

Serving and Drinking Temperature of Coffee Beverages in Rio de Janeiro

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Abstract The International Agency for Research on Cancer (IARC) has classified “very hot beverages” (consumed above 65°C) as “probably carcinogenic to humans” (group 2A) due to chronic thermal injury to the esophageal mucosa. In Brazil, coffee is the most consumed food product and is typically consumed hot. The aim of this cross-sectional study was to measure the serving and drinking temperatures of coffee beverages in Rio de Janeiro and Petropolis, two locations in the state of Rio de Janeiro with different altitudes, climates, and mean annual temperatures (23.6 and 19.7°C, respectively), as a basis for risk assessment of esophageal squamous cell carcinoma and development of educational programs in these places. A total of 703 coffee beverages were evaluated, including 498 in Rio de Janeiro and 205 in Petropolis. Serving temperatures and preferred drinking temperatures were assessed. Serving temperatures ranged from 50.5 to 94.5°C (mean 73.8 ± 8.5°C) in Rio and from 52.4 to 87.7°C (mean 71.7 ± 7.9°C) in Petropolis, with Rio having higher temperatures than Petropolis ($p=0.003$). In Rio, 26% of consumers drank coffee at temperatures $\geq 65^\circ\text{C}$, and 9% drank coffee at temperatures $\geq 70^\circ\text{C}$. In Petropolis, 60% of consumers drank coffee at temperatures $\geq 65^\circ\text{C}$, and 19% drank coffee at temperatures $\geq 70^\circ\text{C}$. Participants who had smoked for four years or more generally preferred higher temperatures ($p<0.05$), but no association was found with education level. The average temperature of coffee consumption in Petropolis, which is close to the IARC limit, may increase the risk of developing esophageal cancer in the long term, as indicated by the higher number of cancer cases compared to Rio. Further studies are needed to investigate the causality of this association.

Keywords: hot beverages, esophageal squamous cell carcinoma, cancer, Rio de Janeiro, Petropolis

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1. Introduction

Cancer is a chronic and progressive disease that is considered a serious public health problem [1]. According to the International Agency for Research on Cancer (IARC), there were almost 10 million deaths from cancer worldwide in 2020 [2]. In Brazil, it is the second leading cause of death, according to the National Cancer Institute (INCA) [3]. Esophageal cancer is one of the most aggressive neoplasms of the digestive tract, with high morbidity and mortality. In the United States of America, it is more common in men (3:1), with a peak incidence in the 6th and 7th decades of life [4]. In Brazil, esophageal cancer is the 6th most common cancer in men and the 15th in women, with 10,790 and 8,690 cases in 2018 and 2020, respectively [3].

The most common histologic types of esophageal cancer are squamous cell carcinoma and adenocarcinoma, which together account for more than 90% of esophageal

neoplasms. Squamous cell carcinoma is homogeneously distributed throughout the esophagus and the most related to food temperature, while adenocarcinoma occurs predominantly in the distal esophagus and at the gastroesophageal junction [5].

Several factors have been associated with an increased risk of esophageal cancer, including smoking, alcohol consumption, drinking very hot beverages, and low intake of fruits and vegetables (which contain antioxidant compounds) [6]. Islami et al. reported concerns about foods consumed at high temperatures, and after analyzing several studies linking the consumption of very hot beverages to the risk of developing esophageal cancer, concluded that there is evidence of a positive association between this habit and esophageal neoplasia [7]. The repeated thermal damage to the esophageal mucosa caused by this consumption pattern is the primary factor explaining the development of esophageal cancer [8,9].

According to the World Health Organization (WHO), polycyclic aromatic hydrocarbons (PAHs), produced by

