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Adherence to the EAT-Lancet Dietary Recommendations for a Healthy and Sustainable Diet—The Case of the Brazuca Natal Study

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Abstract: Background: The "EAT-Lancet Commission Summary Report" commission remodeled the concept of healthy and sustainable diets by proposing a "diet for the Anthropocene", encouraging the development of indices that measure adherence to sustainable diets with a planetary scope. We aimed to report the adherence of adults and elderly people in a northeastern Brazilian capital to the EAT-Lancet recommendations. Methods: We used data from 411 participants in the population-based study. The dietary data were collected with Globodiet, over a standardized 24 h. The diet sustainability data were verified using the Planetary Health Diet Index (PHDI). A Pearson correlation test verified the correlation between the PHDI and the independent variables. We conducted linear regression models that were adjusted for potential confounding variables to examine the correlation between the adherence to the PHDI and the independent variables. Results: The mean total score for the adherence to the PHDI was 29.4 points in a score with a possible range from 0 to 150. Regarding the component scores, the highest scores in the adequacy component were for fruits, followed by legumes and vegetables, while the lowest scores in the moderation group were for animal fat and red meat. We observed, in the final model, that the explanatory variables for the PHDI were being male and not consuming alcohol, which were directly related to the PHDI, while having 1 to 9 years of study and being food insecure were indirectly related to the score. Conclusions: Our results showed a low adherence to a sustainable eating pattern, far from the EAT-Lancet recommendations.

Keywords: food consumption; EAT-Lancet diet; environmentally sustainable diets; diet quality

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1. Introduction

The world is facing a dual challenge of burgeoning population growth and mounting demands for higher food production [1]. In the midst of this, we live in a disparate world, with over 1 billion people being overweight and obese, 868 million suffering from hunger, and an additional 2 billion contending with micronutrient deficiencies [2]. The concept of a global syndemic pursues an integrated approach to address issues that share common factors and are influenced by social determinants. In this instance, it aims to tackle the inter-

connected challenges of the "triple burden" of pandemics involving obesity, malnutrition, and climate change [1].

This worldwide inequality underscores a significant barrier to the attainment of the Sustainable Development Goals (SDGs). The SDGs strive to eradicate poverty, safeguard the planet, and ensure the well-being of humanity by the year 2030 [3]. In this context, healthy and sustainable diets emerge, aimed at understanding planetary limits, with the aim of safeguarding the future of the next generations [4,5]. They are culturally acceptable, economically accessible, and minimize the damage to biodiversity and ecosystems [1,6]. In addition, they are safe and healthy, optimizing natural and human resources [7–9].

In 2019, the EAT-Lancet Commission Summary Report proposed a "diet for the Anthropocene" [10] of universal reference and served as a basis for the development of indexes of sustainable diets that integrate, mainly, the environmental, social, economic, cultural, and health dimensions [7,11–14]. The proposed diet consists of vegetables, fruits, whole grains, legumes, moderate or low amounts of seafood and poultry, and little or no red meat, refined grains, added sugars, and starchy vegetables [15].

Willet et al. (2019) suggest that the adoption of the reference diet needs to be prudent and should be adapted for each country and region in order to avoid unwanted impacts on health and the environment [10,16]. Low- and middle-income countries face significant challenges in adapting to climate change, resulting in more severe impacts such as reduced agricultural yields, rising food prices, scarcity of clean water, and increased incidence of disease [2,17].

An analysis of Brazilian food consumption, based on a national dietary survey—NDS-HBS (in Portuguese Inquérito Nacional de Alimentação—Pesquisa de Orçamentos Familiares—INA/POF)—in 2008–2009 [18], awakens to the cause of planetary health by signaling a greater consumption of food of animal origin with carbon and water footprints of 78% and 58%, respectively [19]. In this context, a Brazilian index appeared in 2021 to measure adherence to the proposed diet, the Planetary Health Diet Index (PHDI), a diet quality index which considers the characteristics proposed by the EAT-Lancet Commission. The development, application, and validation of this index have been previously described [20–23].

The PHDI is an index for dietary caloric density that assigns scores progressively; that is, the components can be scored according to the amount consumed, providing a better distribution of adherence and more reliable score estimates [20]. It may be advantageous to apply it in areas of Food and Nutrition Insecurity (FNI), as it enables interchangeability between equivalent food groups [16]. PHDI scores have been associated with lower greenhouse gas emissions (GHGE) and a higher overall dietary quality, as well as to differences according to age, sex, physical activity, and smoking status [20]. However, the PHDI has not yet been evaluated in terms of its associations with FNI.

