Patterns of beverages consumption and prevalence of non-communicable chronic diseases

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Abstract

Beverages consumption influences diet quality in general and has been associated with the development of non-communicable chronic diseases (NCCD). We aimed to verify the association between beverage consumption patterns and the prevalence of NCCD. A cross-sectional household and population-based study was conducted with 489 individuals aged 20 years and older. The presence of NCCD (arterial hypertension, diabetes, cancer and hypercholesterolemia) was obtained by self-report, while obesity was diagnosed by measuring body weight, height and waist circumference. Beverage consumption patterns were obtained by principal component analysis. The association between beverages patterns and the prevalence of NCCD was verified using Poisson regression, expressed as prevalence ratio (PR) and adjusted for potential confounding factors. Three beverage patterns were identified: 'ultra-processed beverages', 'alcoholic beverages' and 'healthy beverages'. Individuals with greater adherence to the Ultra-processed Beverages Pattern had a 2·77 times higher prevalence of cancer (PR: 3·77; 95 % CI 1·57, 9·07). Higher adherence to the Alcoholic Beverages Pattern was associated with a higher prevalence of obesity (PR: 1·97; 95 % CI 1·13, 3·44). In contrast, individuals in the second tertile of adherence to the Healthy Beverages Pattern had a 39 % lower prevalence of hypercholesterolemia (PR: 0·61; 95 % CI 0·40, 0·92), and individuals in the third tertile had a 10 % lower prevalence of abdominal obesity estimated by the waist-to-height ratio (PR: 0·90; 95 % CI 0·83, 0·97). Beverage consumption patterns may be associated with a higher prevalence of NCCD, regardless of other risk factors. It is therefore important to conduct more studies investigating the impact of beverages patterns on health.

Keywords: **Non-communicable Diseases: Cancer: Obesity: Beverages: Dietary Patterns**

Beverage intake plays a significant role in daily energy and nutrient intake, influencing the overall quality of the diet. Beverages such as milk are important for calcium ingestion, while sugar-sweetened beverages, such as sodas and processed juices, contribute to added sugar intake. The energetic contribution of beverages to overall energy intake can increase the risk of health problems[1]. The consumption of sugar-sweetened beverages, for example, is often associated with the risk of developing diseases including hypertension and various types of cancers[2,3]. Alcohol consumption, in turn, has also been linked to adverse outcomes, such as an increased risk of mortality from cardiovascular diseases (CVD)[4].

The American Heart Association recommends limiting the intake of added sugars, in part, by avoiding sugar-sweetened beverages due to their known association with unfavourable health outcomes, including weight gain, type 2 diabetes, high blood pressure and CVD. However, the consumption of other beverages, such as alcohol, coffee and fruit juices, has also been linked to adverse health effects[5].

Health promotion recommendations often focus on restricting specific unhealthy beverage choices; however, there is a lack of comprehensive information on the health implications of a wide range of beverage options[5]. This occurs because most studies on beverage consumption concentrate on specific beverage items instead of overall consumption patterns, making analyses more limited in assessing the risk of obesity and other cardiometabolic risk factors[6]. Therefore, in the field of nutritional epidemiology, new studies should be developed with the perspective of investigating beverage consumption patterns rather than isolated beverage consumption in relation to health outcomes[7].

In this regard, non-communicable chronic diseases (NCCD) pose an emerging threat to global health and are listed by the WHO as the leading cause of death worldwide. The Global

Burden of Disease study revealed that 543·25 per 100 000 inhabitants died globally in 2019 due to NCCD, also demonstrating a loss of 20 939·23 disability-adjusted life years per 100 000 inhabitants[8].

Therefore, NCCD such as those related to metabolic disorders like obesity, arterial hypertension and diabetes are serious public health issues since they are considered key risk factors for various diseases, such as CVD, which, in turn, deteriorate the quality of life and may increase mortality. As these chronic diseases are preventable and controllable, several risk factors have been identified, and among them, diet has emerged as a crucial modifiable factor. Additionally, the relationships between beverage consumption and various health outcomes have also been investigated[7].

Thus, this study aimed to characterise beverage consumption patterns and examine their association with the prevalence of NCCD in individuals aged 20 years or older from a capital city in Northeastern Brazil.