the pyrolysis of organic products, are suspected carcinogenic or procarcinogenic compounds [10]. Until recently, it was believed that PAHs, possibly formed in tea, mate tea and coffee during processing, were the main elements responsible for the occurrence of esophageal cancer in populations consuming these beverages [11]. In 2016, a group of researchers from several countries met to re-evaluate the carcinogenic potential of coffee, mate, and very hot beverages. Data from more than 1000 observational and experimental studies were used. The combination of data suggesting a lack of carcinogenic potential for breast, pancreatic, prostate, endometrial, liver, bladder and other cancers has led to the conclusion that there was insufficient evidence in humans to assume the occurrence of carcinogenic potential for either coffee or mate tea consumption [8,12]. On the other hand, some beneficial effects of coffee were observed, and therefore, coffee and mate tea were evaluated as “not classifiable as to its carcinogenicity to humans” (group 3). However, on the basis of all the studies found in the literature (including [7]) linking the temperature of very hot beverages (above 65°C) in general, and not just coffee, to esophageal cancer, they were classified as “probably carcinogenic to humans” (Group 2A) [13–15]. Therefore, it is important to monitor the drinking temperature of coffee. It is also worth noting that in commercial settings, hot beverages are most commonly served at temperatures well above 65°C, which can lead to drinking at higher temperatures than people would normally drink at home. Taken together, these facts call for public policies and education to make people aware of the risks of high temperatures. To do this, it is important to first study the habits of the population, but data on the typical drinking temperature of hot beverages in different countries and locations is scarce.

Coffee is by far the most consumed hot beverage in many countries around the world, including Brazil, the world's second largest consumer. The state of Rio de Janeiro alone accounts for about 10% of the country's consumption (about 5.5 kg per person per year) [16]. It is often consumed three times a day, at home, at work and in social settings. The consumption of other hot beverages is negligible compared to coffee (i.e., the average daily *per capita* consumption in southern Brazil is for coffee (hot) 173.7 mL, all types of tea (hot or cold) 13.5 mL, chocolate beverages (hot or cold, mainly cold) 20.2 mL, soups and broths (hot) 28.8 mL [16]). *Camelia sinensis* teas and maté teas are currently consumed mainly as cold beverages in Rio. Therefore, the aim of this study was to measure the serving and drinking temperatures of coffee beverages in the city of Rio de Janeiro and Petropolis, two close locations in the state of Rio de Janeiro with different altitudes and climates, as a basis for risk assessment of esophageal squamous cell carcinoma and development of educational programs in these places.

2. Methods

2.1. Study Design and Locations

This study was conducted in the years 2019-2020 in two phases, as follows. In the first phase, the temperature

of hot beverages as they were served was evaluated in establishments of two municipalities: Rio de Janeiro and Petropolis, Rio de Janeiro state, Brazil.

In the occasion of samples collection, Rio de Janeiro had 6,718 million inhabitants distributed in five geographical areas, with 164 neighborhoods; at sea level [17]. It has a tropical climate with a dry season, with average annual temperatures of 21.5-27.0°C (mean = 23.6°C) [18,19]. At a higher altitude (829 m), Petropolis had about 306 thousand inhabitants, distributed in 52 neighborhoods. The climate is still tropical, with mean annual temperatures of 14.0°C-22.5°C (mean=19.7°C) [16,19,20].

The most commonly consumed coffee beverages in the country and in the target communities are filtered coffee, filtered coffee with milk (coffee-latte), espresso, and espresso with milk (espresso-latte) [20]. Therefore, the first part of this study consisted in evaluating the serving temperature of the four most consumed coffee beverages: filtered coffee (n=313), filtered coffee with milk (n=184), espresso (n=174), and espresso-latte (n=36). They were evaluated in Rio (n=502 beverages) and Petropolis (n=205 beverages), for a total of 703 samples.

The second part of the study consisted of a face-to-face interview with a semi-structured questionnaire to assess hot beverage consumption patterns. Participants were adults residing in the municipalities of Rio de Janeiro and Petropolis. The study was carried out according to the Declaration of Helsinki and approved by the Ethics Committee of the Clementino Fraga Filho Hospital, at the Federal University of Rio de Janeiro (approval number 3.731.774). Inclusion criteria were regular coffee consumers, aged ≥ 18 years. Informed consent was obtained from all subjects involved in the study.

2.2. Temperature Assessment in Commercial Establishments

The temperature of hot beverages (n=703) was measured in commercial establishments in Rio de Janeiro (n=382) and Petropolis (n=89). They included bars, restaurants, cafeterias, kiosks, and bakeries, geographically distributed to represent each of the two cities. Measurements were performed immediately after the beverages were served using calibrated digital skewer-type thermometers (Incoterm Indústria de Termômetros LTDA, Porto Alegre, RS, Brazil).