Brazil is a country with continental proportions, which makes it very diverse in its climate and biomes depending on the geographical location. In turn, climate and biomes influence local history, culture, and economic activities and food system sustainability locally [24]. As these are gaps in the literature, there is a limited number of studies which assess adherence to the recommendations proposed by the EAT-Lancet Commission [11], especially in the Brazilian Northeast region, which is one of the regions of Brazil with the highest prevalence of FNI [25]. Studies indicate a low score in this region due to the low consumption of fruits and vegetables and high consumption of animal foods [22,24,26].

Given the gaps described above, we aim to assess adherence to the EAT-Lancet recommendations for healthy and sustainable diets in an individual consumption survey with adults and the elderly in a capital city in northeastern Brazil. Our purpose will be to contextualize this adherence and identify leverage points related to food consumption and FNI to simultaneously improve human and planetary health.

2. Methodology

2.1. Concept of the Study

This study involves a cross-sectional analysis of data obtained from the "Food insecurity, health and nutrition conditions in an adult and elderly population in a capital city in Northeast Brazil: Brazuca Study (Brazilian Usual Consumption Assessment)" cohort, developed in Natal, Rio Grande do Norte (Brazuca Natal Study). The city of Natal was chosen to represent the Northeast region in the Multicentric BRAZUCA study developed by the University of São Paulo (USP) and proposing to analyze the differences and similarities in the usual dietary intake and its effects on the health of the Brazilian adult and elderly population.

The sampling plan considered a two-stage probabilistic cluster sample (census tracts and households). The census tracts were drawn with a probability proportional to their size (number of households). The draw was made in order to obtain a minimum of 258 interviews for each of the following four sex and age strata: adults (20 to 59 years old) and the elderly (60 or over), both male and female. The minimum size of 258 people in each stratum made it possible to estimate a prevalence of 50%, with an error of 8% and a confidence level of 95%. The design effect (deff) was 1.5 and 15% was added as a non-response rate and closed households. The total estimated sample size was 1032 people (258 people × four strata).

Due to the COVID-19 pandemic, data collection, which began in June 2019, was suspended in March 2020. The sample resulted from the collection of data from 411 people. Of the 71 census tracts planned, 27 were surveyed (38%). According to the comparative analysis of the socioeconomic and demographic variables between the surveyed and non-surveyed sectors, it was found that the losses were random ($p = 0.135$, Little's MCAR test) and that the population was evenly distributed in the strata.

Data collection took place through a structured questionnaire on the Epicollect5® mobile platform [27], divided into five blocks with household and individual information. The complex sampling plan was based on the cluster sampling model, involving the geographic and socioeconomic stratification of all census tracts in the city of Natal-RN, followed by a random selection of tracts in the first stage and households in the second.

The inclusion criteria were as follows: adults (20 to 59 years old) and the elderly (60 or over) of both sexes, living in the city of Natal/RN. The exclusion criteria were as follows: pregnant and breastfeeding women or individuals with cognitive impairments who were unable to answer the interview questions.

This study was carried out in line with the norms and regulatory standards for research involving human beings established in the Resolution of the National Health Council No. 466/2012 and approved by the Research Ethics Committee of the University Hospital Onofre Lopes/Federal University of Rio Grande do Norte (CAAE No. 96294718.4.2001.5292, Approval No. 3.531.721). All the participants volunteered and signed an informed consent form stating the risks and benefits of the study.

2.2. Food Consumption

For the assessment of food consumption, carried out individually, the GloboDiet® software was used. It is a standardized and computerized methodology for collecting individual food consumption data developed by the International Agency for Research on Cancer [28]. The software allows for the conducting of a 24 h Food Recall (24 h) interview, guided by a model script in order to minimize errors. This software ensures a high standardization, as it accurately details foods and recipes and allows the estimating of various household measures (measurement unit and quantity) through the graphical presentation of utensils and estimated portions.

Planetary Health Dietary Index (PHDI)

The PHDI comprises sixteen components, divided into the following four categories: adequacy, optimum, ratio, and moderation, as shown in Figure 1.

