Income effect on consumption of sugar in Brazilian families

Efeito renda no consumo de açúcar em famílias brasileiras

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Abstract: The objective of this paper was to analyze how the consumption of sugar changes as income rises in Brazilian families. We examined the patterns of consumption of sugars in general, crystal sugar, refined sugar, organic sugar and demerara sugar, and how these patterns may shift as households move up the income ladder. The purpose of this study was exploratory, using documentary research as a methodological approach. The database from the *Pesquisa de Orçamento Familiar* (POF), conducted in the biennium 2017-2018, was used. To estimate the direction and magnitude of the income elasticity of these different products, an econometric model was used. Sugars in general, crystal sugar and refined sugar have a negative estimate for the angular coefficient and, therefore, are considered inferior goods. In the opposite direction, the demerara sugar and organic sugar exhibit positive income elasticities, being considered normal and superior goods, since the respective average expenses increase as we witness a growth of per capita family income.

Keywords: econometrics, income elasticities, Brazil, sugarcane.

Resumo: O objetivo deste artigo foi analisar como o consumo de açúcar se altera conforme a renda aumenta em famílias brasileiras. Examinamos os padrões de consumo de açúcares em geral, açúcar cristal, açúcar refinado, açúcar orgânico e açúcar demerara, e como esses padrões podem se modificar à medida que os domicílios ascendem na escada de renda. O propósito deste estudo foi exploratório, utilizando a pesquisa documental como abordagem metodológica. A base de dados da Pesquisa de Orçamento Familiar (POF), realizada no biênio 2017-2018, foi utilizada. Para estimar a direção e magnitude da elasticidade-renda desses diferentes produtos, foi utilizado um modelo econométrico. Açúcares em geral, açúcar cristal e açúcar refinado têm uma estimativa negativa para o coeficiente angular e, portanto, são considerados bens inferiores. Na direção oposta, o açúcar demerara e o açúcar orgânico exibem elasticidades-renda positivas, sendo considerados bens normais e superiores, uma vez que os gastos médios respectivos aumentam à medida que testemunhamos um crescimento na renda familiar per capita.

Palavras-chave: econometria, elasticidades-renda, Brasil, cana-de-açúcar.

1 Introduction

Despite being one of the largest exporters of sugar, a relevant fraction of sugar produced in Brazil is sold domestically. This consumption of sugar is mostly influenced by local aspects unlike exported sugar and ethanol, the latter being highly dependent on the international price of oil. Being one of the largest global producers, the sugar-energy sector is a significant contributor to the Brazilian economy (Matos et al., 2020), and the consumption of sugarcane-based products is an essential component of Brazilian households' daily lives.

As posed by economic theory, one of the main determinants of consumption is income, therefore, if income rises, individuals tend to have higher levels of consumption (Femenia, 2019). However, when analyzing specific products, the response of their consumption when income

changes may not be positive, i.e., some products may be less consumed as individuals become more affluent (Andreyeva et al., 2010).

Brazil has a highly unequal income distribution, with a significant proportion of the population living below the poverty line (Hoffmann, 2019, 2020; Hoffmann & Vaz, 2021). In this context, understanding how income influences consumption patterns is crucial. Income is a critical determinant of consumer behavior, as it provides households with the purchasing power necessary to acquire goods and services. As income rises, the purchasing power of households also increases, leading to changes in consumption patterns (Andreyeva et al., 2010).

The analysis of how the consumption of different types of sugar changes as income rises in Brazilian families is relevant not only for understanding consumer behavior but also for policymakers. This understanding can assist policymakers in formulating policies that aim to reduce inequalities in consumption patterns and promote the sustainable development of the Brazilian sugarcane sector. By understanding the relationship between income and sugarcane product consumption, we can gain insights into how changes in income levels may impact consumer behavior in the context of this important commodity in Brazil.

In this paper, we aim to analyze how the consumption of sugar changes as income rises in Brazilian families. We will examine the patterns of consumption of products such as sugars in general, crystal sugar, refined sugar, organic sugar and demerara sugar, and how these patterns may shift as households move up the income ladder[1].

2 Theoretical Foundation

The relationship between income and dietary habits has been a subject of extensive research in various contexts, including the consumption patterns of sugary foods and beverages among Brazilian households. This topic presents a review of existing literature concerning the association between income levels and sugar consumption in Brazilian families. To accomplish this, key studies have been identified and synthesized to provide a comprehensive understanding of how sugar consumption varies with increasing income.

