asociaciones. El nivel de significancia adoptado en la decisión de las pruebas fue del 5%. Los resultados mostraron aumento en el consumo de alimentos procesados y ultraprocesados entre pacientes con EHGNA, junto con la reducción en el consumo de alimentos naturales o mínimamente procesados. Ambos hallazgos fueron más frecuentes entre pacientes que presentaron aumento de peso superior a dos kilogramos. Sin embargo, el análisis de la composición nutricional de las dietas de los pacientes reveló aumentos en el consumo de carbohidratos como el único factor significativamente correlacionado con el aumento de peso. Hubo un alto porcentaje de individuos que no practicaron ejercicio físico antes de la pandemia, y ese número fue exacerbado durante el aislamiento domiciliario. Por lo tanto, se observa que los pacientes con EHGNA tienen dificultades para mantener un estilo de vida saludable y estas dificultades empeoraron durante la pandemia, lo que refleja el aumento de peso. Por lo tanto, se sugiere que la asistencia nutricional especializada se dirija a los pacientes con EHGNA, ya que tienen un mayor riesgo de progresión hacia formas más graves de COVID-19.

Palabras clave: Enfermedad hepática grasa no alcohólica; Dieta; Consumo de energía; Aumento de peso; COVID-19.

1. Introduction

Over the past three decades, Non-Alcoholic Fatty Liver Disease (NAFLD) has become the most common cause of chronic liver disease in the world (Estes et al., 2018; Younossi et al., 2019). It is believed that approximately 25% of the world's population is affected by some level of NAFLD (Younossi et al., 2016). The spectrum of NAFLD ranges from simple hepatic steatosis, defined histologically as the presence of fatty infiltration in the cytoplasm of more than 5% of hepatocytes, to steatohepatitis with or without fibrosis, advanced cirrhosis and hepatocellular carcinoma (Mahady & George, 2018; Chalasani et al., 2018; Arab et al., 2020).

The occurrence of NAFLD is generally associated with components of metabolic syndrome, such as abdominal obesity, hypertension, dyslipidemia and type 2 diabetes mellitus (Preuss et al., 2018; Younossi et al., 2019) which are also risk factors for development of severe disease following infection with the new variant of coronavirus (SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2) that began transmission in 2019 (Wang et al., 2020). Therefore, NAFLD patients are at high risk for complications following SARS-CoV-2 infection (Williamson et al., 2020; Singh et al., 2021).

The disease that results from SARS-CoV-2 infection has been designated COVID-19 and is currently considered a global health emergency by the World Health Organization (WHO) (WHO, 2020; Johns Hopkins University [JHU], 2021). Brazil is one of the countries most affect by COVID-19 in terms of cases and deaths, while several Brazilian states and municipalities have been forced to adopt social distancing measures due to spread of the virus. For example, in order to reduce person-to-person contact and, consequently, control viral transmission speed, it has been necessary for these areas to ban most events, close schools, and limit non-essential business activities (Brazilian Ministry of Health, 2021; JHU, 2021; Aquino et al., 2020).

Although social distancing measures are necessary to protect public health, studies indicate that home confinement causes changes in individuals' eating behaviors, especially among lower-income populations, thus making maintaining healthy eating habits an even greater challenge during the current pandemic (Aquino et al., 2020; Ribeiro-Silva et al., 2020; Natividade et al., 2020; Ammar et al., 2020; Bezerra et al., 2020; Rodrigues et al., 2021).

Lifestyle modifications involving adequate nutrition and physical exercise remain the main non-pharmacological recommendation for treatment of NAFLD.^{4,6} Some Brazilian studies have evaluated changes in dietary intake among adults due to the COVID-19 pandemic, however, none of these studies have involved patients with NAFLD (Malta et al., 2020; Steele et al., 2020; Maynard et al., 2020; Werneck et al., 2021). The referenced studies observed reductions in the consumption of fruits and vegetables, as well as increased intake of ultra-processed foods and reduced physical exercise. The pandemic scenario has also had an impact on the body weight of individuals. A study performed in Brazil by Costa et al. (2020) demonstrated that 19.7% of the 14.259 adults evaluated gained greater than or equal to two kilograms during the pandemic period; increases in weight were associated with the prior presence of being overweight in this population.

Thus, considering the effect of food on the treatment and metabolic control of NAFLD and that, to the best of our knowledge, there are no prior studies assessing changes in eating behavior and anthropometric parameters among NAFLD patients during the current pandemic in Brazil, the objective of the present study was to investigate food consumption and factors related to weight variation in NAFLD patients during the COVID-19 pandemic.