Methods

Study design

A cross-sectional, population-based study, which corresponds to a subset of data from the research 'Household Health Survey in the municipalities of Teresina and Picos (PI)', aimed at analysing the living conditions and health status of the population through home visits in urban areas of the municipalities of Teresina and Picos, Piauí, Brazil. For the present study, a subset was considered, focusing only on the sample from the city of Teresina, Piauí, Brazil.

The study employed a complex probabilistic sampling method, using clusters in two stages: census tract and household. The census tract is the smallest geographic unit with similar sociodemographic data of residents, consisting of approximately 300 families or about 1000 inhabitants.

For the sample size calculation, the population size of Teresina (767 557 inhabitants) was considered, based on the 2010 IBGE census[9], as well as the stratification of the population in both cities, according to the age of individuals for both sexes.

Based on this, the average number of individuals in each age group per household was calculated. To ensure that a minimum of thirty individuals from each age group participated in the sample, the number of households needed for each group was calculated. Subsequently, the expected number of individuals within the age group and sex was calculated, considering the group with the largest sample size in terms of households, represented by the 3–4 years old female group (n 578 households) in Teresina. Thus, the expected number of individuals for each age group and sex was calculated based on 578 households.

Then, a study was conducted simulating the behaviour of the 95 % CI and the coefficient of variation of the standard error of the proportion – CV(p) for proportion estimates (p) ranging from 10 % to 70 %, according to age groups, sex and their respective sample sizes (values for estimates of 50 %).

However, it was considered that during data collection, losses could occur due to various reasons. The final sample size for this study was adjusted using n = n0/0·90, assuming a response rate of 90 %, resulting in an approximate n of 642 households in Teresina.

Due to logistical reasons, a second collection stage was conducted only in the municipality of Teresina, following the same sampling plan. In this stage, 50 % of the households selected in each census tract were systematically included, forming a subsample of 617 individuals. For this, in addition to the data collected in the first stage, adolescents (10–19 years old), adults (20–59 years old) and older adults (60 years old or older) residing in households included in the subsample were invited to participate in data collection on food consumption, using a 24-h food recall (R24h).

For this study, the age groups of adults (20–59 years) and older adults individuals (60 years or older), of both sexes, who had complete data on dietary consumption, anthropometry, medical diagnosis of NCCD and comprehensive sociodemographic, economic and lifestyle data, were included. Out of the 497 adults and older adults individuals initially included, only eight were excluded due to incomplete data, resulting in a final sample of 489 participants. Comparative analyses of the variables of interest, following the exclusions, indicated no significant differences between the characteristics of the total sample and the final study sample, confirming that the sample remains representative (Fig. 1). Only adults and older adults were selected for the present study due to the low prevalence of NCCD in adolescents. Including adolescents would complicate statistical analyses because of their lower prevalence rates. Additionally, adolescents often have significantly different eating habits compared with adults and older adults, which could introduce bias into the study's findings. Therefore, focusing on adults and older adults allows for a more homogenous sample, facilitating more accurate and reliable results. More information about the sampling process is described in the article by Rodrigues et al.[10].

Data collection

Sociodemographic (age, sex and education), economic (family income), lifestyle (smoking and physical activity) and self-reported chronic disease diagnosis data were obtained through the administration of questionnaires. These questionnaires were previously used in other Brazilian population-based studies[11,12] and were administered using the Epicollect 5® app (Imperial College London, 2018) on mobile devices.

Diagnosis of non-communicable chronic diseases

The diagnosis of NCCD was self-reported through the question 'Has any doctor ever given you a diagnosis of this disease?' with possible answers of 'Yes', 'No' and 'No response'. The investigated diseases were arterial hypertension, diabetes mellitus, hypercholesterolemia and cancer.

