Flexitarians in Brazil: Who are they, what do they eat, and why?

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ABSTRACT

In this study, we conducted the first scientific investigation focusing on Brazilian flexitarians, aiming to characterize their socio-economic and demographic profiles, motivations for adopting flexitarianism, the frequency of animal-based meat consumption, and the primary meat substitutes they consume. To accomplish this, we distributed an online questionnaire with the assistance of university students and researchers from various regions of the country. Data were collected from 1029 individuals in Brazil who self-identified as flexitarians. Our findings reveal that the flexitarian dietary model is primarily adopted by women, constituting 76% of the sample (n = 786). Their motivations include concerns about the environmental impact of meat consumption (n = 361, 35%), personal health (n = 344, 33%), and animal welfare (n = 219, 21%). Flexitarians exhibit varying consumption patterns, which can be categorized into three groups: light flexitarians (consuming meat 36 times a week), medium flexitarians (consuming meat 7 times a week), and heavy flexitarians (consuming meat 4 times a week). The flexitarian dietary pattern is characterized by reduced beef consumption (less than 2 times per week) and higher consumption of chicken (3 times per week). It is complemented by plant-based protein sources and eggs as the primary meat substitutes. The recognition of legumes as the principal meat substitutes opens avenues for an expanded discussion on sustainable food systems and alternative meat products in Brazil. This provides opportunities to enhance the availability and accessibility of these foods and to develop nutritional interventions that prioritize plant-based proteins.

1. Introduction

In recent years, there has been an ongoing discourse concerning the imperative to realign population dietary patterns to establish sustainable systems that adhere to planetary constraints and bolster food and nutritional security (Godfray et al., 2018; Springmann et al., 2020; Willett et al., 2019). The escalating menace of environmental crises (IPCC, 2022) and global food insecurity (FAO, 2021) has unequivocally underscored the necessity of curtailing the consumption of animal-derived foodstuffs (FAO, 2021; Willett et al., 2019), particularly in settings with an abundance of dietary choices.

As a response to the issues linked with elevated meat consumption (Godfray et al., 2018; Willett et al., 2019), an increasing cohort of individuals has embraced plant-based diets impelled by concerns for the environment, health, and animal welfare (De Backer & Hudders, 2015; Hayley, Zinkiewicz & Hardima, 2015; Kemper & White, 2021). This phenomenon perseveres even in South American nations where substantial meat consumption is deeply ingrained in tradition and culture among a significant portion of the population (Reallini et al., 2022; Bifaretti, Pavan, & Grigioni, 2023). Among this consortium of Latin American nations, Brazil emerges as a noteworthy global exporter (Hötzel & Vandresen, 2022), and available evidence highlights a marked upswing in the country's vegetarian contingent, constituting a substantial 14% of the Brazilian denizens, aggregating to an approximate tally of 30 million individuals (Hargreaves, Araújo, Nakano, & Zandonadi, 2020; IPES-Food, 2022).

Nevertheless, despite a notable shift in meat consumption, meat assumes a multifaceted role (Mensah, Mintah, Oteng, Lillywhite, & Oyebode, 2022), with its consumption deeply rooted in culture, representing a symbol of socioeconomic status for individuals (Hötzel & Vandresen, 2022). Furthermore, various factors, including food accessibility and availability, dietary policies, global dietary trends (Milford, Le Mouël, Bodirsky, & Rolinski, 2019), urbanization, media influence, as well as the impact of civil society organizations and increased education regarding food (Vargas-Bello-Pérez et al., 2017), can influence how people eat and shape themselves as either barriers or opportunities for dietary change. Therefore, the discourse on dietary transition must consider the diverse socio-cultural factors that meat consumption presents across different countries and global regions (Fourat & Lepiller, 2015), as the discussion on dietary transition must consider the socio-cultural factors related to meat consumption in various countries and global regions (Fourat & Lepiller, 2015). Excluding meat could potentially pose challenges for numerous individuals and cultures.

In this context, flexitarianism, also referred to as 'flexible vegetarianism' (Blatner, 2009), offers a promising path toward transitioning to sustainable food systems (Ruby et al., 2016). To effectively propel this transition, it is crucial to recognize and comprehend the socio-economic and motivational factors that influence the dietary choices of individuals who adopt this eating approach.

Flexitarianism is a dietary model characterized by a substantial reduction in meat consumption, measured in terms of either the quantity consumed in kilograms (kg) or the frequency of meat-based meals per week (Dagevos, 2014; Derbyshire, 2017). Simultaneously, there is an increased emphasis on incorporating seasonal plant-based foods (FAO, 2021). This dietary approach has garnered significant global attention in recent years, as evidenced by Google Trends data since 2019, along with a growing body of research literature dedicated to the subject (Derbyshire, 2017; Forestell, 2018; Google Trends, 2022; Wozniak et al., 2020).

Despite the clear relevance of flexitarianism to planetary health (Willett et al., 2019), there remains a dearth of information regarding the consumption patterns and socio-economic characteristics of individuals who adhere to this dietary regimen. Existing studies of this nature have primarily focused on the food systems of the Global North (Dagevos, 2021; Morris et al., 2021). Our research, characterized by its exploratory nature, seeks to contribute to the expanding body of literature on flexitarianism. In doing so, our study aligns with the call to prioritize research that systematizes data pertaining to the socio-economic profiles of individuals who exhibit potential shifts in dietary habits and the motivations underlying these changes within food systems. This emphasis specifically targets meat consumption patterns in countries of the Global South (Morris et al., 2021).