Numerous studies have investigated the relationship between socioeconomic status and sugar consumption, providing insights into the influence of income on dietary preferences (Kaplan et al., 2024; Philippidis & Sanjuán-López, 2024; Darsamo & Walbeek, 2023). Within this context, Andriolli et al. (2017) conducted an in-depth exploration of sugar consumption patterns within Brazilian households. Their findings underscore that income stands as a pivotal determinant of food consumption trends in Brazil. However, it's noteworthy that a higher income doesn't necessarily equate to diets of superior nutritional quality. Furthermore, the authors draw attention to the existing food disparities among different Brazilian regions. These disparities could be attributed not only to the varying average income levels of each region but also to the geographical distribution of food production centers.

In a similar vein, Verly Junior et al. (2020) delved into the exploration of food choices that could facilitate the attainment of nutritionally balanced diets, mirroring prevailing dietary patterns, all within the most economically viable range for distinct income segments of the Brazilian population. They found that nutritionally adequate diets are possible but costlier than the observed. The most substantial cost increment necessary for nutritional adequacy was identified within the lowest income stratum. Furthermore, the deviation from the observed dietary patterns required to attain nutritional adequacy at the lowest feasible cost was notably

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[1] The concept of the "income ladder" refers to the progressive movement of households through different income strata as their economic conditions improve over time.

amplified within the lowest income bracket, distinguishing it from the other income levels. The primary modifications necessary to achieve this adequacy encompassed an augmentation in the consumption of fresh foods and a discernible reduction in the consumption of processed food, as well as cookies, cakes, and sugar-sweetened beverages.

In this sense, Claro et al. (2012) undertook an examination into the potential enhancement of household diets in Brazil through the imposition of taxes on sugar-sweetened beverages (SSBs). Their investigation also encompassed an analysis of price elasticity using regression models, accounting for demographic variables, income levels, and the prices of other food and beverage items. The outcomes of their study showcased that augmenting the prices of SSBs resulted in corresponding reductions in their consumption. Specifically, a mere 1.00% increase in the price of SSBs triggered a notable reduction of 0.85% in the caloric intake from SSBs (1.03% reduction for the poor and 0.63% for the nonpoor).

Vaz & Hoffmann's (2020) study delved into shifts in the dietary habits of the Brazilian population during the first two decades of the 21st century. The research unearthed a noteworthy trend: families are gradually decreasing their consumption of traditional staples like rice, beans, potatoes, bread, and sugar. Simultaneously, there's a rising inclination towards processed, ready-to-eat, or easily prepared foods, coupled with increased spending on dining out. Yet, the trajectory was disrupted by the 2014 crisis. The previous decline in sugar expenses, as it got replaced by processed alternatives, took an unexpected turn, registering an upswing in expenditures during 2017-2018. The significant responsiveness of higher-income individuals to expenses on organic and light/diet products signifies that these goods are particularly favored by relatively affluent segments of society and hold potential for further growth in domestic consumption.

Analyzing the dynamics of sugar consumption with changing income, Souza et al. (2013) also delved into assessing the intricacies of sugar consumption and its presence in products. Their study yielded insights highlighting the notable decline in both per capita consumption and expenditure linked to crystal and refined sugar over the examined timeframe. Conversely, a discernible surge was observed in the consumption of sugar through processed products. Furthermore, their findings revealed a pronounced difference in income elasticity between industrialized products and pure sugar. This discrepancy points to a pronounced preference for processed consumables, which aligns with the observed trend of income growth during the study period.

The dynamics of sugar consumption in response to changing income levels are closely intertwined with the underlying price dynamics of sugar. As individuals experience shifts in their economic status, their dietary choices can be influenced by the relative affordability of sugar and sugar-related products. Thus, understanding the nexus between the dynamics of sugar consumption and income variations in conjunction with sugar price fluctuations offers valuable insights into the intricate interplay of economic forces and dietary behaviors.

Henceforth, the determination of crystal sugar prices in Brazil has been a subject of debate in the works of Brandt et al. (1987), Costa & Burnquist (2001), Bacchi & Alves (2004), Campos (2010), and Kfouri (2018). Among the principal findings, it is evident that the pricing dynamics of sugar in the Brazilian market are characterized by short-term imbalances. Factors such as inventory levels, forecasting inaccuracies regarding market surpluses/deficits, and the level of the real interest rate have the potential to modify incentives on both the demand and production sides, thereby influencing international prices in the short and medium term. Additionally, it is worth noting that industrial activity serves as a significant transmission channel in the formation of sugar prices.