Anthropometric data

Body weight and height were measured according to Jelliffe and Jelliffe[13] and Cameron[14]. Body weight was measured with an electronic scale with an accuracy of 100 g. Height was measured
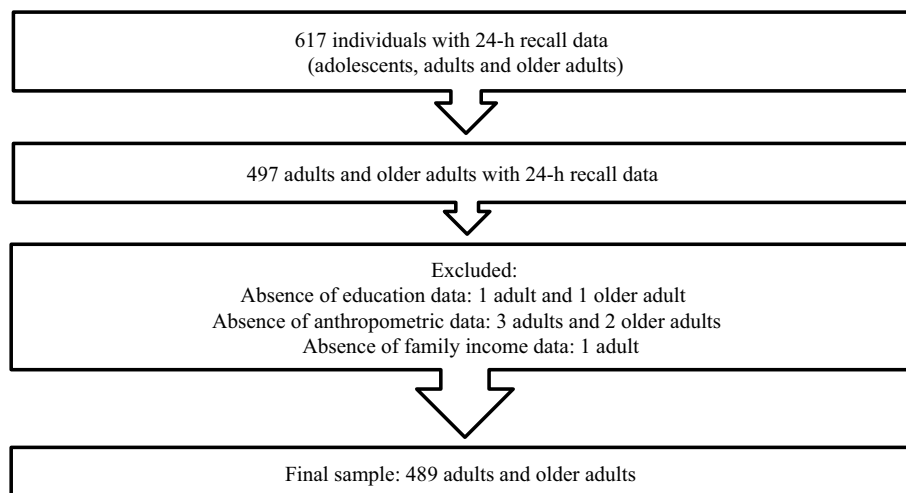
Fig. 1. Sample selection flow chart.

with a portable stadiometer with an accuracy of 0·1 cm. BMI was calculated according to the WHO[15] and was classified according to the WHO[15] recommendation for adults and according to OPAS[16] for older adults. Waist circumference (WC) was measured at the midpoint between the last true rib and the iliac crest, using an inelastic measuring tape with an accuracy of 0·1 cm[17]. WC classification was performed as recommended by the WHO[17], considering cardiometabolic risk for a WC ≥ 80 cm for women and ≥ 94 cm for men.

The waist-to-height ratio (WHR) was calculated as the ratio of WC in centimetres to height in centimetres. Individuals with WHR greater than or equal to 0·50 were classified as having abdominal obesity[18].

Dietary intake

Dietary intake was obtained through a R24h using the Multiple-Pass Method[19]. A second R24h was conducted in 40 % of the population after a 2-month interval, employing the same procedures as the first interview, to adjust for intrapersonal variability, as demonstrated in the study by Verly-Jr *et al.*[20], which showed minimal loss of precision in estimating dietary intake, regardless of sample size. The household measures reported by the interviewees were converted into grams (g) or millilitres (ml) with the help of the Table for Assessing Food Intake in Household Measures[21]. Data from both R24h assessments were used to adjust for intrapersonal variability in intake using the Multiple Source Method statistical technique[22].

Descriptions of preparations were standardised, and in cases where habitual sugar consumption was reported but the interviewee could not quantify it, the addition of 5 g of sugar for every 100 ml of coffee, coffee with milk (whole, semi-skimmed and skimmed milk), tea and 10 g of sugar for every 100 ml of juices and smoothies was standardised.

Dietary patterns

More than 800 food items consumed were identified and categorised into twenty-one food groups based on consumption frequency and nutritional characteristics. The data were analysed in grams or millilitres. Measurements were not standardised. Dietary patterns were identified through principal component analysis using the Stata® version 13.0 program. Initially, the applicability of the method was assessed using statistical tests: Kaiser–Meyer–Olkin (KMO), which is acceptable when KMO > 0·50, and Bartlett's test of sphericity (BTS), acceptable when < 0·05. The BTS measured the presence of relationships within the data ($P < 0.001$), and the KMO measured the sampling adequacy (KMO = 0·51). Both demonstrated the dietary dataset was suitable for principal component analysis which reduces the diet components based on their correlations with one another while retaining as much variation within the diet as possible[23].

The scree plot (graphical representation of eigenvalues >1·45) was analysed. Three factors or patterns were identified. The factors (dietary patterns) were then orthogonally rotated using the varimax rotation technique to ensure they were uncorrelated and to facilitate the interpretation of their meaning. Factor loadings with values ≥ 0·25 were considered components of the pattern. Based on the items considered in each factor, the patterns were interpreted and labelled as 'Healthy', 'Bakery' and 'Ultra-processed'. The three patterns obtained explained 20·1 % of this population's dietary consumption (online Supplementary Table 1).

Beverage consumption patterns

Initially, all beverages (measured in millilitres) were grouped into thirteen different categories based on consumption frequency and nutritional characteristics. Measurements were not standardised. The categories included teas (sweetened and unsweetened), coffee with milk (sweetened or not), coffee without milk (sweetened or not), skimmed or semi-skimmed milk, whole milk, dairy beverages, chocolate milk, natural juices (sweetened or not), fruit smoothies (sweetened), ultra-processed juices, sodas, fermented alcoholic beverages (beers) and distilled alcoholic beverages (whisky and cachaça).