2. Methods

2.1 Study population

This is a longitudinal observational study that evaluated the food consumption of 81 patients of both genders, aged between 20 and 60 years, with a clinical diagnosis of NAFLD confirmed by abdominal ultrasonography. Enrolled individuals agreed to participate in the study during their first consultation with the Nutritionist at the Nutrition and Hepatology Outpatient Clinic of a University Hospital Complex located in the city of Salvador, Bahia, Brazil.

Patients diagnosed with congestive heart failure, decompensated or severe lung disease, neoplasms, kidney disease, advanced liver disease (Child-Pugh C), schistosomiasis, hemochromatosis, Wilson's disease or either viral or autoimmune hepatitis were not included in the research protocol. Additionally, pregnant women, lactating women, illicit drug users and patients reporting alcohol intake greater than 20 g/day for women or 30 g/day for men (Sanyal et al., 2011) or with a history of alcoholism with abstinence for less than six months were not included in the study. The presence of any of the previously mentioned conditions, in addition to a recent history of any surgical procedure, hospitalization, or infection for up to 30 days preceding the initial interview, were considered factors capable of altering typical food consumption and, thus, were basis for exclusion from the study.

The present study was approved by the Ethics and Research Committee of the Professor Edgard Santos University Hospital Complex, with approval number 2.635.954. All eligible patients were asked to sign a consent form.

2.2 Data collection

The initial patient recruitment took place in person during the years 2018 and 2019. Subsequent to the onset of the pandemic, further contact was made through telephone calls (April to October 2020). In the face-to-face evaluations, a standardized questionnaire was used to collect sociodemographic information (gender, age, marital status, family income, number of household members and education), anthropometric measurements (weight and height) and physical exercise.

Education was assessed in full years of formal study with approval. Total family income, in terms of the Brazilian minimum wage, was defined by the sum of the income of any individual(s) occupying a single household, including incentives

from government programs; the per capita income value was then obtained by dividing the total family income by the number of household residents.

During the face-to-face consultation, weight measurements were obtained using an electronic scale (Filizola, Brazil) with 200 kg capacity and a sensitivity of 100 g, while height measurements were taken using a metric scale with a limit of 2.0 m and sensitivity of 1.0 cm (Lohman et al., 1988). The follow-up weight value obtained after the onset of the pandemic was self-reported by the patient (Carvalho et al., 2014).

Regarding physical exercise, the individuals answered whether they practiced any type of exercise and, if so, the weekly frequency. Those who reported regular physical exercise three to four times a week were considered active, which is equivalent to an average of 150 minutes per week, as recommended by the World Health Organization (WHO, 2020).

To assess food consumption prior to the onset of the pandemic, up to three 24-hour recalls were used per participant, with one being in person at the time of the first consultation and two being by telephone covering a weekend day. To assess food consumption during the COVID-19 pandemic, two 24-hour telephone recalls, also covering a weekend or holiday day, were applied per individual. All calls and consultations for data collection on food consumption were performed by a single, previously trained, researcher (Buzzard et al., 1998; Verly Junior et al., 2013).

To help the patient remember their food consumption over the previous 24 hours, the five steps recommended by the Multiple Pass Method were used, both in person and over the phone (Moshfeg et al., 2008). At the time of the presential interview, was also used a photo album of homemade measurements and portions of food produced for this project from previous publications. The 24-hour recalls had the homemade measures mentioned for each food or preparation transformed into grams (g) or milliliters (mL). The preparations were detailed based on standardized recipes and their respective ingredients were converted into homemade measures and later also transformed into g or mL (Brazilian Ministry of Health, 1996; Monteiro et al., 2007).

After converting the home measurements, Virtual Nutri Plus software (Online version) was used to obtain the energy value and nutritional composition of macronutrients and micronutrients of all the foods presented in the recalls, in order to obtain global and individual consumptions. For this study, information on food consumption regarding energy intake, carbohydrates, fiber, lipids, proteins, iron, zinc, selenium, vitamins A, E, C and calcium were all considered to be relevant.

To obtain information about increased or reduced consumption of different food groups during the COVID-19 pandemic, patients answered open-ended questions about their observed changes in food intake and acquisition, using a semi-structured script. The most frequently mentioned changes were organized into four categories: 1) consumption of fruits, vegetables and beans and 2) consumption of meat and milk, collectively representing the intake of natural or minimally processed foods; as well as 3) consumption of bread, biscuits, instant noodles, embedded foods and processed meats and 4) consumption of prepared fried foods and/or sugary foods, such as soft drinks, industrialized juices, chocolates, cakes and various sweets, collectively representing the consumption of processed and ultra-processed foods (Monteiro et al., 2018).

Participants were also questioned regarding the main factors relating to any reported changes in food intake and acquisition. The reports were organized into four categories: income reduction, increased food price, displacement restriction for food shopping and fear and anxiety caused by the COVID-19 pandemic.