2.3. Assessment of Hot Beverage Consumption Patterns

A semi-quantitative frequency questionnaire of hot beverage consumption was developed for the study, with the reference period being the previous month. Six types of beverages were assessed: filtered coffee, coffee-latte, espresso, espresso-latte, and cappuccino. Participants were asked (by trained interviewers) about the frequency and amount they usually consumed for all beverages. The place and time at which the participants usually consumed the beverages, the preferred temperature (warm, hot, or very hot), and the variation in temperature according to place of consumption and season of the year were also assessed.

The frequency of consumption reported for each beverage was converted to a daily frequency, which was multiplied by

the usual portion consumed, to obtain the daily amount of beverage consumed. Thus, the sum of the daily amount of all beverages reported by each participant provided an estimate of the daily amount of hot beverages consumed.

Sociodemographic characteristics and smoking patterns were obtained using the same structured questionnaire, including information on gender; age (divided into three categories: 18-29 years, 30-59 years, and ≥ 60 years); educational level ($\leq$ high school, college graduate); and smoking pattern (nonsmoker, current smoker or former smoker).

2.4. Evaluation of Drinking Temperature

Participants from Rio de Janeiro ($n=362$) and Petropolis ($n=135$) also rated the temperatures at which hot coffee is typically drunk. The evaluation was conducted at public and private universities in each city.

The test consisted of offering each volunteer 30 mL of the most popular soluble coffee in Brazil (1.5g of soluble coffee per 100 mL prepared with spring water at 95°C, sweetened with 9g of sugar) at different temperatures, at 55°C, 60°C, 65°C, and 70°C. As they tasted each sample, they were asked whether the temperature matched their drinking preferences and habits. A higher temperature sample up to 70°C was always offered to confirm the previous response. For statistical purposes, preferred temperatures above 70°C were treated as 75°C. Similarly, for temperatures below 55°C (which were rare), 50°C was used. During the test, a structured questionnaire in the form of interviews was used to assess socio-economic data and smoking patterns.

2.5. Data Analysis

The normal distribution of the data was examined using the Shapiro-Wilk test. Data were described using mean and standard deviation for continuous variables, and absolute and relative frequencies for categorical variables. The chi-squared test was used to compare categorical variables, and the Mann-Whitney and Kruskal-Wallis tests were used for continuous variables.

Results were considered statistically significant at a p -value < 0.05 . Statistical analyses were performed using SPSS v. 21.0 (IBM, Armonk, NY, USA).

3. Results and Discussion

3.1. Temperature Assessment of Coffee Beverages in Commercial Establishments

The serving temperatures of plain filtered coffee, coffee-latte, espresso, and cappuccino coffees, purchased in commercial establishments in Rio de Janeiro and Petropolis are presented in Table 1. Considering all types of beverages in Rio, serving temperatures varied from 50.5°C to 94.5°C (mean: 73.8; SD: 8.5°C) and were higher than in Petropolis where serving temperatures varied from 52.4 to 87.7°C

(mean: 71.7; SD: 7.9°C) ($p = 0.005$).

The mean temperature for filtered coffee was higher than for espresso in both communities (75°C vs. 71.8°C; $p \leq 0.01$). This may be explained by the fact that filtered coffees are usually prepared with pre-boiling to boiling water (95-100°C), while espresso machines are usually set to lower temperatures (90-95°C).

Table 1. Mean temperature of coffee beverages served in commercial establishments located in the cities of Rio de Janeiro ($n=498$) and Petropolis ($n=205$)

Temperature (°C)	Rio ($n=498$)	Petropolis ($n=205$)	p-value ^a
All the beverages	73.8 $\pm$ 8.5	71.7 $\pm$ 7.9	0.005
Filtered Coffee	75.7 $\pm$ 8.8	73.0 $\pm$ 8.3	0.024
Coffee Latte	71.5 $\pm$ 9.0	72.2 $\pm$ 8.1	0.922
Espresso	73 $\pm$ 7.0	70.0 $\pm$ 6.9	0.466
Espresso-latte	70 $\pm$ 4.2	68.6 $\pm$ 6.8	0.732
p-value ^b	0.000	0.04	

^a Difference in beverage temperature for each city. Mann-Whitney test.