Subsequently, the applicability of the method was assessed through the statistical tests KMO (KMO = 0·52) and BTS ($P < 0.001$). Both demonstrated the dietary dataset was suitable for principal component analysis.

Following this, through the principal component analysis of beverage groups, beverage consumption patterns were categorised. The factors (beverage patterns) were orthogonally rotated using the varimax rotation technique to ensure they were uncorrelated and to facilitate the interpretation of their meaning. Factor values were determined after evaluating eigenvalues, graphical analysis and interpretability. Each factor was defined by a subgroup that placed beverages on the factor axis, with an absolute loading ≥ 0·25 (groups with a loading factor ≥ 0·25 were considered to make a significant contribution to the beverage pattern). The derived factors were then labelled to make the data easily interpretable.

Covariates

The covariates used included sociodemographic and economic data (age, sex, education and family income), lifestyle factors (smoking and physical activity), use of medication and/or supplements in general, and anthropometric data (body weight, height and WC).

Smoking status was estimated using the question 'Do you currently smoke or have you smoked in the past (at least 100 cigarettes or 5 packs)?' And through the question 'Do you currently smoke? If yes, do you smoke daily?'

The use of medication or supplements in general was assessed using the question: 'Are you currently taking any medication or food, vitamin or mineral supplements?'

Physical activity was estimated using the International Physical Activity Questionnaire (IPAQ), the long version for adults and the short version for the elderly[24]. Individuals were classified as insufficiently active or active according to the 2020 WHO recommendations[25], which advocate for at least 150 min of light to moderate physical activity and/or 75 min of vigorous physical activity per week.

Ethical aspects

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Human Research Ethics Committee of the Federal University of Piauí under opinion number 2.552.426. Written informed consent was obtained from all subjects.

Statistical analysis

Continuous variables were expressed as mean and standard deviation, and categorical variables were expressed as absolute and relative values. The distribution of continuous variables was analysed using the Shapiro–Wilk test. The Kruskal–Wallis test and the Bonferroni *post hoc* test were used to analyse continuous variables. Categorical variables were analysed using Pearson's χ^2 test. The factor scores of beverage patterns were categorised into tertiles. The association between tertiles of beverage consumption patterns and the prevalence of NCCD was examined through Poisson regression, expressed as crude and adjusted prevalence ratio (PR), adjusting for potential confounding factors based on the scientific literature[5,26], including age, sex, education, smoking, physical activity, WC, use of medications and/or supplements in general, and Healthy, Bakery, and Ultra-processed dietary patterns identified from the overall diet in the first model. Due to the cross-sectional nature of this study, which prevents determining whether WC is a mediator or a confounder, a second model without adjustment for this variable was included.

The sample was not weighted, given that the probability of the sample was equiprobable. All analyses were performed using Stata version 13.0. The survey mode was utilised to adjust the analyses for the complex sampling of the survey. A significance level of 5 % and 95 % CI were adopted.

Results

Table 1 shows the results of the characterisation of the study sample. The average age was 46·5 years, and the majority of the population was female (66·9 %), of brown skin (62·4 %), had studied up to high school (40·9 %), had a family income of up to two minimum wages (76·5 %), were not smokers (78·1 %) and were physically active (80·4 %).

As for the prevalence of NCCD, the prevalence of hypertension, diabetes, hypercholesterolemia, cancer, obesity and abdominal obesity was 28·0 %, 9·6 %, 20·4 %, 3·9 %, 27·0 % and 65·6 %, respectively.

Table 2 shows the factor loadings of the patterns identified. Three patterns of beverage consumption were identified: Ultra-processed Beverages Pattern, Alcoholic Beverages Pattern and Healthy Beverages Pattern. The Ultra-processed Beverages Pattern was characterised by the consumption of ultra-processed dairy beverages, semi-skimmed and skimmed milk, chocolate milk, industrialised juices and sodas. The Alcoholic Beverages Pattern was characterised by the consumption of fermented and distilled alcoholic beverages, and the Healthy Beverages Pattern was characterised by the consumption of coffee with milk, skimmed or semi-skimmed milk and natural fruit juices and the non-adherence to the consumption of coffees without added milk.