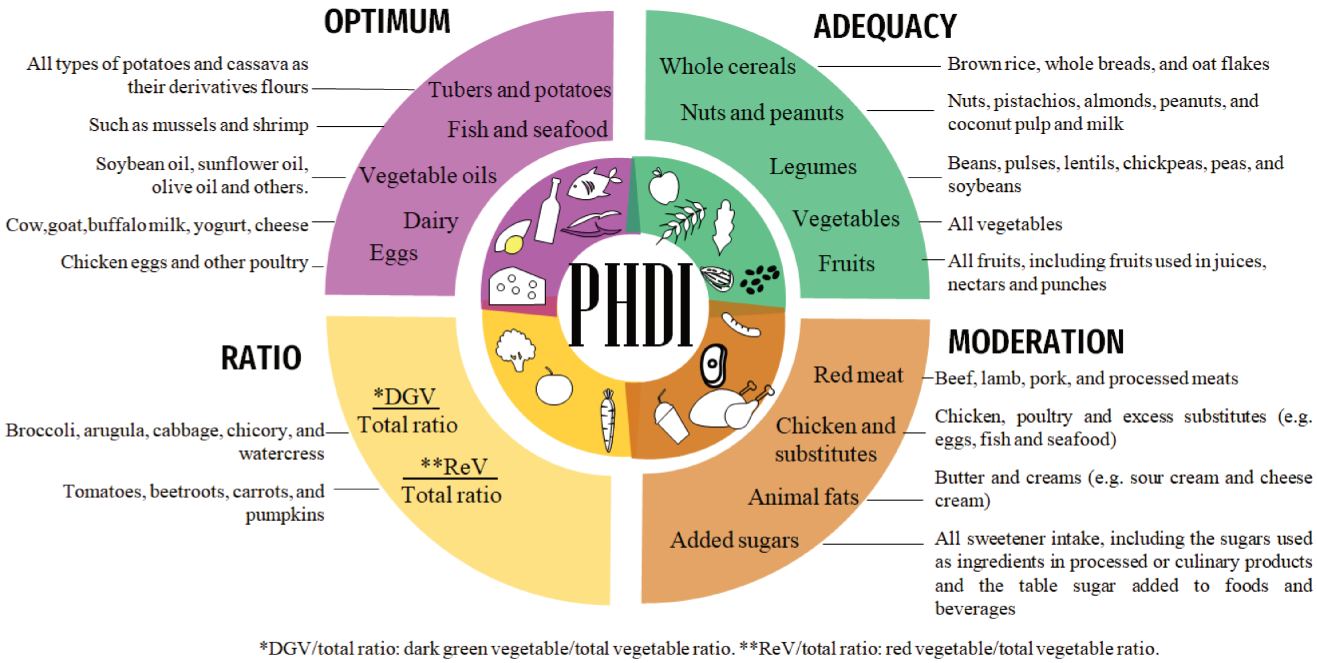

Figure 1. Food groups included in the PHDI components. Adapted from Cacau et al. [21].

A maximum of 5 or 10 points can be assigned, resulting in a total proportional score ranging from 0 to 150 points. All the components are scored between 0 points and 10 points, except for the "Ratio" component, which has a maximum score of 5 points and has a certain minimum intake level which, if exceeded, obtains a lower score; the same occurs with the "Optimum" component. A higher score is associated with a reduced consumption of foods categorized under "Moderation", while the inverse holds true for the foods falling under "Adequacy". This underscores the importance of promoting the consumption of specific foods to foster a healthy and sustainable diet. Alcoholic beverages were not included, as they are generally not counted in planetary health diet scores.

The index does not assign positive scores for a zero intake of food groups that should be moderately consumed, such as, for example, the consumption of red meat. The final score is gradual and varies according to food consumption by groups/components for each individual who has well-established scoring criteria and cutoff points [20].

According to Cacau et al. (2021), we calculated the individual PHDI score [20]. First, all foods were allocated into their proper components. Mixed recipes were identified and decomposed into their ingredients according to standardized homemade recipes available in the national literature [21].

For ultra-processed products based on a main food (e.g., wheat flour products), we calculated the fraction of the total energy of these ingredients based on the total fat content and added sugars, as described in the Norma Brasileira de Dados' Assessment of Nutrient Intake from the Food Composition Table (TBCA NIE-DB) [29]. The ultra-processed meats were distributed in the components according to the origin of the predominant ingredient, such as, for example, the chicken sausage that was contained in the moderation component in "Chicken and substitutes".