Given the current research gap in South American nations, our study aims to elucidate the multifaceted factors influencing the adoption of flexitarianism in Brazil. This includes profiling the individuals who embrace this dietary model, understanding their dietary habits, and discerning the motivations that guide their choices. Exploratory studies like ours have the potential to yield valuable insights that may facilitate the transition to sustainable food systems in future research endeavors.

2. Materials and methods

2.1. Participant recruitment strategies

We conducted a pilot study (n = 58) to identify any inconsistencies in our questionnaire and evaluate the effectiveness of our outreach strategy. This stage did not introduce any new questions, ensuring the continuity of our data collection process. However, it enabled us to pinpoint regions characterized by low response rates and establish collaborations with new partners and volunteers to strengthen our outreach efforts. This phase took place from March 19th to 25th, 2022, and involved the administration of a self-administered questionnaire requiring 10–20 min for completion. Subsequently, from March 26th to June 30th, 2022, we initiated our data collection phase with the support of diverse groups, educational and research institutions, professional boards, and digital influencers. The volunteers engaged in data collection primarily consisted of undergraduate students from various fields of study, journalists, and digital influencers covering a wide array of topics, each boasting an average following of 4,000 to 50,000 followers.

We enlisted at least one volunteer in each state of Brazil to actively facilitate the promotion of our data collection instrument during both the pre-collection and collection phases. Following predetermined criteria, this convenience sample surpassed our initial estimated sample size by nearly double. The recruitment of participants primarily transpired in the online realm, employing diverse strategies that encompassed the dissemination of the research questionnaire across social media platforms, websites, and institutional emails. In addition, paid research advertisements were disseminated on Instagram. These recruitment procedures adhered to established research methods commonly employed in cross-sectional studies dedicated to characterizing the vegetarian population in Brazil (Hargreaves et al., 2020). All recruitment strategies were carried out with the dedicated support of volunteers.

2.2. Sampling and inclusion criteria

To ensure the proper characterization of participants in this study, we established specific inclusion criteria for the target population. The participants were required to meet the following criteria: (i) be over 18 years of age, (ii) be residents of Brazil, and (iii) intentionally exclude meat from at least one meal per week. However, individuals who identified themselves as vegetarians or vegans were excluded from the study. This exclusion criterion was implemented to ensure that only the intended target audience (i.e., flexitarians) participated in the study, thus mitigating the risk of inaccurate characterization.

For the calculation of the sample size, we determined a minimum of 576 valid responses, considering a 5% margin of error (d), a 95% confidence level (Z = 1.96, α = 0.05), a design effect (EDFF) of 1, and a hypothetical frequency of 50% (p) in an infinite population (N). We employed the formula presented by Kasiulevičius, Šapoka, and Filipavičiūtė (2006) and performed the calculation using the OpenEpi® program (version 3.0.1).

$$n = \frac{[EDFF * Np(1-p)]}{\left[\left(\frac{d2}{Z21} - \frac{\alpha}{2} * (N-1) + p * (1-p) \right) \right]}$$

We chose an expected frequency of 50%. As the variability of a frequency increases, a larger number of samples is required. The selection of a 50% proportion signifies the maximum variability within a population and is a common choice when estimating outcomes with unknown frequencies. This choice ensures that the calculated sample size may be larger than if the true variability of the population attribute were used. In conclusion, we increased the initial sample size, denoted as "n" (n = 384), by 50%, resulting in a final "n" of 576. This adjustment was made to maintain control over bias and account for potential high non-response rates.

2.3. Data collection

2.3.1. Instrument for data collection

We utilized an online self-administered survey created through Google Forms® that consisted of two question modules. The first module encompassed socio-economic and demographic inquiries, while the second module encompassed the Food Frequency Questionnaire (FFQ), which focused on assessing the frequency of meat consumption, processed food intake, and potential alternatives to these dietary choices.

We gathered self-reported data regarding several demographic factors, which included "ethnicity" (white, Asian, multiethnic, black,

indigenous, and preferred not to answer), "education" (elementary, high school, undergraduate, master's degree, doctorate), "area of residence" (rural, urban), "income" (with an open-ended response format), "political orientation" (left, neutral, right), "gender" (cisgender woman, transgender woman, cisgender man, transgender man, non-binary, and preferred not to answer), "sexual orientation" (heterosexual, LGBT, preferred not to answer), "federal unit" (list of all Brazilian states), and "age" (with an open-ended response format). To enhance analytical precision, we aggregated response options with low frequencies, such as "elementary" and "high school."

Furthermore, we categorized the "federal units" based on the geographical regions within the country, resulting in the creation of the variable "region," which included categories for the central west, northeast, north, southeast, and south regions. Participants' income was reported in Brazilian reais (R$) through an open-ended question ("What is your total family income in Brazilian Reais?"). Subsequently, we converted the income figures from Brazilian reais (R$) to US dollars (USD) using the exchange rate in effect on December 29, 2022, where 1 US dollar equated to 5.28 Brazilian reais.

Moreover, in our investigation of factors influencing adherence to flexitarianism, we adopted a methodological approach based on a comprehensive review of specialized literature within the field. This approach was underpinned by the model proposed by Hargreaves et al. (2020) and facilitated the collection of data pertaining to patterns of plant-based diets. The variables/alternatives considered included: "concerns about environmental impact," "concerns about animal welfare," "concerns about health," "religion, beliefs or spirituality," "aversion, intolerance or allergies," and "other factors." We conducted a narrative literature review to identify key studies relevant to the topic. This involved utilizing databases such as Scopus and Web of Science, following the criteria outlined by Green, Johnson, and Adams (2006). To shed light on the motivations behind individuals' adoption of flexitarianism, we included a question designed to determine whether our participants perceive flexitarianism as a transitional step toward adopting vegetarian or vegan diets ("In your opinion, does flexitarianism serve as a pathway to transitioning to vegetarianism or veganism?"; with response options: yes, no, and maybe).