^b Difference between temperatures of the four beverages, Kruskal-Wallis test.

In Rio, coffee-latte was served at a lower mean temperature compared to filtered coffee (71.5°C vs. 75.6°C, $p = 0.001$), probably because in coffee-latte preparation, milk is added to filtered coffee, either hot or at room temperature. Such a difference was not observed in Petropolis, probably because milk is traditionally heated there (72.2°C vs. 73°C, $p = 0.055$).

No difference was found between espresso and espresso-latte or cappuccino serving temperatures in either city. This is likely related to the high variability in serving temperature of latte and cappuccino beverages due to the number of added ingredients (milk foam and chocolate) in some of these beverages. Different machine temperature settings and cup temperatures are common for these types of beverages. While some establishments heat the cup before pouring coffee, others may not.

The average serving temperature observed for all types of beverages was approximately 72-74°C, depending on the location. There are no internationally accepted or consistent regulations or recommendations for serving hot beverages. Some older literature suggested 70°C as the ideal serving temperature [21]. However, some more recent guidelines suggest that the ideal serving temperature for hot beverages such as coffee and tea should be between 60-65°C to avoid scalding injuries, which can cause burns and other serious injuries [22,23]. Given the most recent IARC-WHO level of 65°C [8], most of these beverages are not ready to drink when purchased, especially filtered coffees, which are the most widely consumed in the country.

3.2. Assessment of Coffee Drinking Behavior and Temperature Preference

The main sociodemographic characteristics of the study participants are presented in Table 2.

Table 2. Sociodemographic characteristics and consumption of hot beverages among adults according to municipality of residence

		Rio (n=498)	Petropolis (n=205)	
		%	%	p-value ^a
Sex	Total	73	27	0.26
	Male	44	38	
	Female	56	62	
Age group(years old)	18-29	72	54	<0.01
	30-59	16	25	
	≥60	12	21	
Education level	≤High school	50	78	<0.01
	College graduate	50	22	
Smoking status	Never Smoked	78	78	1.00
	Smoker or former Smoker	22	22	
Smoking duration (years)	<4 years	50	19	<0.01
	≥ 4 years	50	81	
Temperature preference for coffee consumption (°C) ^b	55	40	10	0.00
	60	35	30	>0.05
	65	16	41	0.00
	70	9	19	0.003

^aChi-square test; ^bPercentage of individuals in each municipality who chose their preferred temperature when tasting coffee. The p-value refers to the difference between the proportions of these respondents at each temperature, according to municipality

Table 3. Reported volume of hot beverages consumed by adults in Rio de Janeiro and Petropolis

Daily consumption of all hot beverages (mL/Day)	Rio de Janeiro		Petropolis		p-value a
	N	%	N	%	
All hot beverages, X(SD)	435	(± 444)	655	(± 431)	0.001
Q1 (≤ 188)	115	32	10	6	<0.001
Q2 (189-364)	96	26	29	22	
Q3 (365-678)	77	21	48	36	<0.001
Q4 (≥ 679)	76	21	48	36	<0.001
Espresso coffee (mL/day)					
Espresso coffee, X(SD)	89	(± 143)	74	(± 113)	0.90b
Q1 (≤ 7)	33	27	10	24	>0.05
Q2 (8-30)	28	23	10	24	>0.05
Q3 (31-100)	33	27	13	32	>0.05
Q4 (≥ 101)	27	23	8	20	>0.05
Filtered coffee (mL/day)					
Filtered coffee, X(SD)	336	(± 402)	438	(± 409)	0.001b
Q1 (≤ 86)	52	35	5	8	<0.001
Q2 (87-200)	40	27	15	22	>0.05
Q3 (201-600)	36	24	26	38	0.03
Q4 (≥ 601)	22	14	22	32	<0.01
Coffee-latte (mL/day)					
Coffee-latte, X(SD)	203	(± 243)	350	(± 277)	0.001b
Q1 (≤ 50.0)	52	35	5	8	<0.001
Q2 (50.1-150.0)	40	27	15	22	>0.05
Q3 (150.1-300.0)	36	24	26	38	0.03
Q4 (≥ 300.1)	22	14	22	32	<0.01
Espresso-latte and cappuccino (mL/day)					
Cappuccino, X(SD)	30	(± 45)	54	(± 277)	0.07b
Q1 (≤ 7)	25	26	7	21	>0.05
Q2 (8-20)	29	30	5	15	>0.05
Q3 (20-41)	23	24	9	27	>0.05
Q4 (≥ 42)	20	20	12	37	>0.05