Then, the ingredients that score in the PHDI (only the food groups recommended in the EAT-Lancet report itself) both from the disaggregated mixed recipes and from the ultra-processed foods were grouped into their respective components. The score for each component was calculated based on a caloric intake rate. From this, the overall PHDI was calculated as follows:

$$\text{PHDI} = (\text{sum of the foods in each component in terms of caloric value}) / (\text{sum of all the foods included in the index})$$

2.3. Co-Variates

The dependent variable evaluated in the statistical analysis is the adherence to the PHDI. The independent variables analyzed were the following: gender, race, marital status, age, education, per capita household income, smoking, alcohol use, physical activity, body mass index (BMI), and Food and Nutrition Insecurity (FNI). Marital status was categorized into "with a partner" and "without a partner". Race was categorized into "white" and "non-white". Schooling was categorized into years of study, as follows: illiterate, 1–9 years, 10–13 years, and ≥14 years.

Smoking was stratified by current smokers, former smokers, and non-smokers. The measure based on excessive alcohol consumption (with ethanol consumption ≥140 and ≥210 g/week, for women and men, respectively) was dichotomized into yes or no [30].

The subjects were classified according to their levels of leisure-time physical activity as sedentary or physically active, according to the International Physical Activity Questionnaire (IPAQ) (≥150 min/week of moderate activity or ≥75 min/week of vigorous activity) [31].

The BMI was calculated as the weight (kg) divided by the height squared (m^2) [32]. To assess the weight, we utilized a portable scale (Líder® P200M) with a capacity of 200 kg and a precision of 50 g. Height was measured using a portable stadiometer (Avanutri®) ranging from 20 cm to 210 cm, with a graduation of 0.1 cm, secured on the base, with a stabilizer to lean against the wall, providing a greater stability to the measuring ruler. The measurement was performed with the participant standing, barefoot, touching the head, buttocks, and heels to the base of the device, with eyes fixed on the horizontal plane.

To measure the presence of FNI in the households of the interviewees, a version of the Brazilian Food Insecurity Scale (BFIS) was applied. It comprised 14 central closed questions, with dichotomous answers, about the experience in the last three months of insufficiency. Based on the sum of the scores, in which one point is assigned for each positive response, the FNI is classified into four levels: food security, mild FNI, moderate FNI, and severe FNI [33]. For this study, a continuous variable was used, and it categorized the individual as being in Food and Nutrition Security (FNS) or in FNI.

2.4. Statistical Analysis

The packaged software SPSS (IBM SPSS Statistics 22) was used for the statistical analysis. Methodological adjustments were made to ensure that the information generated from the collected subsample could provide the initially expected information; so, we used a complex sampling model, incorporating the sample design and weight to calculate population estimates.

The prevalences and the respective confidence intervals were estimated for all categorical variables. For the quantitative variables, the population means, the respective standard errors, and the confidence intervals were estimated. A Kolmogorov–Smirnov test was used to verify the normality of the outcome distribution, and, after measuring normality, a Pearson correlation test was used to verify the correlation between the outcome and the quantitative independent variables. Additionally, the averages of the outcome by categories of categorical independent variables and their respective confidence intervals were verified.

For the multiple analyses, a multiple linear regression model was used. In the initial model, all the independent variables were included. While, in the final model, adjusted for age, income, BMI, race, level of physical activity, and smoking, variables with a p-value ≤ 0.05 remained. Verification of the adequacy of the specified model was performed through a link-test, which demonstrated that the model was specified within the appropriate functional form. It was observed that the model residuals have a normal distribution, fulfilling the assumption of the regression model.

3. Results

Data were collected from 411 individuals of both sexes, with an average age of 45.06 ± 0.80 years, and they were evenly distributed among the four age and sex strata. Table 1 presents the characteristics of the analyzed population. Most participants were female (57.7%), non-white (64.7%), lived with a partner (63.3%), had between 1 and 9 years of study (43.8%), were sedentary (77.9%), did not consume alcohol (60.1%), never smoked (67.9%), and were in FNS (57.7%).

Table 1. Characteristics from the sample of participants in the Brazuca Natal Study (2019–2020).