In summary, a growing body of research suggests that as income levels rise among Brazilian families, there is a noticeable increase in sugar consumption. This trend can be attributed to changes in dietary preferences, accessibility to a variety of foods, and evolving lifestyles.

However, the implications of this relationship extend beyond dietary choices, impacting public health outcomes. Recognizing the link between income and sugar consumption is essential for designing effective strategies to promote healthier dietary habits across different income strata.

3 Methodology

In order to achieve the proposed goal, this study adopted an exploratory approach to identify factors that determine or contribute to the occurrence of a phenomenon. The methodological approach used was documentary research. Furthermore, these research features were selected based on the definition proposed by Gil (2022).

We used the database from the *Pesquisa de Orçamentos Familiares* (POF) conducted in the biennium 2017-2018 (the most recent data available) and led by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, 2023). The POF is a sample-based household survey that evaluates spending and income of "units of consumption", enabling, for example, studies on the composition of such household spending according to income classes. The data was collected from more than 178.000 people.

The method chosen to estimate income elasticities is similar to that described in Vaz & Hoffmann (2020), in which a mathematical equation is estimated in order to express how per capita household spending on determined good varies according to the income of the households, considering the average values of ten different income classes. When grouping the data into income classes, according to the authors, the results should be more coherent than those that would be obtained by estimating a regression directly on the individual data, since taking the average of the classes, errors in measuring income family, typical of research families, are attenuated. Furthermore, the use of family expenses and income stems from the perception that consumer behavior is better described based on the characteristics of their family group or "unit of consumption".

Table 1 presents general sample data for different per capita family income (PCFI) classes used. They are the same as in the work by Vaz & Hoffmann (2020) and accompany the sampled information on the number of people, families, average number of individuals per family and PCFI for each of the income strata.

Table 1. People and families by per capita family income classes, Brazil, 2017-2018.

Family income classes per capita (R$)	People		Families		People per family	Family income per capita (R$)	% of total income in the class
	Number (thousand)	(%)	Number (thousand)	(%)			
From 0 to 399	29,889,988	14.43	7,016,507	10.17	4.26	257.05	2.05
From 400 to 699	35,510,640	17.15	9,544,657	13.83	3.72	546.64	5.19
From 700 to 999	31,583,293	15.25	9,411,683	13.64	3.36	842.53	7.11
From 1,000 to 1,299	25,396,023	12.26	8,755,750	12.69	2.90	1,145.78	7.77
From 1,300 to 1,599	18,782,385	9.07	7,059,436	10.23	2.66	1,442.42	7.24
From 1,600 to 1,999	16,958,662	8.19	6,562,398	9.51	2.58	1,784.81	8.09
From 2,000 to 2,999	21,349,558	10.31	8,715,620	12.63	2.45	2,418.24	13.79

Source: own elaboration based on the data of the POF 2017-2018 (Instituto Brasileiro de Geografia e Estatística, 2023).

Table 1. Continued...

Family income classes per capita (R$)	People		Families		People per family	Family income per capita (R$)	% of total income in the class
	Number (thousand)	(%)	Number (thousand)	(%)			
From 3,000 to 4,999	15,262,317	7.37	6,303,672	9.13	2.42	3,777.14	15.40
From 5,000 to 9,999	8,684,465	4.19	3,853,333	5.58	2.25	6,873.32	15.95
Greater than 10,000	3,686,459	1.78	1,794,648	2.60	2.05	17,692.01	17.42
Total	**207,103,790**	**100**	**69,017,704**	**100**	**3.00**	**1,807.55**	**100**

Source: own elaboration based on the data of the POF 2017-2018 (Instituto Brasileiro de Geografia e Estatística, 2023).

In this paper, five different types of sugar were considered and collected by the POF, namely: sugars in general, crystal sugar, refined sugar, demerara sugar and organic sugar. To estimate the direction and magnitude of the income elasticity of these different products, an econometric model was used according to Equation 1.

$$\ln(Y_i) = \alpha_i + \beta \ln(X_i) + \varepsilon_i \tag{1}$$

Where Y_i represents the average per capita expenditure in the i-th income class; X_i corresponds to the PCFI; and ε_i is the zero-mean random error term. The use of logarithms on both sides of the equation is convenient, as it allows interpreting the coefficient β_i as the percentage change in spending on a given input obtained in response to a variation in PCFI. In other words, the estimate of β_i is exactly the income elasticity of the analyzed good. Table 2 summarizes a description of the variables analyzed in this paper.