^a Chi-Square test with Bonferroni's correction; ^b Mann-Whitney test

3.2.1. Reported Volume of Hot Beverage Consumption

Based on the responses to the questionnaires (Table 3), filtered coffee (regular and latte) represented 65% of all types of coffee consumed in Rio (average volume 10.3 L/month) and 63% in Petropolis (average volume 13.8

L/month). The preference for filtered coffee, with or without milk, is consistent with data from a market survey published by the Brazilian Coffee Industry Association [24]. For all types of coffee beverages, except espresso, participants from Petropolis reported higher coffee consumption than participants from Rio. This may

indicate that residents of cities with cold climates consume more hot beverages, although according to Gauthier, consumption of hot foods and beverages is more related to lifestyle than to thermal discomfort [25].

3.2.2. Drinking Temperature

The typical coffee drinking temperature in Rio (n=362) was 60.2°C, while in Petropolis (n=135) it was 64.4°C. Figure 1 shows details on the frequency for five different temperature groups. No difference was observed between the usual coffee drinking temperature for men and women in Rio (n=161, 60.9°C, and n=207, 59.6°C) and Petropolis (n=52, 64.4°C, and n=83, 64.3°C), respectively, which is not surprising considering that drinking hot beverages is an expected behavior as a function of individual pain or thermal injury threshold [25–27]. Considering that beverages consumed at temperatures above 65°C are classified by IARC as “possibly carcinogenic to humans” (group 2A), 64.4°C is a value that does not allow for any margin of safety, even considering the high inter-individual differences between subjects [8]. Since the mean temperature is close to the IARC limit, the population of Petropolis has a higher risk of developing chronic thermal lesions of the esophageal mucosa and, in the long term, esophageal cancer, compared to the population of Rio [28,29]. This hypothesis becomes more concrete when comparing the number of esophageal cancer cases per 100,000 inhabitants in both cities (2.69 in Rio versus 4.39 in Petropolis in 2017, the most recent data available for Petropolis) [3]. It should be noted, however, that other factors contribute to the development of esophageal cancer, such as alcohol consumption, smoking patterns, and a diet low in antioxidants [6]. Therefore, causality remains unclear at present, and other study designs, such as case-control studies, seem necessary to follow up on coffee drinking patterns to explain the differences in cancer cases between the two cities.

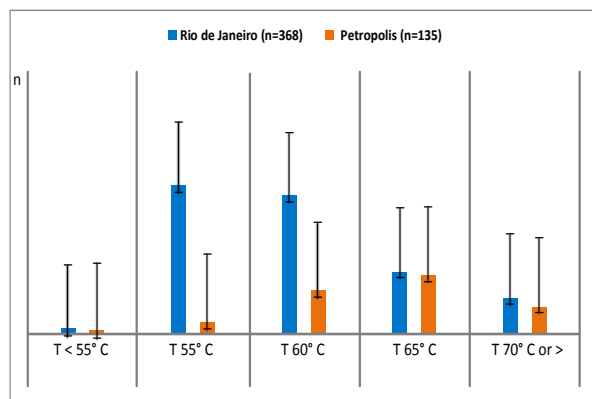


Figure 1. Frequency of regular consumption of hot coffee beverages at temperatures $\leq 55^{\circ}\text{C}$ up to $\geq 70^{\circ}\text{C}$ in Rio de Janeiro and Petropolis. (vertical bars denote 0.95 confidence intervals)