2.3 Data analysis

To characterize the sample, sociodemographic, anthropometric and physical exercise data, as well as energy value and nutritional composition, were analyzed by frequencies, percentages, measures of central tendency and dispersion. The assumption of normality of quantitative variables was verified using the Shapiro-Wilk test. All data referring to food consumption had the within-person variance of each food and nutrient corrected by statistical modeling techniques incorporated in the Multiple

Source Method (MSM) software (version 1.0.1, 2011) (Hartig et al., 2011). Subsequently, through the residual method, the adjustment of nutrient consumption by energy was performed (Willett & Stampfer, 1986).

Based on information from 24-hour recalls, the individuals' daily energy intake and consumption of macronutrients, fibers and micronutrients were classified as either insufficient, adequate or high. The classification of energy intake was performed according to the values recommended by Chen et al. (2008) and by the I Brazilian guideline for the diagnosis and treatment of metabolic syndrome (Carvalho et al., 2005). For macronutrients (carbohydrates, proteins and lipids), the classification was based on percent contribution to total diet calories and the Acceptable Macronutrient Distribution Ranges (AMDR) (Institute of Medicine [IOM], 2005).

To classify fiber and micronutrient consumption, the Recommended Dietary Allowances (RDA) or, in the absence of an established RDA value, the Adequate Intake (AI) values were used (IOM, 2000; IOM, 2001; IOM, 2005; IOM, 2011). Intake of saturated fat was classified as adequate or high according to the Recommendations on Fat Consumption and Cardiovascular Health (2021), published by the Brazilian Society of Cardiology (Izar et al., 2021).

To analyze variations in weight, two categories were adopted: weight gain less than or equal to two kilos and weight gain greater than two kilos. The categories were defined according to the median weight gain of the assessed group, being similar to the cutoff point used in the study by Costa et al. (2020) To verify differences between median income variations and variables related to food consumption (energy, macronutrients and micronutrients) between the two evaluation periods according to the category of weight gain during the COVID-19 pandemic, we used the Mann-Whitney test.

Subsequently, scatter plots were used to assess the assumptions of linearity of the values of variation in macronutrient intake, income and weight. Then, since the assumption of linearity was not followed, Spearman's correlation coefficient was calculated between the investigated variables, and the values were presented through the figure of a matrix.

To assess the association between weight gain categories with the qualitative changes in reported food consumption and the main related factors, Fisher's exact test was used. The significance level adopted in the decision of the tests was 5%. All analyses, with the exception of the within-person variability adjustment, were performed using Stata[®] software, v.12 (Statacorp, College Station, Texas, USA).

3. Results and Discussion

Most of the evaluated sample was composed of women (81.5%), and the majority (51.1%) of the evaluated patients had completed high school. Before the COVID-19 pandemic, physical exercise was practiced by 35.8% of patients while, during the pandemic, the percentage of individuals practicing physical exercise decreased to 12.3%. Of the 81 patients evaluated, 48 responded to three 24-hour recalls, 18 responded to two recalls and eight responded only once in person, resulting in a total of 188 inquiries referring to the period prior to the COVID-19 pandemic. Regarding analysis post-onset of the pandemic, all evaluated patients answered two 24-hour recalls, resulting in 162 inquiries relating to this period.

The characteristics of the patients' food consumption both before and during the COVID-19 pandemic, according to the recommendations for daily food intake, are shown in Table 1. According to data obtained from the 24-hour recalls, more than 90% of patients had adequate energy consumption when considering the adopted recommendations, both before and during the pandemic, which was considered to be approximately 20 to 25 Kcal/Kg. Regarding the consumption of macronutrients, the percentage of individuals with adequate consumption of carbohydrates varied between 45% and 65% of the Total Daily Energy Intake (TDEI), while adequate protein consumption varied between 10% and 35% of the TDEI; both nutrients had similar intake values during both measurement periods. For total lipids, the percentage of individuals with high consumption decreased from 18.5% to 11.1% during the COVID-19 pandemic. Similar results were seen for the consumption of saturated lipids, for which

the percentage of individuals with high intake decreased by 21% during the pandemic. Additionally, the number of patients demonstrating adequate fiber consumption decreased by 11.1% between the evaluation periods.

Regarding micronutrients, the percentage of individuals consuming adequate amounts of vitamin A and selenium increased during the pandemic. Calcium consumption was insufficient for all individuals during both evaluation periods. All other micronutrients analyzed (vitamin C, vitamin E, iron, and zinc) demonstrated increases in the percentages of individuals with insufficient consumption during the pandemic, when compared to the previous period (Table 1).