Table 2. Description of variables.

Variable	Description
Sugars in general	It corresponds to the set of crystal, refined, demerara, artificial sweetener and brown sugar, which may or may not be organic.
Organic sugar	Organic sugar does not use pesticides or chemicals at any stage of its production, which may be refined, crystal or demerara.
Crystal sugar	Crystal sugar is the most consumed sugar in Brazil. It turns white through a refining process and the use of chemical additives.
Refined sugar	Refined sugar is produced from crystal sugar, but with a more extensive refining process.
Demerara sugar	Demerara sugar undergoes a slight refinement process without the use of chemical additives.

Source: own elaboration based on the data of the POF 2017-2018 (Instituto Brasileiro de Geografia e Estatística, 2023).

4 Results and Discussion

In economic theory, goods can assume a demand according to the direction and magnitude of their elasticity. Normal goods respond positively to increases in income but less than proportionally, meaning that, if income rises 1%, the consumption of a normal good would rise less than 1%. In Economics jargon, the income elasticity of a normal good is between 0 and 1 (Browning & Zupan, 2020; Besanko & Braeutigam, 2020).

Similarly, inferior goods are those that have negative income elasticity, so that their demand goes in the inverse direction to that of family income, decreasing when income rises and increasing when income is reduced (Browning & Zupan, 2020; Besanko & Braeutigam, 2020). The word "inferior" can also be linked to the fact that, if one person has enough economic resources, they will substitute these goods for "better" or "more desirable" ones. Typically, the goods of this category are usually cheap and/or of low quality, and their consumption diminishes as purchasing power increases, as exemplified by Castro et al. (2018). In this sense, many staple foods have characteristics of inferior goods with individuals consuming less of them as they can afford a more diverse diet, which in principle is more expensive (Hoyos & Medvedev, 2011). Extrapolating this consumer behavior to entire economies, it can be inferred that the potential increase in demand for inferior goods is limited if income is rising – as is the case for the world economy since the 19th century –, therefore, the growth in consumption of sugar bought in bags is limited in the long run.

Finally, the last classification is the superior goods, where their variation takes place in proportions above the variation observed in the income of families. This condition is represented by an income elasticity above 1, which means that for a 10% increase in household income, the demand for a superior good increases by more than 10% (Browning & Zupan, 2020; Besanko & Braeutigam, 2020).

Following the analysis, Table 3 presents the statistical results for each of the five goods considered. In general, the models showed a good fit to the data, presenting an R^2 above 0.7 in virtually all cases, except for refined sugar, which exhibited a coefficient of determination of 0.43. The t and F tests were highly significant, indicating that the variation between income strata is a good explanatory variable in the determination of the average expenses with each of the pre-selected goods.

Table 3. Estimation of the income elasticity coefficients of each product.

	Dependent variable: Average household expenditure				
	Organic sugar	**Sugars in general**	**Crystal sugar**	**Refined sugar**	**Demerara sugar**
Yield per capita	1.081***	-0.155***	-0.325***	-0.101**	0.798***
	(0.192)	(0.010)	(0.029)	(0.041)	(0.085)
Constant	11.348***	2.828***	3.336***	1.441***	-7.509***
	-1.459	(0.079)	(0.223)	(0.311)	(0.646)
R2	0.798	0.965	0.939	0.433	0.917
Test F	31.65***	223.54***	123.30***	6.10***	87.92***

Significance levels: *p<0.1; **p<0.05; ***p<0.01. Standard deviation in parentheses.
Source: own elaboration.

As shown in the table above, sugars in general, crystal sugar and refined sugar have a negative estimate for the angular coefficient and, therefore, are considered inferior goods, which means that there is a reduction in their expenses compared to a positive variation in income. This result is in line with the ideas presented by Botelho et al. (2019) when analyzing sugar consumption in the low-income population in Brazil. It is worth noting the existence of an intersection between these products, to the extent that crystal and refined sugars make up much of the category sugars in general. This condition is evidenced by the fact that the income elasticity of the latter group is between the intervals of the income elasticities estimated for the crystal and the refined.