Variables	n	N	%	95% CI *
Sex				
Male	174	14,434	42.3	28.6–40.5
Female	237	27,601	57.7	59.5–71.4
Race				
White	145	14,517	35.3	26.3–43.8
Non-white	266	27,518	64.7	56.2–73.7
Marital status				
With partner	258	26,365	63.3	56.8–69.3
No partner	153	15,291	36.7	30.7–43.2
Education				
Illiterate	28	1565	6.8	2.1–6.6
1–9 years	180	15,852	43.8	30.3–45.8
10–13 years	126	15,835	30.7	32.4–43.2
≥14 years	77	8782	18.7	14.3–29.5
Level of physical activity				
Sedentary	91	11,221	77.9	68.0–78.1
Physically active	320	30,814	22.1	21.9–32.0
Use of alcohol				
No	247	23,283	60.1	50.3–60.9
Yes	164	18,570	39.9	39.1–49.1
Smoking				
Never smoked	279	31,242	67.9	69.0–79.6
Ex smoker	99	6723	24.1	11.8–21.5
Current smoker	33	3888	8.0	6.1–13.9
BFIS **				
Food Safety	237	24,255	57.7	53.0–62.8
Food Insecurity	174	17,781	42.3	37.2–47.0

* Confidence Interval. ** Brazilian Food Insecurity Scale.

The daily average of the consumed per capita energy was 1951 Kcal (CI 95% 1866–2056), and the average score of the sustainable diet index in the population was 29.4 points (CI 95% 28.04–30.81), in a total score which can range from 0 to 150. It was estimated that the population had an average age of 45 years (95% CI 43.47–46.65), an average per capita household income of R$971.95 (95% CI 720.98–1222.92), a body mass index of 28.8 Kg/m^2 (95% CI 28.02–29.54), and a mean BFIS score of 2.19 (95% CI 1.64–2.74).

Regarding the scores of the PHDI components (Figure 2), the highest score in the adequacy components was for fruits (7.29; 95% CI 6.88–7.71), followed by legumes (6.20; 95% CI 5.84–6.61) and vegetables (5.44; 95% CI 5.09–5.76). In the group of the optimum components, the best scores were for vegetable oils (2.97; 95% CI 2.71–3.23) and dairy (2.09;

95% CI 0.46–0.81). In terms of ratio, the ReV/total ratio had the highest score (0.96; 95% CI 0.82–1.11). As for the group of the moderation components, the lowest values were for animal fat (0.30; 95% CI 0.16–0.44) and red meat (0.37; 95% CI 0.25–0.50).