In reference to weight variation, during the pandemic period 43.2% of patients had an increase equal to or less than two kilograms, while 56.8% gained more than two kilograms in body weight. The median weight gain in the evaluated group was 2.3 kg, with a maximum gain of 5.4 kg. Analyzing by category, a median gain of 1.1 kg was observed among patients with weight variation less than or equal to two kilograms, while a median gain of 3.7 kg was seen among patients with higher weight variation. However, no significant differences were observed between income variation and macronutrient and micronutrient consumption before and during the COVID-19 pandemic according to the weight gain categories (Table 2).

Table 1 - Food consumption characteristics of NAFLD patients before and during the COVID-19 pandemic.

| | Daily recommendation | Before the Pandemic | | | | | During the Pandemic | | | | |
|---------------------------|------------------------------|---------------------|----------------|--------------------|----------------|------------|---------------------|----------------|--------------------|----------------|------------|
| | | Median | (p25 - p75) | Insufficient n (%) | Adequate n (%) | High n (%) | Median | (p25 - p75) | Insufficient n (%) | Adequate n (%) | High n (%) |
| Energy (Kcal/Kg) | 20 – 25 ^a | 16.5 | 13.3 – 21.1 | - | 74 (91.4) | 7 (8.6) | 15.4 | 12.9 – 17.4 | - | 79 (97.5) | 2 (2.5) |
| Carbohydrate (% TDEI) | 45 – 65 ^b | 57.7 | 50.8 – 64.0 | - | 62 (76.5) | 19 (23.5) | 55.1 | 50.3 – 60.8 | - | 64 (79.0) | 17 (21.0) |
| Protein (% TDEI) | 10 – 35 ^b | 20.7 | 16.7 – 24.9 | - | 79 (97.5) | 02 (2.5) | 23.4 | 21.3 – 25.3 | - | 79 (97.5) | 02 (2.5) |
| Lipid (% TDEI) | 20 – 35 ^b | 37.6 | 22.5 – 32.5 | - | 66 (81.5) | 15 (18.5) | 24.3 | 20.3 – 29.3 | - | 72 (88.9) | 09 (11.1) |
| Saturated lipids (% TDEI) | ≤ 7 ^c | 8.4 | 6.8 – 10.9 | - | 24 (29.6) | 57 (70.4) | 7.0 | 5.6 – 8.1 | - | 41 (50.6) | 40 (49.4) |
| Fiber (g/dia) | 38 (M) 25 (W) ^d | 22.3 | 18.6 – 26.0 | 51 (63.0) | 30 (37.0) | - | 23.4 | 16.9 – 29.5 | 60 (74.1) | 21 (25.9) | - |
| Vitamin A (µg RE) | 900 (M) 700 (W) ^d | 789.5 | 393.9 – 1440.2 | 36 (49.3) | 37 (50.7) | - | 1094.2 | 679.2 – 1756.0 | 24 (29.6) | 57 (70.4) | - |
| Vitamin C (mg) | 90 (M) 75 (W) ^d | 153.1 | 85.6 – 222.8 | 16 (19.7) | 65 (80.2) | - | 88.8 | 55.6 – 120.1 | 35 (43.2) | 46 (56.8) | - |
| Vitamin E (mg) | 15 ^d | 10.2 | 7.7 – 12.5 | 77 (95.1) | 04 (4.9) | - | 6.5 | 4.8 – 8.9 | 80 (98.8) | 01 (1.2) | - |
| Calcium (mg) | 1000 ^d | 458.4 | 359.5 – 560.7 | 81 (100) | - | - | 429.2 | 319.1 – 493.5 | 81 (100) | - | - |
| Iron (mg) | 08 (M) 18 (W) ^d | 15.9 | 13.7 – 18.5 | 48 (59.3) | 33 (40.7) | - | 10.2 | 8.5 – 11.4 | 66 (81.5) | 15 (18.5) | - |
| Selenium (mg) | 55 ^d | 38.3 | 30.2 – 50.1 | 67 (82.7) | 14 (17.3) | - | 42.7 | 34.3 – 52.9 | 62 (76.5) | 19 (23.5) | - |
| Zinc (mg) | 11 (M) 08 (W) ^d | 7.5 | 6.4 – 9.7 | 49 (60.5) | 32 (39.5) | - | 7.3 | 6.7 – 8.0 | 67 (82.7) | 14 (17.3) | - |

p25 = percentile 25; p75= percentile 75; - = no data in category; ^aChen et al.⁴⁰; I Brazilian guideline for the diagnosis and treatment of metabolic syndrome;⁴¹ ^bAcceptable Macronutrient Distribution Ranges (AMDR);⁴² ^cPosition Statement on Fat Consumption and Cardiovascular Health;⁴⁶ ^dRecommended Dietary Allowances (RDA) ou Adequate Intake (AI) for men (M) and women (W);⁴²⁻⁴⁵ Kcal/Kg = Kilocalorie/Kilogram; TDEI = Total Daily Energy Intake; g = gram; µg RE = micrograms of retinol; mg = milligram. Source: Authors (2021).