In the second module, we utilized a section of the "Adult Food Frequency Questionnaire" developed by Fisberg, Colucci, Morimoto, and Marchioni (2008). We retained the original format and wording of the questions while carefully selecting specific food items relevant to our research. Subsequently, our Food Frequency Questionnaire (FFQ) comprised 14 items encompassing both animal and plant-based protein sources. The questionnaire had previously undergone an assessment of its reproducibility, as conducted by Selem et al. (2014).

However, due to the absence of certain essential food item specifications in the questionnaire for our research, including items like mushrooms and unconventional plant-based foods, we opted to incorporate descriptions of these foods consistent with the data collection instrument employed by the Brazilian Institute of Geography and Statistics (IBGE), adhering to the national standard. Additionally, in some instances, we grouped items aligning with our analytical categories (e. g., various pork meat types were consolidated into a singular "pork" category). These groupings were derived from the IBGE and did not compromise the existing data within the FFQ.

In this dietary survey, data collection occurred once per participant. We introduced four distinct time measures (day, week, month, and year) and a range of consumption frequencies spanning from "Never" to "10 times" to capture food consumption information (Supplementary Box 1). Each participant selected the time measure that most accurately represented their consumption habits. To standardize these time measures, we converted them to a "weekly" basis. For instance, responses under the "day" measure were multiplied by 7 (to reflect the number of days in a week) and consolidated into a new database. Similarly, the "month" measure was divided by 4 (to align with the number of weeks in a month), and the "year" measure was divided by 52 (to match the

number of weeks in a year).

We categorized flexitarians into three distinct groups (i.e., heavy, medium, and light) based on their average weekly meat consumption. The heavy flexitarian consumption profile represents the average within the first tertile, the medium flexitarian profile embodies the average within the second tertile, and the light flexitarian profile corresponds to the average within the last tertile. Participants were categorized as follows: individuals who consumed meat 0 to 4 times were designated as "heavy flexitarians," those consuming meat 5 to 7 times were classified as "medium flexitarians" and those who consumed meat more than 7 times were labeled "light flexitarians". A similar approach was employed to establish income brackets, based on the means presented within each quintile.

2.4. Data analysis

For categorical variables (i.e., gender and education level), we applied Kruskal-Wallis tests, followed by Dunn's post-hoc tests, with a significance level set at $p < 0.001$. The dependent variable was the "frequency of meat consumption per meal per week," and the independent variables included "gender," "income," and "education."

As for the numerical variable "income," we conducted a Spearman correlation test with a 99% confidence level. The normality of our data was assessed using the Kolmogorov-Smirnov test, and all analyses were performed using R within the RStudio interface (R version 4.1.0).

We examined the presence of outliers and determined that the variability observed in our results is not indicative of systematic errors but rather reflects the natural variance in food consumption. Consequently, we made the decision not to exclude these data points.

2.5. Ethical considerations

Our research adhered to all regulations governing studies involving human subjects in Brazil, as outlined in Resolution of the National Health Council No. 466/2012. All research protocols were submitted to the Ethics Committee of the Onofre Lopes University Hospital (CEP/ HUOL) at the Federal University of Rio Grande do Norte (UFRN) and received approval under protocol number CAAE 5.348.343.

3. Results

3.1. Socioeconomic and demographic characteristics of flexitarians

We analyzed 1,048 responses from flexitarians residing in various regions and states across Brazil. Among these, 1,029 responses met all the research participation criteria and were deemed valid. Therefore, 19 participants were excluded for not satisfying the criteria illustrated in Fig. 1.

Our study unveiled that the majority of the investigated flexitarians were women (76%) and possessed a high level of formal education. Specifically, 52% held an undergraduate degree, while 21% held a master's degree. The level of educational attainment exhibited some gender-based variation, with 52% of female flexitarians possessing an undergraduate degree, 20% holding a master's degree, and 15% holding a doctorate. In contrast, 50% of male flexitarians held an undergraduate degree, 26% held a master's degree, and 12% held a doctorate.

Furthermore, the average total family income of these individuals amounted to USD 1,723.44, equivalent to seven and a half times the minimum wage in 2022. Table 1 displays the per capita income range, which varied from USD 236.74 to USD 8,207.

The majority of the examined flexitarians self-identified as white (60%) and predominantly resided in urban areas. Their distribution primarily concentrated in the Northeast (44%) and Southeast (28%) regions. This group exhibited political alignment with the left (68%) and represented a diverse spectrum of sexual orientations, with 72% identifying as heterosexual and 24% as LGBT.
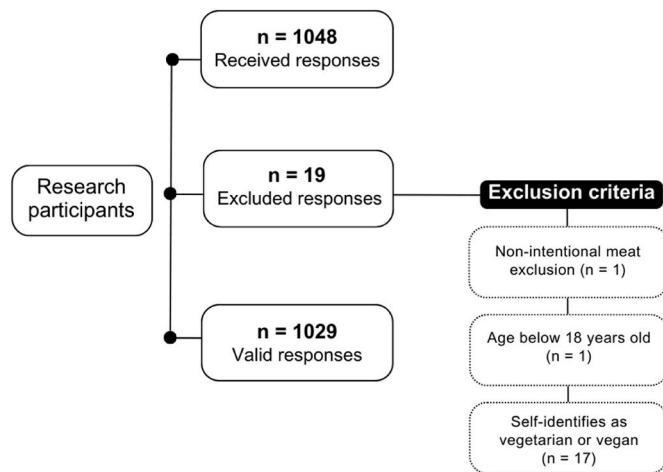
Fig. 1. Number of participants included, analyzed, excluded, and reasons for exclusion.