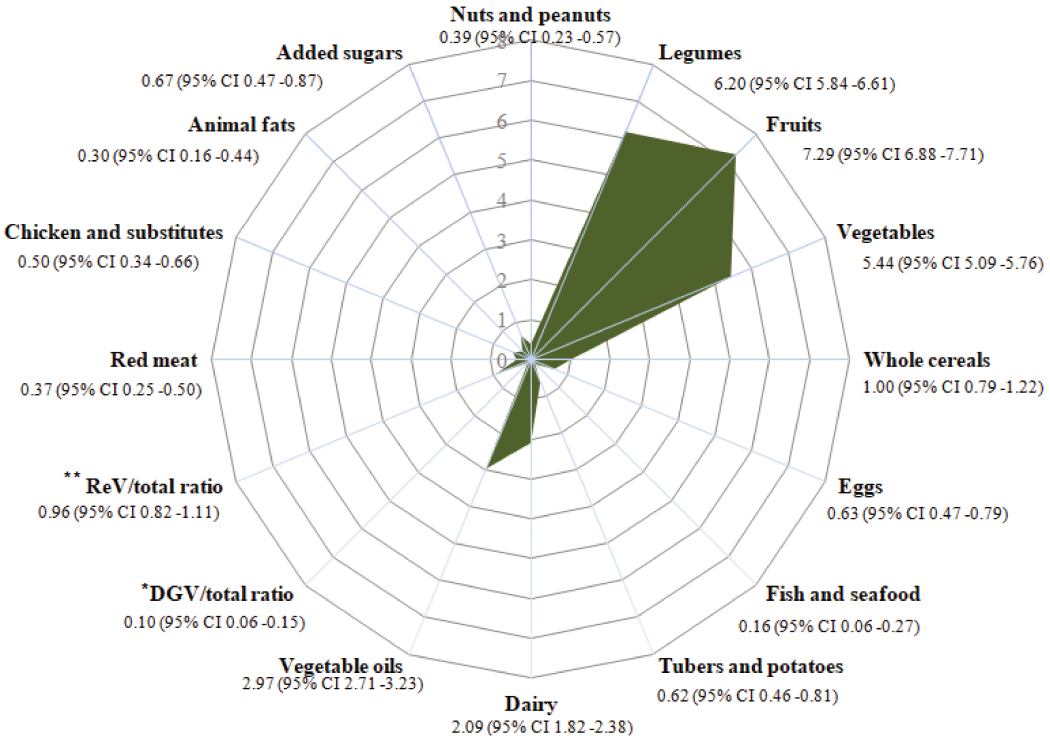

Figure 2. Planetary Health Diet Index (PHDI) component scores by food groups with their respective confidence intervals, according to dietary intake by participants in the Brazuca Natal Study (2019–2020). * DGV/total: ratio between the energy intake of and the total of vegetables (denominator) and dark green vegetables (numerator) multiplied by 10. ** ReV/total ratio: ratio between the energy intake of the total of vegetables (denominator) and red and orange vegetables (numerator) multiplied by 10.

Table 2 presents the correlation between the PHDI and the study's continuous independent variables. We recorded a positive correlation between the PHDI and the per capita income ($p \leq 0.05$), in which the higher the income per capita, the higher the sustainable diet index score in the analyzed population. Similarly, the higher the age, the greater the adherence to the PHDI, but this result was not statistically significant ($p > 0.05$). As for the BMI and FNI, there was a negative relationship, in which the higher the PHDI score, the lower the food insecurity score and the BMI ($p \leq 0.05$).

Table 2. Correlations between the PHDI scores, income, body mass index, age, and food and nutrition insecurity from the Brazuca Natal Study (2019–2020).

Variables	r	*p*-Value *
Household income per capita (BRL)	0.145	0.004
Body mass index (BMI)	−0.052	0.036
Age (years)	0.059	0.235
Food and nutrition insecurity (FNI)	−0.178	0.004

* Pearson correlation test.

When analyzing the variables which influence the Sustainable Diet index (Table 3), we observed, in the final model, that being male and not consuming alcohol were positively related to the PHDI, while having 1 to 9 years of study and being in FNI showed a negative

relationship with the PHDI. The diet sustainability index was 3.40 points higher for males. Individuals who did not consume alcohol scored 3.58 points higher on the PHDI index. Regarding education, there was a negative relationship, in which people with 1 to 9 years of study had 3.66 points less in the index compared to individuals with higher education. Similarly, each additional point on the FNI scale reduced the PHDI by 0.6 points, keeping the other conditions constant.

Table 3. Multiple linear regression of PHDI and independent variables, Study Brazuca Natal (2019–2020).

Variables		Initial Model		Final Model *	
		β	*p*-Value	β	*p*-Value
Sex	Male	3.545	0.010	3.401	0.008
Education	1–9 years of study	−1.793	0.590	−3.659	0.005
	10–13 years of study	0.839	0.816	-	-
	≥14 years of study	0.762	0.840	-	-
Alcohol consumption	Does not consume alcohol	3.678	0.014	3.576	0.016
FNI	Yes	−0.666	<0.001	−0.618	<0.001

* Link-test to evaluate the functional form of the model, $p = 0.795$; Kolmogorov–Smirnov test to evaluate the normality of the residues, $p = 0.100$. * Final model adjusted for age, income, BMI, race, physical activity level, and smoking covariates.

4. Discussion

This study evaluates the adherence to the EAT-Lancet diet by adults and elderly people in a capital city in northeastern Brazil through the application of the PHDI. In our study, the result obtained was 19.6%, far from the average of Brazilian studies which also used the PHDI and presented 40.3% [20] and 30.6% [22] of adherence. At the same time, it is similar to the average for the Brazilian Northeast region [22]. This reflects the difficulty in achieving the recommendations proposed by the EAT-Lancet Commission [10].

As evidenced in the literature, adherence to a healthy and sustainable diet is explained by sex, age, education, income, nutritional indicators, and environmental and health impacts, with the highest scores being associated with women [22,34], the elderly [22,26], people with higher education [21,34], higher per capita income [12,21,26,34], and non-obese [14,21,35], which have a lesser environmental impact [12,20,21,36] and a lower risk of non-communicable chronic diseases [23,37–41].