In the opposite direction, the demerara sugar exhibits positive income elasticities, and allow for the characterization of this item, according to the literature presented above, as a normal good, since the respective average expenses increase as we witness a growth of per capita family income (PCFI).

Finally, organic sugar can be seen as a superior good, that is, with an income elasticity greater than 1, which suggests that the expenditure on this class of goods tends to vary more than proportionally to the increase in household income. Despite organic products being related to more sustainable approaches to agricultural production, in Brazil, there is evidence that their acquisition is highly related to health concerns that are more common among richest Brazilians. According to Dalmarco et al. (2014), even in a sample with more than half of the respondents having a graduate degree, the most relevant reason for buying these products was health rather than sustainability concerns – which usually are associated with this type of production.

A similar phenomenon was also found by Chen (2022) when analyzing the consumption basket of Chinese families, who noticed that some expensive foods, such as green food, organic food and luxury food, whose elasticity is greater than 1, become the choice of ordinary households.

Another aspect influencing the decline sugar consumption as income rises is the substitution of direct consumption in favor of indirect consumption, particularly in processed food as also concluded by Bezerra et al. (2021). Since our measures are limited to direct consumption, this substitution may appear as an income elasticity below zero. In addition, according to Vaz & Hoffmann (2020), the income elasticity of household consumption of regular white sugar has been declining, becoming negative in the last Household Budget Survey (from June 2017 to July 2018), and is therefore categorized as an inferior good along with rice, cassava and soybean oil.

The dispersion of the average expenditure according to the family income strata for each of the products, as well as the respective estimated regression lines, are shown in Figure 1. In the case of inferior goods, it is noted that the adjusted line has a decreasing slope, representing the inverse relationship between expenditure and income of these items. For those classified as normal goods, the adjusted line presents a positive inclination, describing the variations in the same direction and representing this condition. It is important to highlight that the interpretation of income elasticity takes place in terms of how the average expenditure on a given good is affected by variations in the PCFI, allowing us to quantify this relationship through the magnitude of its estimate. In this sense, evidence was found that a 10% increase in per capita family income reduces, on average, 3.25% and 1.01% of expenses incurred with crystal and refined sugar, respectively.

On the other hand, we highlight here the high estimates for the coefficients of organic sugar and demerara, suggesting a more elastic behavior of these products and, therefore, a greater sensitivity of expenses with these items in relation to variations in income. Expenses with these goods tend, on average, to increase by 10.81% and 7.98% for the same variation in PCFI.

Changes in income lead towards the consumption of other foods rather than staple foods, including processed ones. Considering that traditional white sugar is a staple food – and an inferior good –, as societies get richer, its demand will fall in favor of other sweeteners or in favor of processed food in general (which can be made with sugar).