Table 2 – Variation in income and food intake of NAFLD patients, according to the variation in weight during the COVID-19 pandemic

| | Weight Gain ≤ 2 Kg (n=35) | | Weight Gain > 2 Kg (n=46) | | p-value [#] |
|------------------------------|------------------------------|----------------|------------------------------|------------------|----------------------|
| | Median | (p25 - p75) | Median | (p25 - p75) | |
| Total household income (R\$) | 0.0 | -685.0 – 91.0 | 0.0 | -131.0 – 91.0 | 0.35 |
| Per capita income (R\$) | 0.0 | -273.0 – 114.0 | 0.0 | -104.0 – 110.0 | 0.48 |
| Energy (Kcal) | -91.4 | -418.7 – 129.9 | -126.4 | -289.3 – 61.3 | 0.92 |
| Energy (Kcal/Kg) | -1.3 | --5.6 – 1.7 | -1.9 | -4.3 – 0.0 | 0.71 |
| Carbohydrate (g) | -21.5 | -69.3 – 29.7 | -25.0 | -59.2 – 35.6 | 0.72 |
| Carbohydrate (g/Kg) | -0.2 | -0.9 – 0.3 | -0.3 | -0.8 – 0.3 | 0.97 |
| Fiber (g) | 2.5 | -4.7 – 6.7 | 2.8 | -4.9 – 7.3 | 0.76 |
| Lipid (g) | -5.9 | -12.5 - -0.7 | -6.7 | -13.3 - -0.9 | 0.99 |
| Lipid (g/Kg) | -0.1 (-0.2 – 0.0) | -0.2 – 0.0 | -0.1 | -0.1 – 0.0 | 0.58 |
| Saturated lipids (g) | -3.0 | -5.5 - -0.3 | -3.3 | -6.1 - -1.2 | 0.51 |
| Protein (g) | -0.1 | -8.3 – 11.3 | 2.3 | -14.8 – 13.2 | 0.88 |
| Protein (g/Kg) | 0.0 | -0.1 - 0.2 | 0.0 | -0.2 – 0.1 | 0.34 |
| Vitamin A (µg RE) | 23.9 | -792.8 – 725.1 | 375.8 | -332.3 - -1055.0 | 0.18 |
| Vitamin C (mg) | -73.5 | -165.7 – 0.5 | -40.6 | -120.5 – 15.4 | 0.24 |
| Vitamin E (mg) | -2.9 | -6.5 - -1.0 | -2.7 | -6.4 – 0.7 | 0.59 |
| Calcium (mg) | -49.6 | -90.5 – 90.6 | -66.2 | -183.1 – 75.0 | 0.56 |
| Iron (mg) | -6.5 | -9.9 - -2.6 | -5.9 | -9.0 - -3.5 | 0.88 |
| Selenium (mg) | 8.4 | -6.9 – 16.7 | 4.3 | -11.1 – 14.4 | 0.44 |
| Zinc (mg) | -0.1 | -1.6 – 1.5 | -0.6 | -2.5 – 0.6 | 0.15 |

p25 = percentile 25; p75= percentile 75; R\$ = real; Kg = Kilogram; Kcal = Kilocalorie; g = gram; µg RE = micrograms of retinol; mg = milligram; [#]Mann Whitney test. Source: Authors (2021).

Figure 1 shows the correlation matrix between the variation in weight with the variation in income and macronutrient intake of patients during the COVID-19 pandemic. Positive and statistically significant correlations were seen only for changes in carbohydrate intake and patient weight ($p < 0.05$).

Figure 1 - Correlation matrix between weight variation, macronutrient intake and income of NAFLD patients during the COVID-19 pandemic. WV = Weight variation; PV = Protein variation; CV = Carbohydrate variation; FV = Fiber variation; LV = Lipid variation; TIV = Total income variation; PCV = Per capita income variation. Spearman's correlation test: the dark cells indicate non-significant correlations and lighter ones significant correlations (p-value<0.05)*. The numbers inside the cells indicate the correlation coefficient found.

| | | | | | | | |
|-----|--------|--------|--------|--------|--------|--------|--------|
| WV | 1.000 | 0.075 | 0.322 | -0.049 | 0.055 | 0.040 | 0.062 |
| PV | 0.075 | 1.000 | -0.006 | -0.030 | 0.094 | -0.018 | -0.044 |
| CV | 0.322 | -0.006 | 1.000 | 0.029 | -0.077 | -0.022 | -0.032 |
| FV | -0.049 | -0.030 | 0.029 | 1.000 | -0.393 | -0.084 | -0.104 |
| LV | 0.055 | 0.094 | -0.077 | -0.393 | 1.000 | -0.122 | -0.191 |
| TIV | 0.040 | -0.018 | -0.022 | -0.084 | -0.122 | 1.000 | 0.880 |
| PCV | 0.062 | -0.044 | -0.032 | -0.104 | -0.191 | 0.880 | 1.000 |
| | WV | PV | CV | FV | LV | TIV | PCV |

Source: Authors.