The KMO value was 0·52. The BTS was < 0·001. Each dietary pattern presented eigenvalues of 1·45, 1·42 and 1·41 for Ultra-processed Beverages Pattern, Alcoholic Beverages Pattern and Healthy Beverages Pattern, respectively. The three patterns obtained explained 33·0 % of this population's beverages consumption.

Table 3 presents the characterisation of the study population according to tertiles for each beverage consumption pattern. Individuals in the first tertile of the Ultra-processed Beverages Pattern had a higher mean age. In contrast, those in the third tertile of the Alcoholic Beverages Pattern were younger compared with the first tertile. Significant associations were found between skin colour and the Alcoholic Beverages Pattern, as well as between education and all three beverage patterns.

Additionally, individuals in the first tertile of the Ultra-processed Beverages Pattern had a higher prevalence of

Table 1. Characterisation of the study population (*n* 489) (Mean values and standard deviations; numbers and percentages)

Variables	Total	
	Mean	SD
Age	46·5	17·2
Sex	*n*	%
Female	327	66·9
Male	162	33·1
Skin colour		
White	56	11·4
Black	83	17·0
Brown	305	62·4
Others*	45	9·2
Education		
Illiterate	29	5·9
Elementary school	149	30·5
High school	200	40·9
Higher education	111	22·7
Family income		
Less than 2 minimum wages	374	76·5
More or equal to 2 minimum wages	115	23·5
Smoking		
No	382	78·1
Former smoker	71	14·5
Smoker	36	7·4
Physical activity level		
Insufficiently active	96	19·6
Active	393	80·4
Diabetes mellitus diagnosis		
No	442	90·4
Yes	47	9·6
Hypertension diagnosis		
No	352	72·0
Yes	137	28·0
Cancer diagnosis		
No	470	96·1
Yes	19	3·9
Hypercholesterolemia diagnosis		
No	389	79·6
Yes	100	20·4
Obesity prevalence (BMI)		
Non-obese (BMI < 30 kg/m^2)	357	73·0
Obese (BMI ≥ 30 kg/m^2)	132	27·0
Prevalence of abdominal obesity (WC)		
No	168	34·4
Yes	321	65·6
Prevalence of abdominal obesity (WHR)		
No	102	20·9
Yes	387	79·1
On medication and/or supplements in general		
No	293	59·9
Yes	196	40·1

WC, waist circumference; WHR, waist-to-height ratio.
* Yellow, Indigenous and others.

hypertension, whereas those in the third tertile of this pattern had a higher prevalence of cancer. Conversely, individuals in the third tertile of the Healthy Beverages Pattern exhibited a lower prevalence of abdominal obesity, as estimated by the waist-to-height ratio (WHR).

Table 4 shows the results of the association between beverage consumption patterns and the prevalence of NCCD. It was observed that individuals with higher adherence to the Ultra-processed Beverages Pattern (third tertile) had a 2·77 times higher prevalence of cancer (PR: 3·77; 95 % CI 1·57, 9·07) compared with the first tertile in adjustment model 1, and 2·91 times higher prevalence of cancer in model 2 (PR: 3·91; 95 % CI

Table 2. Factor loading matrix for beverage consumption patterns (*n* 489)

Beverages	Pattern 1 Ultra-processed beverages	Pattern 2 Alcoholic beverages	Pattern 3 Healthy beverages
Tea	−0·0583	−0·0661	0·0006
Coffee with milk	−0·0858	−0·0147	**0·6863**
Coffee without milk	−0·0173	−0·1422	**−0·4905**
Semi-skimmed and skimmed milks	**0·2683**	−0·0290	**0·5894**
Whole milk	−0·1517	−0·0165	−0·1777
Ultra-processed dairy beverages	**0·7101**	−0·0053	0·0513
Chocolate milk	**0·6831**	−0·0027	0·0321
Sweetened and unsweetened natural fruit juices	−0·1002	−0·1077	**0·5239**
Sweetened fruit smoothies	0·1433	−0·0459	0·0374
Industrialised fruit juices	**0·5140**	−0·0784	−0·1917
Sodas	**0·2728**	0·2111	−0·0771
Fermented alcoholic beverages	0·0193	**0·8347**	−0·0143
Distilled alcoholic beverages	−0·0461	**0·7975**	−0·0013
Percentage of variability explained	11·0 %	11·0 %	11·0 %

Factor loadings ≥ **0·25**.
The bold text has been used to highlight and facilitate the identification of the beverages that represent each consumption pattern.