In general, the results suggest that products with higher added value also present a greater tendency to consumption in the face of an increase in household income. However, this same aspect also reveals a potential obstacle in the evolution of demand for these products since it tends to remain stagnant in the absence of economic growth or even to retreat if there is a reduction in household income.
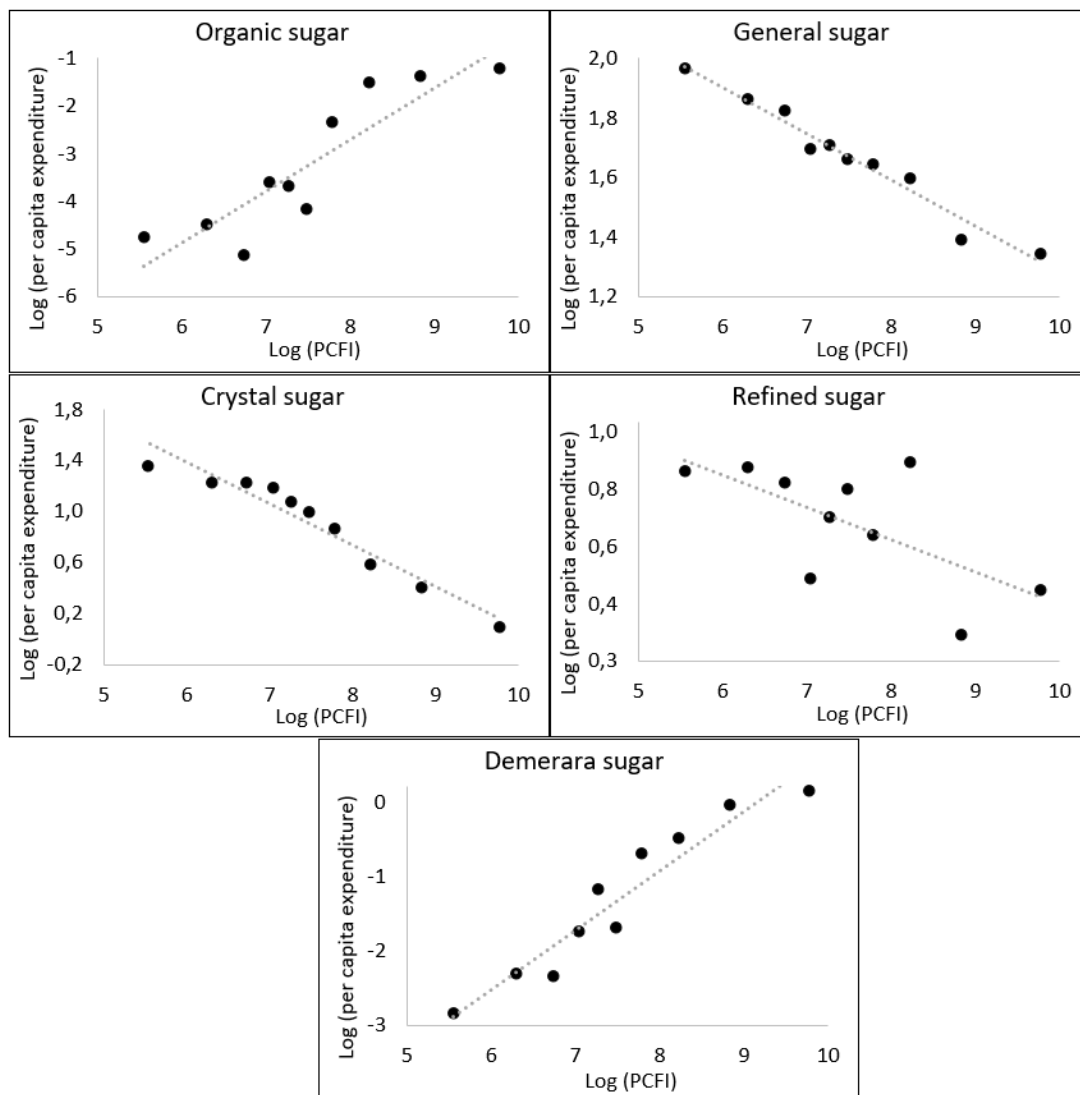
Figure 1. Dispersion between average expenditure and per capita family income (PCFI) classes for each of the products.
Source: own elaboration.

5 Conclusion

In this paper, we analyze the changes in sugar consumption with the increase in the income of Brazilian families, such as sugars in general, crystal sugar, refined sugar, organic sugar and demerara sugar. The pattern of sugar consumption has a different behavior among Brazilian families, being related to income range.

In Brazil, in most cases, this direct consumption of sugar may be in the form of sugar bags or sachets. Common white sugar, such as crystal and refined, is a staple food, especially in low-income segments of society. It provides high levels of energy and is essential for preparing many recipes at home. At the same time, a large fraction of sugar produced in Brazil is sold domestically and changes in consumption patterns for this commodity may have relevant effects on the development of the local sugar-energy sector.

Some insights can be taken from results found in this research. First, income is an important factor not only for the types of products consumed, but also for the attributes observed when making purchase decisions. In this sense, health concerns that arise as income grows may influence the substitution of traditional types of sugar for other niche varieties, particularly demerara and organic.

It is important to note that the relationship between income and sugar consumption is complex, and other factors such as education level, cultural norms, and access to healthy food options may influence income elasticity of goods. In addition, economic shocks such as dramatic increases in food prices or falling income in a recession can led to changes in consumer behavior that are not necessarily predicted by elasticity calculated with data collected under normal market conditions. Further research is needed to fully understand the dynamics of this relationship and to develop effective policies and interventions to promote healthy eating habits across all income levels in Brazil.

Authors' contributions:

HJTS: Conception/design of the study. RDBS: Data collection, Analysis and interpretation. IRA: Analysis and interpretation, Writing of the manuscript. PFAS: Analysis and interpretation, Writing of the manuscript . PVM: Critical review.

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