Regarding overall changes observed in food consumption during the pandemic period, 50.6% of patients reported a reduction in the intake of fruits, vegetables and beans, and 51.8% reported a reduction in the intake of meat and milk. It was also observed that 42.0% of the evaluated individuals increased their intake of breads, cookies, instant noodles, embedded foods and processed meats, while 54.3% increased their intake of fried and/or sugary foods.

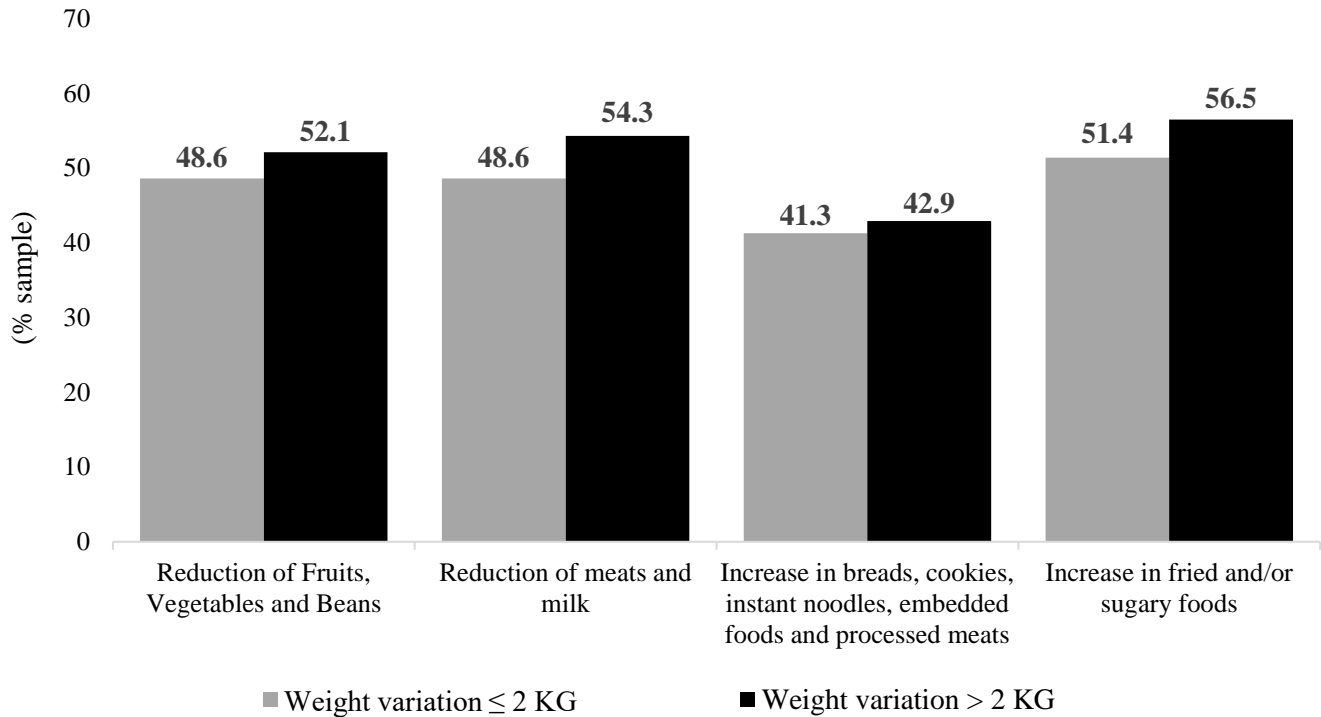
The main changes reported by respondents are described according to weight gain category in Figure 2. All changes were more frequent among patients who gained more than two kilograms when compared to those who gained less weight. However, there was no statistically significant association between changes in food consumption and weight variation during the COVID-19 pandemic (p-value > 0.05) (Figure 2).

The main factors related to changes in food consumption were income reduction (16.0%), increased food prices (28.4%) and changes caused by social isolation, especially the restriction of frequent commuting for food shopping (24.7%), fear and anxiety caused by the COVID-19 pandemic (30.9%).