3.2. Meat consumption frequency: consumption profile among different groups

Based on the different consumption trends presented by the flexitarian investigated in this research, we divided flexitarians into three groups: (i) light flexitarians (33.94%): those who consume meat thirty-six times during the week; (ii) medium flexitarians (34.76%): those who consume meat seven times during the week; and (iii) heavy flexitarians (31.28%): those who consume meat four times during the week. The consumption profile with the highest percentage of participants is the medium flexitarians, and when combined with the heavy flexitarians profile, these two groups account for 66% of the total.

Each of these groups exhibits variations in the type and frequency of meat consumed per week: light flexitarians consume more chicken (5 times), beef (3 times), and processed meat (2 times); medium flexitarians consume more chicken (2 times) and have a lower consumption of processed meat (less than once a week); heavy flexitarians maintain the trend of greater consumption of chicken (1 time) and fish (1 time), with less than once a week consumption of the other meat types, except for processed meats, which were never consumed.

Despite the difference in the average frequency of consumption between these groups, they have a homogeneous consumption profile in terms of the types of meat consumed. This trend is also similar when comparing the reduction profile among the different groups of the flexitarian participants, especially concerning the gender of the participants (Fig. 2).

Our findings indicate that while the characterization of flexitarianism in our study is predominantly associated with female participants, there is no statistically significant correlation between gender and the frequency of meat consumption. Men and women exhibit similar patterns of consumption. Nevertheless, upon analyzing the specific types of meat consumed, a significant difference ($p < 0.01$) was observed, with women consuming less pork, goat, and wild game compared to men. Chicken stands out as the most consumed meat among all groups, with an average of over three meals per week.

Within this cohort of participants, higher levels of formal education may exert influence over the consumption of specific meat types. Our results suggest that, although consumption profiles appear consistent across groups with varying education levels, as depicted in Fig. 2, the consumption of fish, more prevalent among flexitarians with higher educational attainment, demonstrates significant disparities ($p < 0.01$) primarily between those with a high school education and those holding a doctoral degree. Additionally, when exploring the relationship between the frequency of meat consumption and the per capita income of flexitarians, our analysis did not reveal a correlation between meat

Table 1
Socioeconomic and demographic characteristics of flexitarians, Brazil, 2022.

Gender	n	%	99% CI*
Female	786	76.4	72.7–79.6
Male	203	19.7	16.7–23.1
Nonbinary	07	0.7	0.2–1.8
Preferred not to answer	33	3.2	2.0–5.0
Education	**n**	**%**	**99%CI**
High School	112	10.9	0.9–13.7
Undergraduate	545	53.0	49.0–57.0
Master's degree	220	21.4	18.2–25.0
Doctorate	152	14.7	12.1–17.9
Per capita income (U$D)	**n**	**%**	**99%CI**
Up to 236	203	20.4	17.3–24.0
237–420	194	19.5	16.4–23.0
421–640	199	20.0	17. 0–23.5
641–1136	219	22.0	19.0–25.6
1137–8207	178	18.0	15.0–21.3
Sexual Orientation	**n**	**%**	**99%CI**
Heterosexuals	745	72.4	68.6–76.0
LGBT	253	24.6	21.25–28.2
Preferred not to answer	31	3.0	1.8–4.7
Age	**n**	**%**	**99%CI**
18–25	185	19.7	16.5–23.3
26–31	198	21.1	18.0–24.7
32–38	183	19.5	16.3–23.1
39–49	175	18.6	15.5–22.2
50–78	198	21.1	18.0–24.7
Ethnicity	**n**	**%**	**99% CI**
White	624	60.6	56.6–64.5
Asian	25	2.4	1.4–4.0
Multiethnic	280	27.2	23.7–31.0
Black	71	7.0	5.1–9.3
Indigenous	12	1.2	0.5–2.4
Preferred not to answer	17	1.6	0.8–3.1
Region	**n**	**%**	**99% CI**
Central West	86	8.3	6.3–11.0
Northeast	453	44.0	40.0–48.1
North	61	6.0	4.2–8.2
Southeast	292	28.4	25.0–32.2
South	137	13.3	10.7–16.3
Housing area	**n**	**%**	**99% CI**
Urban	967	94.0	91.7–95.6
Rural	62	6.0	4.3–8.3
Political Orientation	**n**	**%**	**99%CI**
Left	707	68.7	64.8–72.3
Neutral	279	27.1	23.6–30.9
Right	43	4.2	2.8–6.1

CI = Confidence Interval.

reduction behavior and individuals' income (Supplementary Table 2).

3.3. Main meat substitutes

A similarity in meat consumption frequency is evident between men and women, and this pattern is likewise observed in the consumption patterns of eggs and plant-based proteins among individuals of these gender categories, as depicted in Fig. 3.