As a result of our study, we observed that males had higher scores on the PHDI; the same result was obtained by Shamah-Levy et al. (2020) in a Mexican study [35]. In the global context, women are the ones most affected by food crises and the resulting health impacts of deprivation. They tend to reduce their own consumption in favor of other family members in an FNI scenario. In addition, they generally have less purchasing power, which makes them more susceptible to less diverse and lower quality diets, both individually and in the households they lead, making it difficult to adhere to the recommendations for a healthy and sustainable diet [1,42].

In this context, socioeconomic aspects influence access to quality food and encourage the inequalities observed in the country [22]. In our findings, we noticed a direct correlation between the per capita income and the adherence to the PHDI and that low educational level would make this adherence unfeasible. Populations with higher incomes are able to purchase foods of greater variety and nutritional value [43]. It is also observed that lower education is one of the main challenges for the transformation of food systems [44]. Data similar to this were found by Zhang et al. (2023), who reinforced that a greater adherence to a sustainable diet occurred in people who had a university degree [34]. Previous studies describe this concern about the costs of a sustainable and healthy diet [45–48], which might be costly for less favored population strata with low educational levels [46].

It should be pointed out that a sustainable and environmentally sound diet must be affordable [12]. The implementation of government policies for food and social protection is fundamental for achieving food sovereignty. In the case of the Northeast region of Brazil, the problem is not a lack of incentives for agricultural production, as evidenced by the historical significance of sugar production during the colonial period. Instead, the issue lies in the unequal access to land [24]. Measures such as combating poverty, improving access to education, supporting family farming, and income transfer programs are social policies which have fostered the national economy, improving this situation in the last two decades [49].

From this perspective, the Food Guide for the Brazilian Population (FGBP) emerges as a nutritional education strategy that, despite not explicitly addressing the issue of sustainability, has convergent objectives [50]. It promotes sustainability by encouraging the population to prioritize whole, natural foods and predominantly plant-based options, while discouraging the consumption of ultra-processed foods [51]. Initiatives such as those of the FGBP can reduce cultural stigma, lowering the obstacles to its implementation, reducing the chasms which lead to FNI [52].

However, studies warn of the scarcity of evaluations on the social aspects of a sustainable and healthy diet [11,53]. In our findings, we deduced an inverse correlation between the PHDI and FNI scores, in which each additional point on the BFIS reduces the PHDI score. The dialogue between FNS and sustainable food is already well-established, and both are dynamic and constantly evolving concepts [2]. More recently, the HLPE (2020) established that FNS, on top of its four dimensions (availability, access, use, and stability), incorporates two more dimensions, i.e., the agency dimension, which represents autonomy, and the sustainability dimension, which reflects the adequate supply of food keeping the planet within a safe operating space [54].

Although the Brazuca-Natal participants did not even achieve half of the possible points on the PHDI, the individuals with a higher adherence had a reduced likelihood of developing overweight or obesity conditions. We observed an inverse correlation between the BMI and the PHDI, a relationship which has been well-established in other studies. For instance, Cacau et al. (2021) [21] found that Brazilians with higher PHDI scores (showing a greater adherence to the EAT-Lancet diet) were 24% less likely to be overweight or obese. The same was also observed in international studies [14,35,40]. These results suggest that following a sustainable and healthy diet can benefit both the health of the planet and human health.

Consistent with our findings, Marchioni et al. (2022), in their study of adherence to the PHDI based on food components in the Northeast region, pointed out that the highest scores were for dairy products, fruits, vegetables, legumes, and vegetable oils. However, their study differs from our findings regarding the mean scores for red meat and animal fats [22].

In our findings, we recorded the best scores on the suitability components for vegetables, fruits, and legumes. Ali et al. (2023), when assessing adherence to the EAT-Lancet diet in Gambia, had high scores for fruits and vegetables among participants from urban areas, similarly to our results [16]. Among vegetables, we observed a low score on the proportion components for dark green and orange-red vegetables, supporting the findings of Hwalla et al. (2023) [55]. Reaching the target for vegetables and fruits is one of the major challenges according to the EAT-Lancet guidelines [45,48].