The frequency of the mentioned factors was also evaluated according to weight gain category (Figure 3). It was found that income reduction (17.1%) and the effects of displacement restriction (28.6%) were cited more frequently by patients who gained two or less kilograms, while increased food prices (30.4%) and the effects of fear and anxiety were reported more

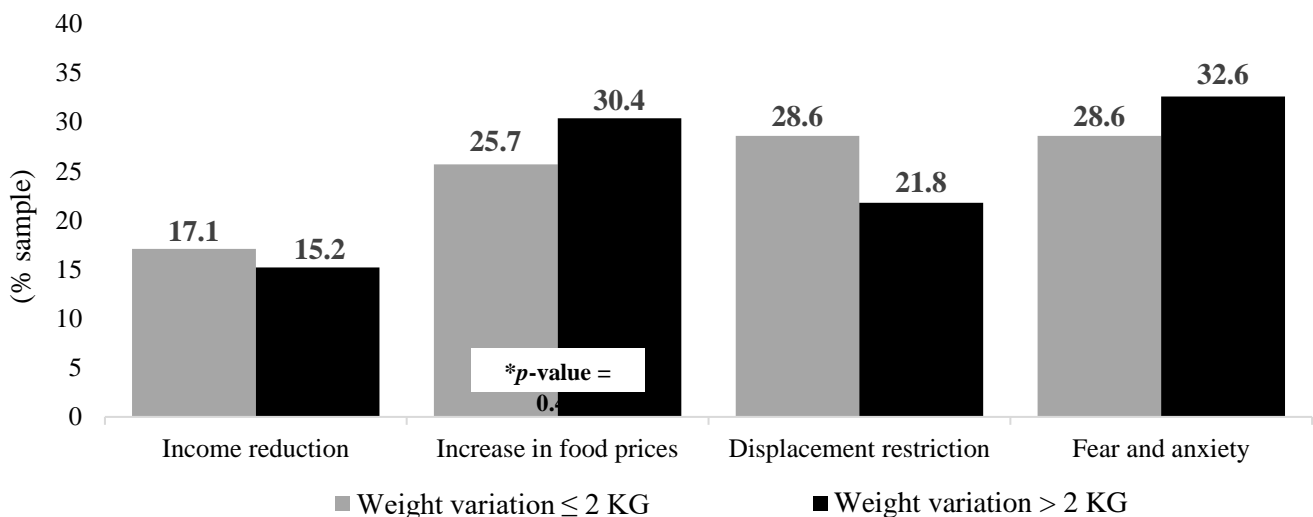
frequently (32.6%) by patients with greater weight gain. However, there was no statistically significant association between the aforementioned factors and weight variation during the COVID-19 pandemic (p -value > 0.05) (Figure 3).

Figure 2 - Main changes in food consumption observed by the NAFLD patients.



Source: Authors (2021).

Figure 3 - Main factors related to changes in food consumption observed by the NAFLD patients.



Source: Authors (2021).

Using 24-hour recalls, the present study identified that NAFLD patients followed-up in an outpatient clinic in Brazil had similar food consumption patterns both prior to and during the COVID-19 pandemic. Despite observing a median weight gain three times greater in the group with weight variation greater than two kilograms, no significant differences in food

consumption data were identified between these weight gain categories. However, there was a significant correlation between increased carbohydrate intake and patients' weight gain.

Increased carbohydrate intake through processed and ultra-processed foods was reported primarily by individuals with weight gain greater than two kilograms. It is known that high carbohydrate foods have high caloric value and can promote weight gain (Poti et al., 2017; Hall et al., 2019). Additionally, more than half of patients with weight gain greater than two kilograms reported reduced consumption of fruits, vegetables, and beans during the COVID-19 pandemic period. Therefore, there was a reduction in the intake of natural and/or minimally processed foods, as well as an increase in the consumption of processed and ultra-processed foods, i.e., eating behaviors unfavorable to the metabolic control of NAFLD (Bahrami et al., 2019; Mirizzi et al., 2019; Tutunchi et al., 2021; Salehi-Sahlabadi et al., 2021).

This result is worrying as healthy eating patterns with greater amounts of natural and minimally processed foods and lower intake of processed and ultra-processed foods, in addition to bringing benefits for the metabolic control of NAFLD, can reduce the risk of complications due to SARS CoV-2 infection, especially due to their higher content of nutrients with anti-inflammatory and antioxidant actions (Iaccarino et al., 2021; Chesnut et al., 2021; Moreb et al., 2021; Calder et al., 2021).

Recent studies have reported that COVID-19 patients are at an increased risk of evolving to more severe forms of the disease when concomitantly affected by metabolic diseases such as hypertension, diabetes and metabolic syndrome. Such comorbidities are common in NAFLD patients, therefore, these patients are considered vulnerable to progression to more severe forms of COVID-19 (Williamson et al., 2020; Singh et al., 2021; Portincasa et al., 2020; Huang et al., 2020; Hegyi et al., 2021).