Eggs and beans were reported as the primary meat substitutes, with beans being the most consumed substitute by men. Women, on average, consume eggs five times a week, which exceeds the general participant average. In contrast, men consume eggs four times a week but have a higher bean consumption (5 times a week). Plant-based protein sources, such as legumes and soy-based veggie burgers, are typically consumed about once a week. Open-ended responses indicate that legumes, grains, and vegetables are among the main reported substitutes.
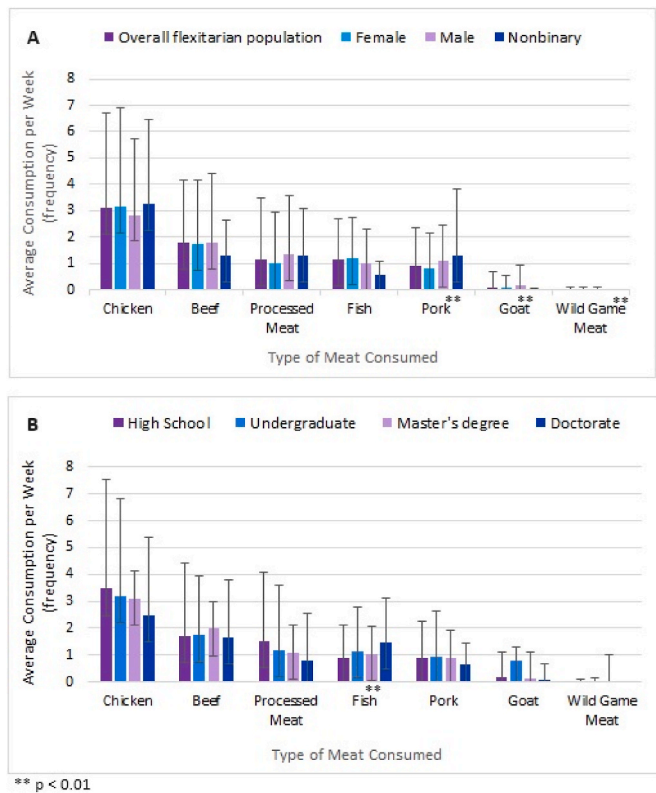
** p < 0.01

Fig. 2. Average frequency of consumption of meat in meals per week, considering (A) gender differences and (B) level of education.
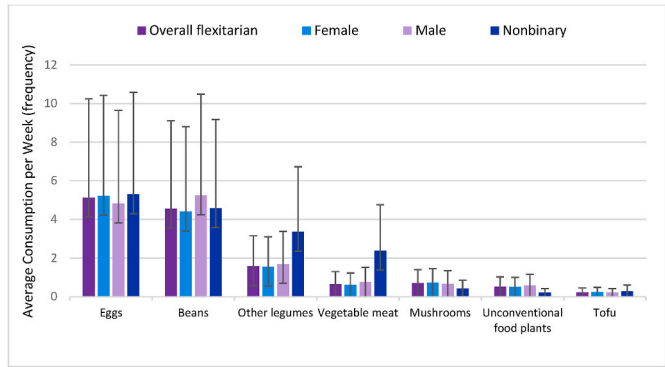

Fig. 3. Average frequency of consumption of eggs, beans and other legumes, plant-based proteins considering gender differences.

Analyzing meat substitutes based on the per capita income of our participants yielded significant results (p < 0.01) regarding the consumption of beans and other vegetable protein sources, such as mushrooms and tofu (Supplementary Table 2). Our results suggest a negative correlation between bean consumption and income, indicating that participants with lower incomes tend to consume beans more frequently. In contrast, the consumption of mushrooms, non-conventional plant foods, and tofu is more frequent among flexitarians with higher incomes.

Animal-based substitutes were also frequently mentioned as alternatives to beef, with an emphasis on eggs and cheeses. Furthermore, 61% of our participants (n = 628) stated that they view flexitarianism as, or believe it can be, a transitional step toward adopting a plant-based diet, such as a vegan or vegetarian diet.

3.4. Factors that motivate adherence to flexitarianism

The decision to embrace a flexitarian diet was driven by various factors within this participant group. Among the motivations cited, 35% of participants expressed concerns related to the environmental impact of meat production and consumption, 33% were motivated by personal health concerns, and 21% cited ethical considerations regarding animal welfare. A smaller proportion of participants indicated other motivations, such as religion, beliefs, and spirituality (4%), as well as aversions, allergies, or intolerances to meat (5%). It is important to note that these motivations exhibited variations based on the participants' consumption profiles and gender, as illustrated in Fig. 4.

4. Discussion

Brazil currently ranks third globally in meat consumption, with an average of 24 kg per capita, trailing behind Argentina and the United States (OECD-FAO, 2023). This surge in meat consumption is primarily attributed to an increase in poultry and pork consumption (Hötzel & Vandresen, 2022; OECD-FAO, 2023). Various factors contribute to this upsurge in meat consumption. In the case of Brazil, tradition and culture play a pivotal role in dietary habits and Brazilian cuisine (Ribeiro & Corção, 2013). The symbolic values associated with meat and the influence of the livestock sector in Brazilian social structure maintain a strong connection between the population and meat consumption (Ribeiro & Corção, 2013; Hötzel & Vandresen, 2022). This connection can make reducing meat consumption a challenging endeavor, especially since meat plays a central role in individuals' sociability through the culture of "barbecue" (Hase Ueta et al., 2023). Other barriers related to income (Hötzel & Vandresen, 2022) and the availability of plant-based foods as meat substitutes (GFI, 2022) can also contribute to this high meat consumption.