Beans, a regional food and the staple diet of Northeasterners, scored the highest among legumes in the PHDI, despite a reduction in consumption by Brazilians [51,56]. The consumption of beans must be reinforced, as they strengthens the expansion of family farming, which plays a fundamental role in preserving food diversity and promoting healthy eating habits, essential for promoting FNS [57]. The decrease in bean consumption may be indicative of the contemporary Brazilian agricultural model, which is primarily focused on monocultures and the high demand for commodities such as soy, corn, wheat, and sugar [24]. It could also suggest an increase in the consumption of ultra-processed foods

or a decrease in cooking practices, compared to the period analyzed with the NDS-HBS of 2008–2009 [51].

Within the optimum components, our study identified a notable emphasis on vegetable oil intake, a trend which aligns with the observations made by Campirano et al. (2023) [58] and Marchioni et al. (2022) [22] for the Northeast region of Brazil. Next, dairy products emerged as a key component, an outcome which corresponds to the results of a national study which focused on the Northeast region [22]. This contrasts with the findings of Trijsburg et al. (2021), in which individuals consumed less than the recommended amount of dairy [12].

In our study, the lowest scores in the moderation component of the PHDI were observed for foods that should be consumed in moderation, notably, animal fat and red meat, which implies that, given the reversal of scores in this component, these individuals have a higher consumption of these foods. Although the elevated meat consumption may appear contradictory in relation to the FNI situation [25], it is crucial to bear in mind that the PHDI sets a threshold of 2.4 points for red meat consumption, equivalent to a maximum of 2.4% of the total calorie density in the diet. This limit can be easily met by foods rich in proteins and fats.

In 2010, the NDS-HBS 2008–2009 found that meat is one of the most consumed foods by Brazilians [18]. However, it is important to consider the quality of this meat, since an important portion of this consumption by individuals from Brazuca-Natal is made up of ultra-processed products (28.33%) which generally have a low nutritional quality and are cheaper, meats with a lower market value (e.g., pork and viscera), and locally processed meats, which represent 26.39% of the mentioned meats, as is the example of beef jerky and sun-dried meat. It is recommended that this consumption be moderate and replaced by dairy products, legumes, eggs, and fish [10,12].

Considering what we know, we are pioneers in assessing adherence to the EAT-Lancet recommendations for sustainability in a northeastern Brazilian capital using a national index. We think that these results can lead to the development of action strategies that have a positive impact, acting more effectively on local problems.

As an innovation in our study, there is the originality in correlating FNI and sustainability, a scarce topic in the literature but relevant in order to encourage the formulation of public policies which support compliance with the EAT-Lancet diet recommendations among residents of low- and middle-income countries, despite its potential cost of around 89% of the per capita family income [47,48]. This, in a way, addresses the deficiency that exists in the formulation of the PHDI and in several other indices, which do not consider socioeconomic aspects in their structure [11,59].

Other strengths of this study were the following: the use of complex sampling so that the Brazuca-Natal sample was representative of the entire city of Natal-RN, despite the interruption because of the COVID-19 pandemic; the use of a 24 h timeframe, which has a high validity at the individual level, since most studies are based on the frequency of food consumption; and the use of tools such as Epicollect5® and GloboDiet®, which allowed us to collect standardized and detailed information about diet and lifestyle, enabling the rigorous determination of results.

As limitations, we had the interruption of data collection because of the advent of the COVID-19 pandemic, which was circumvented in the statistical analysis. Another difficulty lies in comparing our results to other countries', because of the use of different definitions, indicators, and metrics, making comparability difficult. Another limiting point was the scarcity of studies that directly addressed FNI and adherence to sustainable diets.

5. Conclusions

Our results indicate that adherence to the EAT-Lancet recommendations for a sustainable and healthy diet is low in the northeastern Brazilian capital where the Brazuca-Natal study was developed. The analysis of food consumption highlights the need to decrease the consumption of foods in the moderation component and exchange their consumption

with equivalent food groups. In turn, vegetables, especially dark green and orange-red ones, should be encouraged to improve the quality of the diet.

In the Northeast region of Brazil, the resolution of this low adherence demands changes that should promote local initiatives, such as investing in nutritional education as a way to decrease the stigma of this kind of diet and the opening of public markets for local food, favoring access and food security while lowering food prices.

It is also essential to adopt comprehensive structural changes, such as subsidizing public policies aimed at education, support for family farming, income, and land redistribution, as well as incentives for farmers to participate in community-supported agricultural operations. In summary, these changes must recognize the significance of integrated approaches in addressing complex challenges and seek to significantly improve the quality of life and food security to achieve the EAT-Lancet diet guidelines.

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