The study by Zhou et al. (2020) evaluating 327 adult and elderly patients diagnosed with COVID-19, showed that patients under the age of 60 years with NAFLD had a four-fold greater risk of developing the severe form of COVID-19 compared to individuals without liver disease. This result reinforces the importance of paying greater attention to individuals with NAFLD, especially given the current circulation of the SARS-CoV-2 virus and the low vaccination coverage in Brazil.

The median caloric values for the diets of the patients analyzed in this study, both before and during the pandemic, had values below 20 kcal/kg, which is a calorie restriction indicated only for patients with obesity in specialized care (McClave et al., 2016; Bischoff et al., 2020). Since this level of calorie intake is characterized as a low-calorie diet, the observed weight gain would seem unlikely given the reported calorie intakes of less than 20 kcal/kg of body weight per day. It is believed that prior information for weight control and NAFLD, obtained through social media or through health professionals, may have influenced the report of food intake.

A possible explanation for the low caloric intake observed from the 24-hour recall data would be the underreporting of food intake by these patients. Thus, this underestimation may have influenced the assessment of the consumption of macronutrients and micronutrients, as well as the observation of the investigated associations; these findings would corroborate reports in the literature regarding the underestimation of food consumption among overweight individuals (Brazilian Association for the Study of Obesity [ABESO], 2016; Avelino et al., 2014).

Our perception is that the information provided by patients regarding observed changes in food intake and acquisition from a semi-structured script seem to have been more reliable than the data obtained from the 24-hour recalls, since the results resemble those from other national (Malta et al., 2020; Steele et al., 2020; Maynard et al., 2020; Werneck et al., 2021) and international (Ruiz-Roso et al., 2020; Chenarides et al., 2020; Marty et al., 2021; Murphy et al., 2020) studies; these studies identify that the COVID-19 pandemic has led to acquisition or exacerbation of unhealthy eating habits, such as increased consumption of sweets, desserts, embedded foods, soft drinks and other ultra-processed foods.

In the present study, it was observed that measures of social distancing, in addition to favoring weight gain, may also have affected the population's mental health, as factors such as anxiety and fear were mentioned by more than a third of the patients evaluated. These findings are similar to those presented in studies carried out on eating behaviors during the pandemic,

which have revealed that feelings of anxiety and fear can cause changes in nutritional habits and food preferences of individuals (Maynard et al., 2020; Kaya et al., 2021).

Our results showed that a high percentage of the NAFLD patients did not practice physical exercise before the COVID-19 pandemic, and that this number increased during the period of home restriction, thereby also negatively affecting the metabolic control of patients with NAFLD and other chronic diseases. This data coincides with information regarding a sedentary lifestyle being one of the main risk factors for several diseases worldwide (WHO, 2020).

Many reasons justify the study of the impact of the COVID-19 pandemic on the eating behavior of populations, including the unpredictability of the duration of the pandemic and the restrictive measures adopted for its control. Our study portrays the initial period of home confinement in Brazil, in which the city of Salvador had strict measures of social distancing and closure of non-essential activities.

It is noteworthy that the pandemic scenario brought difficulties for conducting clinical research. As limitations of the current study, one could mention the sample size, which was limited by the interruption of in-person data collection due to the COVID-19 pandemic, as a factor that may have influenced the results and promoted limitations in more robust statistical analyses, such as the development of logistic or linear regression models with proper adjustments.

The participants' self-reported weight during the pandemic can also be considered a limitation. However, studies have already shown that self-reported measures can be used to monitor adult individuals in population studies and that collection of information about weight through a telephone interview can be a viable, practical and economical instrument for use in anthropometric status monitoring studies of populations (Carvalho et al., 2014; Oliveira et al., 2012; Thomaz et al., 2013).

4. Conclusions

Food consumption of NAFLD patients did not differ significantly in the periods before and during the COVID-19 pandemic, even when comparing NAFLD patients that gained more or less than two kgs in the period. However, a significant correlation was observed between carbohydrate intake and patient weight in which carbohydrate intake was positively correlated with weight gain.

Coping measures for the COVID-19 pandemic have imposed difficulties in maintaining proper nutrition and regular physical exercise. These characteristics are worrisome with regards to the advancement of comorbidities associated with overweight individuals, as well as the metabolic control of patients with NAFLD, as a healthy lifestyle remains the basis for non-pharmacological management of the disease. Thus, special attention should be directed to patients with NAFLD, since they are at higher risk of progression to more severe forms of COVID-19, which is why we reinforce the importance of developing more studies involving this population.

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