In a study conducted in southern Germany, Verst et al. found that the average drinking temperature in this region of Germany was about 10°C higher than the maximum recommended by IARC (about 75°C) [30]. Another important point raised by the authors is the assumption that consumers who have been in the habit of consuming very hot foods and beverages for years gradually become less sensitive to the perception of heat. This was also

observed in the present study, considering the data presented in Table 2 and the real drinking temperatures observed. The temperature that is initially perceived as hot is gradually perceived as pleasant. As a result, the swallowing temperature of beverages may gradually increase throughout life. Human behavior regarding beverage temperature is difficult to change because it is associated with cultural traditions and preferences. In Europe and the United States, consumers may be more willing to take greater risks for intentional behaviors, such as high beverage temperatures, than for unintentional risks, such as PAH contamination [11]. In Brazil, there is no evidence of a specific coffee culture related to drinking temperature, but consumers drink coffee immediately after brewing. The authors also believe that there is currently no risk awareness among consumers of very hot beverages, in contrast to the consumption of tobacco or alcohol products.

3.3. Relationship Between Coffee Drinking Temperatures, Socio-Economic Status and Lifestyle Factors

3.3.1. Influence of Level of Education

In Rio and Petropolis, the highest mean coffee drinking temperatures (65.5°C and 66.4°C, respectively) were observed among those with incomplete or complete low education (Table 4). For the other levels of education, complete primary, complete secondary, complete undergraduate and postgraduate, the preferred temperatures were as follows: 64.0°C, 64.1°C, 65.2°C, and 60.0°C.

Table 4. Preferred coffee consumption temperatures dependent on lifestyle factors, considering average data for Rio and Petropolis

		Consumption temperature							
		55°C		60°C		65°C		70°C	
		n	%	n	%	n	%	n	%
Education level	High school	78	52.7	97	61.0	65	59.6	35	58.3
	Graduation	70	47.3	62	39.0	44	40.4	25	41.7
Smoking pattern	Never smoked	122	78.7	131	79.4	90	78.9	42	70.0
	Smoker or former smoker	33	21.3	34	20.6	24	21.1	18	30.0
Smoking (how long)	<4 years	17	58.6	14	45.2	6	28.6	3	20.0
	≥ 4 years	12	41.4	17	54.8	15	71.4	12	80.0

^a Chi-Square test with Bonferroni's correction.

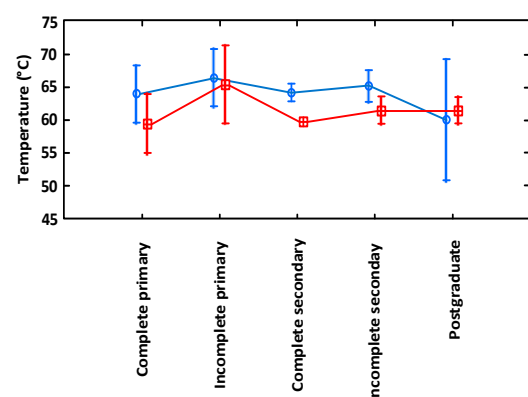


Figure 2. Relationship between drinking temperature and education level in coffee consumers from Rio de Janeiro (in red) and Petropolis (in blue) (vertical bars denote 0.95 confidence intervals)

In both cities, no clear relationship was observed between the level of education and the average preferred temperature (Figure 2), but in both cities, the group with the lower level of education (basic level) preferred very hot beverages. An intervention for this group of people seems to be necessary, especially because these are the people who generally have a lower quality of diet, including bioactive compounds that could protect their digestive tract against inflammation and cancer development [31,32]. A low level of education is usually associated with a lack of knowledge about health and nutrition, which has a negative impact on their preferences and choices in these areas [33].

3.3.2. Influence of Smoking Patterns

Considering that regular smoking tends to reduce the thermal sensitivity of the tongue [34], the authors investigated an association between coffee drinking temperature and smoking patterns. Mean drinking temperatures for smokers (60.4°C), ex-smokers (60.3°C), and non-smokers (60.1°C) were similar in Rio and Petropolis (66.1, 65.5 and 64.0°C, respectively). In Petropolis, the group of smokers and ex-smokers preferred to drink coffee at higher temperatures than the group of people who had never smoked (Figure 3). Smoking is another risk factor for the development of esophageal cancer due to inhaled carcinogens such as nitrosamines, acrolein, cadmium, and others [35]. Smoking also tends to be positively correlated with coffee consumption [9], but no synergistic effect is expected if the coffee temperature remains below 65°C.