However, Brazilian governmental initiatives focusing on public health and nutrition emphasize the importance of reducing meat
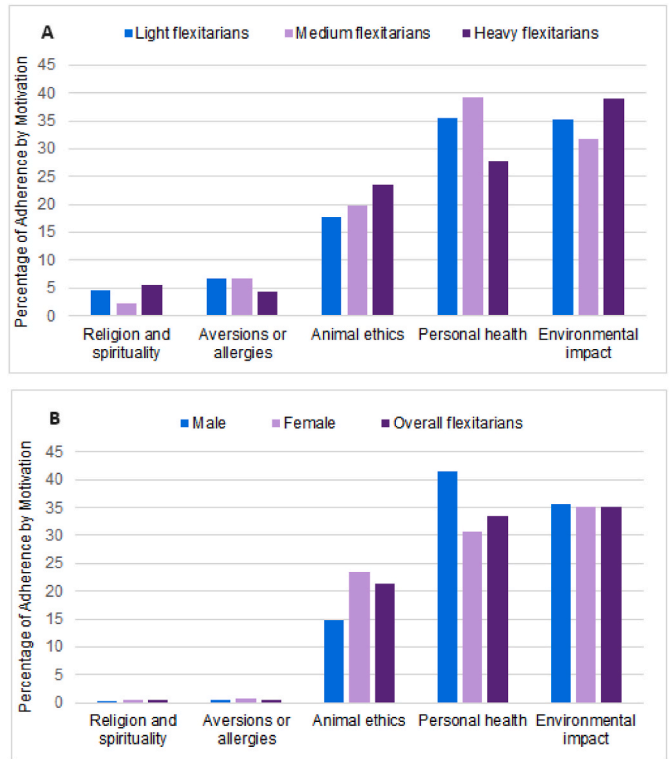

Fig. 4. Percentage of motivations for adopting a flexitarian diet according to (A) consumption profiles and (B) gender of the participants.

consumption and increasing the intake of plant-based foods (Brasil, 2014), positioning Brazil as a conducive environment for promoting dietary changes. Furthermore, Brazilians have displayed willingness to transition to reduced meat consumption, as evidenced by their growing interest in exploring new plant-based foods and considering dietary flexibility as a significant factor (Veiga, Moreira, Veiga, Souza, & Su, 2023). Additional indicators show an increase in the number of people choosing not to consume meat, including the 14% of the Brazilian population identified as vegetarians (Hargreaves et al., 2020). Furthermore, the independent census named "Mapa Veg" (2023) discloses that over 30,500 individuals are registered as vegans, vegetarians, or supporters of these dietary choices.

This positive trend of reducing meat consumption is not unique to Brazil but is also observed in other Latin American countries, such as Uruguay (Realini et al., 2022) and Argentina (Ruby et al., 2016). In this regard, our study significantly contributes to this debate by elucidating the individuals inclined to modify their habits and the reasons driving such changes. It adds to the expanding body of research investigating flexitarians worldwide (Dagevos, 2021; Halkier & Lund, 2023; Malek & Umberger, 2021; Verain, Dagevos, & Jaspers, 2022).

In general, our results reveal the following key findings: (i) the flexitarian dietary model exhibits a high adoption rate, primarily among well-educated women residing in urban areas; (ii) flexitarians display diverse meat consumption profiles, with variations in frequency based on adherence levels categorized into three groups: light flexitarians (consuming meat 36 times per week), medium flexitarians (consuming meat 7 times per week), and heavy flexitarians (consuming meat 4 times per week); (iii) eggs and plant-based protein sources, such as beans and other legumes, are the primary substitutes for meat in this cohort. These insights shed light on the demographics, dietary habits, motivations, and (iv) primary concern of these individuals, which is the environmental impact of meat consumption.

Our findings regarding the socioeconomic profile identified in our survey align with numerous studies that present a relatively uniform profile associated with meat reduction (Beardsworth et al., 2002; Kemper & White, 2021; Latvala et al., 2012; Mullee et al., 2017; Wozniak et al., 2020). In summary, these studies indicate that this group predominantly comprises individuals with high levels of formal education, primarily women, and individuals of Caucasian ethnicity. However, it's crucial to note that this profile strongly contrasts with the non-flexitarian Brazilian population, primarily composed of Black and Brown ethnic groups, which constitute 56.01% of Brazilians, with a comparatively lower level of education, as only 17.4% of individuals over 25 years old hold a college degree (IBGE, 2022a).

Another distinguishing factor is the relatively higher income among the flexitarians in our study (U$D 740.67), compared to the average income of the broader Brazilian population (U$D 256.25) (IBGE, 2022b). This suggests that purchasing power may not be the primary driver of reduced meat consumption among our participants. Furthermore, sociocultural factors such as self-reported left-wing political leanings and LGBT orientation as distinct characteristics of flexitarian identity may suggest that this dietary flexibility might also be associated with cognitive and psychological aspects, as discussed by Rosenfeld (2018). Notably, this association may be even more pronounced among our participants, with 24% identifying as LGBT, in contrast to the 12% of the Brazilian population who identify as such (Spizzirri, Eufrásio, Abdo, & Lima, 2022).

Upon analyzing the dietary consumption profile of our participants, we observed that individuals falling into the "light flexitarian" category consume an average of 36 meat-containing meals per week. This high number may be influenced by two primary factors. Firstly, the participants might be overestimating their meat consumption due to the length of the Food Frequency Questionnaire, which can lead to doubts and misunderstandings. Secondly, the self-identification of participants as flexitarians may not align with the dietary habits traditionally associated with flexitarianism. Review studies, such as that conducted by Hans

Dagevos (2021), highlight the lack of consensus on the dietary structure of flexitarianism, resulting in variations in the definition of meat reduction and the analysis of flexitarianism.

Nonetheless, it is essential to provide a detailed perspective on the meat consumption of flexitarians to facilitate more precise inferences about the impact of this dietary model on global health. This becomes particularly relevant in the Brazilian context, where the potential positive effects of a flexitarian diet on global health could be compromised if the reduction in meat consumption is offset by an increase in the export of animal-derived meats.

Despite these complexities, our results indicate that the frequency of meat consumption, particularly within the category of "heavy flexitarian," aligns with global trends reported in various studies (Dagevos, 2014; Dakin et al., 2021; Malek & Umberger, 2021). These studies, including the work of Kemper and White (2021), reveal a substantial reduction in beef consumption among flexitarians, with beef being consumed twice a week. Similar trends are also reported in market research on Brazilian flexitarians and the plant-based market, where beef consumption decreases to as little as three times a week (GFI, 2022). Malek and Umberger (2021) found that 51% of the flexitarians in their study consume meat up to 4 times a week, Kemper, Benson-Rea, Young, and Seifert (2023) found that this consumption occurs in three meals per week among New Zealand flexitarians.

The beef consumption trend among our participants also aligns with the guidelines provided by the FAO (2021), which recommend consuming red meat only once a week. This corresponds to the habits of 28% of the Brazilian population, who consume red meat once or twice a week (Santin, Gabe, Levy, & Jaime, 2022). Notably, this frequency is lower than that reported by Realini et al. (2022) in Uruguay, where 56% of their respondents consume beef up to three times a week. When examining gender differences in terms of red meat consumption within the non-flexitarian Brazilian population, a study (Santin et al., 2022) identified that 64.6% of Brazilian women and 51.6% of men consume red meat three times a week.

Our results indicated a higher consumption of white meats, particularly fish, among individuals with higher levels of education – a trend that may be associated with income. These findings are consistent with the outcomes of the Brazilian National Health Survey (Santin et al., 2022), which reported that 54.9% of people in the highest income bracket and 55% of Brazilians holding a college degree consume fish at least once a week. This implies that, within the framework of modern food systems where individuals make food purchases, there is a potential connection between socio-economic factors (such as income), motivations (e.g., health concerns), and food choices, leading to a higher preference for fish over beef.

Moreover, regardless of varying degrees of reduction in flexitarianism, we observed a consistent pattern of increased consumption of white meats and decreased consumption of red meats.

Our findings highlight that the primary plant-based meat substitutes in this group are plant proteins, specifically legumes, which are consumed in quantities ranging from one to five meals per week. These consumption frequencies of legumes as meat substitutes among flexitarians do not significantly exceed those of the general population or national dietary recommendations (Santin et al., 2022). The results regarding the primary beef substitutes also align with trends observed in studies like those conducted by Vainio, Niva, Jallinoja, and Latvala (2016), where legumes, such as beans and soy derivatives, were the main sources of protein. Particularly among flexitarians, the most consumed substitutes include vegetables, beans, and legumes, with their consumption frequency significantly surpassing that of meat eaters (Kemper et al., 2023). While these findings are preliminary in terms of comparisons, they offer valuable insights into a consumption pattern that has been relatively underexplored among flexitarians, particularly in Brazil (Dagevos, 2021).

The trend in meat substitute consumption also aligns with dietary patterns observed in plant-based diets such as vegetarianism and

veganism in various countries (Weinrich, 2018; Groufh-Jacobsen, Bahr Bugge, Morseth, Pedersen, & Henjum, 2022). This dietary pattern implies that flexitarianism could serve as a transitional step towards more sustainable food systems, especially as a significant proportion of flexitarians express that this dietary model is a steppingstone towards adopting vegan and vegetarian diets. Additionally, the consumption of diverse and underutilized foods – e.g., unconventional plant-based foods and mushrooms – (FAO, 2017) as meat substitutes may serve as an indicator of dietary quality (Lachat et al., 2018) and suggests a promising pathway towards a greater variety of plant-based products in the Brazilian market, positioning Brazil as a conducive environment for expanding the discourse and consumption of healthy and sustainable foods.

Our findings indicate that Brazilian flexitarians share motivations in line with global literature on the subject. For instance, a study of meat reducers (i.e., flexitarians) in New Zealand conducted by Kemper et al. (2023) identified environmental concerns as their primary motivation, followed by the perception of meat as being unhealthy (33%), with 28% expressing concerns about animal welfare. In our research, the primary reasons for embracing a low-meat diet among Brazilian flexitarians are associated with the ethical aspects of meat consumption, encompassing environmental concerns and animal welfare. These combined factors account for 56% of all the motivations driving our participants' choices, followed by individual health concerns (33%).

Taking these motivations into account, we believe that within flexitarianism, a connection may exist between the concepts of environmental conservation and animal rights, which often align with the political spectrum. Women and individuals on the left end of the political spectrum tend to be more inclined to advocate for these issues (Birch, 2019), while conservative or right-leaning individuals often provide stronger justifications for animal consumption (Mertens et al., 2020). Similar findings have been reported by Duckett, Lorenzo-Arribas, Horgan, and Conniff (2020) and Kemper and White (2021), who examined motivations associated with flexitarian adherence, highlighting awareness of the environmental impacts of meat consumption, individual health concerns, and animal welfare concerns.

Other studies (Dakin et al., 2021; Hanras, Mathieu, Chevrier, Boujut, & Dorard, 2022; Malek & Umberger, 2021; Mullee et al., 2017; Rosenfeld, Rothgerber, & Janet Tomiyama, 2020) also corroborate these factors. For instance, Malek and Umberger (2021) found that 52% of individuals classified as "heavy meat-reducers" are motivated by the environmental impact of meat, while 68% of "moderate meat-reducers" are motivated by health concerns.

In summary, these studies reveal that the trends in reduced meat consumption are underpinned by two main categories of factors: (i) ethical and moral motivations tied to environmental and animal welfare concerns, and (ii) individual considerations, including health concerns, aversion to the taste of meat, and religious restrictions. The motivations for reducing meat consumption vary based on the gender and consumption profile of our participants.