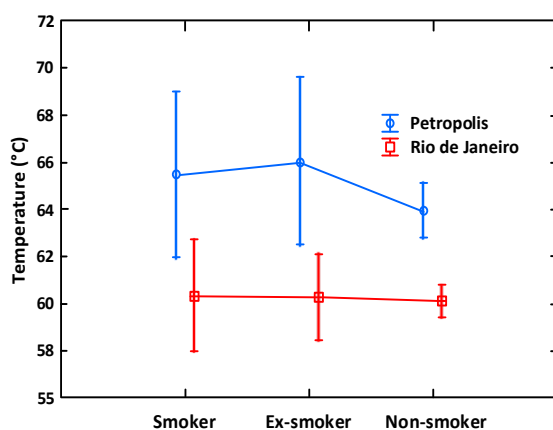


Figure 3. Relationship between the preference in consumption temperature and smoking (vertical bars denote 0.95 confidence intervals)

3.4. Comparison with Previous Literature and Study Limitations

Another study performed in the Northeast region of Brazil aimed to investigate the serving temperature of coffee beverages in low-cost food service establishments (LCFS) and coffee shops (CS) [36]. The study found that serving temperatures of coffee beverages in both LCFS and CS were on average 68-90% above the recommended threshold of 65°C and that a minimum cooling time of about 2 minutes should be allowed before drinking. Corroborating the findings of the present study, Nóbrega et al. [36] found that the majority of coffee beverages served were above

the recommended temperature threshold of 65°C, which is classified as "probably carcinogenic to humans" by the International Agency for Research on Cancer.

Taken together, these findings highlight the need for public health campaigns to raise awareness of the risks associated with the consumption of very hot beverages, especially coffee, and the importance of appropriate cooling periods before consumption. Nevertheless, the present study has limitations. First, the study includes data from only two cities in Brazil, which limits the generalizability of the results to other regions or countries. The small sample size in our study, especially for certain comparisons such as smoking, should also be recognized as a limitation. Future studies including other regions with larger sample sizes are warranted to validate and extend our findings.

In addition, as Brazilians are mostly used to consume portions of 50 mL at a time, the study did not account for the effects of different portion sizes and cup types, which could also affect beverage temperature. The study also relied on self-reported data on coffee consumption frequency, which could be subject to recall and social desirability bias. Another limitation of this study is the sex distribution, with a larger proportion of women, which may affect the generalizability of the findings to both sexes. Another limitation of this study is the lack of data on specific health outcomes such as esophageal cancer incidence or prevalence, which limits the ability to directly assess the impact of coffee consumption temperatures on long-term health risks.

The very end of the data collection was performed in the beginning of COVID-19 pandemic. At this time, the authors believe that coffee consumption patterns in relation to temperature in Brazil were not affected by the pandemic. The authors also believe that COVID-19 did not affect the results of the study, other than limiting the number of participants.

4. Conclusions

The type of beverage, but not the local climate, influenced the coffee serving temperature in both cities studied. However, the average coffee drinking temperature was similar for the majority of participants. Nevertheless, when looking at subsets of participants, which is more significant than simply considering the average, there was a subset who drank coffee at temperatures above 65°C, and the average coffee drinking temperature for this group was higher in Petropolis. This fact is important considering that the incidence of esophageal cancer is also higher in Petropolis. The findings highlight the need for public health campaigns to raise awareness of the risks associated with the consumption of very hot beverages, especially coffee, and the importance of adequate cooling periods before consumption. It is also important to emphasize that there is a group of people who consume coffee well above 65°C, which is a temperature that has been shown to increase the risk of esophageal cancer. By raising awareness of this risk, public health campaigns can help to reduce the number of people who consume coffee at unsafe temperatures. Further research is needed to assess the impact of consumption of hot beverages other

than coffee because although coffee is the most consumed beverage in Rio and Petropolis, it is possible that other beverages, such as tea or hot chocolate, may also increase the risk of esophageal cancer. By conducting further research, we can better understand the risks associated with the consumption of hot beverages and develop more effective public health interventions.

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