Our findings diverge from the information presented by The Good Food Institute (2022) concerning motivations for meat reduction. According to their study, 45% of participants adopted the flexitarian model due to the high economic cost of meat, followed by health concerns (36%). Within the research of the Institute, environmental impact and animal welfare concerns were also mentioned but to a lesser extent. These results suggest that there might be two distinct groups within the population that can be regarded as flexitarians: (i) those who willingly choose to follow a flexitarian dietary pattern, and (ii) those who are compelled to adopt this dietary behavior due to financial constraints. To prevent potential confusion in determining who qualifies as a flexitarian, it's crucial to clearly differentiate between these groups. In this context, the motivations guiding dietary choices can demarcate the boundaries between individuals who are flexitarians and those who are economically disadvantaged. While the first group consciously opts to reduce meat consumption in their diet, the second group exhibits this dietary behavior due to external financial limitations.

In this latter case, distinguishing between flexitarians and individuals with limited resources can be challenging. The context in which flexitarianism emerged reinforces this argument, revealing that this dietary model was designed for those aspiring to become vegetarians but who occasionally wish to include meat in their diet, particularly during social events. This may provide a plausible explanation for the differing motivations found between our participants and those of the other study (GFI, 2022), particularly when considering that 60% of our participants stated that flexitarianism serves as a path toward adopting a vegetarian or vegan diet.

In summary, our study offers valuable insights into the adoption of flexitarianism and the primary characteristics of this cohort in Brazil. Nevertheless, our study comes with a principal limitation, which is the utilization of a non-probability sampling approach based on a convenience sample comprising individuals with access to smartphones and the internet. Despite our efforts to mitigate biases in participant selection by widely promoting the research across diverse regions of Brazil and in various contexts, we advise caution when interpreting certain results, such as the concentration of participants in the Northeast and Southeast regions. This concentration may reflect the reach of our research rather than the true representation of the target audience.

Moreover, it is essential to consider the potential influence of memory bias when employing food frequency questionnaires (FFQs) as a method to assess dietary intake. FFQs are inherently retrospective, relying on an individual's memory of their dietary consumption over a specific timeframe. This reliance on memory can introduce bias into the data collected through FFQs, leading individuals to overestimate their dietary intake.

We believe that the predominantly exploratory nature of our study sets the stage for future research endeavors. In forthcoming analyses, we aim to conduct a more comprehensive investigation into the relationship between levels of meat reduction and the primary challenges faced by flexitarians. This approach will enable the identification of effective and context-appropriate strategies for reducing meat consumption in the Brazilian context.

Furthermore, it is crucial to examine how gender, ethnicity, and sexual orientation within consumption groups (light flexitarians, medium flexitarians, and heavy flexitarians) are associated with the diverse motivations for adopting flexitarianism. Therefore, we intend to further investigate the relationship between the gender of flexitarians and their motivations, specifically examining whether women and younger individuals are notably more influenced by concerns related to environmental conservation and animal ethics, while men and older individuals are primarily driven by health-related factors.

5. Conclusions

Our findings reveal that, despite Brazil's deeply ingrained culture of meat consumption, flexitarianism can serve as a pivotal catalyst in the transition toward a more sustainable food system. We have provided empirical evidence establishing a profound connection environmental concerns and the adoption of flexitarianism, with women exhibiting a greater propensity for embracing this choice. Furthermore, the demographic profile of self-identified flexitarians in Brazil is characterized by a prevalence of white women with high levels of education and relatively substantial income. This demographic alignment mirrors the typical attributes of flexitarians in the Global North while markedly deviating from the socioeconomic landscape of the broader Brazilian populace.

As a result, we recommend prudence for educators and policymakers when extrapolating the findings of this study to advocate for flexitarianism, particularly among individuals who heavily depend on meat as a primary dietary resource. We encourage future research on flexitarianism in the Global South to prioritize self-reported adherence to this dietary model rather than the quantification of meat consumption. It is

important for researchers to account for the potential confounding variable of income when utilizing meat consumption as a metric, and to distinctly delineate how they differentiate flexitarians from those who may be reducing meat consumption due to financial constraints. Our study also identifies legumes as one of the primary plant-based protein sources for adherents of this dietary model. This observation opens the door to further research on the development of recipes and alternative meat products that harness the diversity of Brazilian food resources, encompassing not only wild edible plants but also fungi and algae. In essence, this emerging demographic represents an opportunity to expand the discourse surrounding food systems and non-meat alternatives.

Author contributions

Conceptualization and methodology, Michelle Jacob, Sávio Gomes, Carla Teixeira; formal analysis, Carla Teixeira, Savio Gomes.; writing—original draft preparation, Carla Teixeira.; writing — review and editing, Dirce Marchioni, Michelle Jacob, Savio Gomes, Viviany Moura, Virginia Motta.; project administration, Michelle Jacob.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript.

Ethical statement

Our research followed all regulations governing research involving human subjects in Brazil outlined in National Health Council Resolution No. 466/2012. All research protocols were submitted to the Ethics Committee of the Onofre Lopes University Hospital (CEP/HUOL) at the Federal University of Rio Grande do Norte (UFRN) and were approved under the protocol number CAAE 5.348.343. Additionally, informed consent was obtained from all participants involved in the study.

Declaration of competing interest

The authors declare that they have no conflicts of interest regarding the submission of this manuscript to the journal Appetite. The research reported in this manuscript was conducted independently and without any financial or personal relationships that could compromise the integrity or objectivity of the work. The authors have no financial or personal relationships with any organizations or individuals that could influence or be perceived to influence the work reported in this manuscript.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107093.

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