1·64, 9·34). Additionally, higher adherence to the Alcoholic Beverages Pattern, represented by individuals in the third tertile, was associated with a 97 % higher prevalence of obesity in model 2 (PR: 1·97; 95 % CI 1·13, 3·44), compared with those in the first tertile.

On the other hand, individuals in the second tertile of adherence to the Healthy Beverages Pattern had a 39 % lower prevalence of hypercholesterolemia compared with the first tertile in model 1 (PR: 0·61; 95 % CI 0·40, 0·92) and model 2 (PR: 0·61; 95 % CI 0·40, 0·93). Similarly, individuals in the third tertile of adherence to the Healthy Beverages Pattern also had a 10 % lower prevalence of abdominal obesity estimated by the WHR in adjustment model 2 (PR: 0·90; 95 % CI 0·83, 0·97).

Discussion

In this study, three main patterns of beverage consumption were identified: Ultra-processed Beverages Pattern, Alcoholic Beverages Pattern, and Healthy Beverages Pattern. Similar beverage consumption patterns were found in the study by Lee and Shin[7], conducted with Koreans from the Korea National Health and Nutrition Examination Survey (KNHANES), such as the Healthy Beverages consumption pattern characterised by high consumption of fruit/vegetable juices, as well as the Sugar-Sweetened Beverages pattern characterised by elevated consumption of beverages like sodas, industrialised fruit juices and sugary coffees or teas.

Similarly, in studies by Salinas-Mandujano *et al.*[6] and Rebholz *et al.*[5], conducted with Mexican students from the Autonomous University of Queretaro and US adults from Jackson, Mississippi, respectively, the Alcoholic Beverages Pattern was also identified, characterised by high consumption

Table 3. Characterisation of the study population according to tertiles of beverages consumption patterns (*n* 489) (Mean values and standard deviations; numbers and percentages)

Variables	Pattern 1 Ultra-processed beverages							Pattern 2 Alcoholic beverages							Pattern 3 Healthy beverages						
	1° tertile		2° tertile		3° tertile		P value†	1° tertile		2° tertile		3° tertile		P value†	1° Tertile		2° tertile		3° tertile		P value†
	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	
Age (years)	51·6a	17·7	43·4b	14·8	44·4b	17·8	< 0·001‡	48·5a	16·6	47·6ab	17·5	43·5b	17·2	0·01‡	46·9	16·7	45·4	15·9	47·3	18·9	0·72‡
Sex	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
Female	112	67·9	109	67·7	106	65·0	0·80	106	64·6	109·	67·3	112·	68·7	0·67	104·	62·3	109·	69·0	114·	69·5	0·16
Male	53	32·1	52	32·3	57	35·0		58	35·4	53	32·7	51	31·3		63·	37·7	49	31·0	50	30·5	
Skin colour	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
White	21	12·7	21	13·0	14	8·6	0·14	14	8·5	30	18·5	12	7·4	0·02	21·	12·6	19	12·0	16	9·8	0·48
Black	22	13·3	33	20·5	28	17·2		24	14·6	35	21·6	24	14·7		32·	19·1	29	18·4	22	13·4	
Brown	112	67·9	94	58·4	99	60·7		109	66·5	86	53·1	110	67·5		95·	56·9	100	63·3	110	67·0	
Others*	10	6·1	13	8·1	22	13·5		17	10·4	11	6·8	17	10·4		19·	11·4	10	6·3	16	9·8	
Education	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
Illiterate	10	6·1	7	4·3	12	7·3	0·008	4·	2·4	9·	5·6	16	9·8	< 0·001	6·	3·6	11	7·0	12	7·3	0·02
Elementary school	69	41·8	43	26·7	37	22·7		53	32·3	63	38·9	33	20·3		53·	31·7	50	31·6	46	28·0	
High school	54	32·7	75	46·6	71	43·6		67	40·9	59	36·4	74	45·4		70·	41·9	72	45·6	58	35·4	
Higher education	32	19·4	36	22·4	43	26·4		40	24·4	31	19·1	40	24·5		38·	22·8	25	15·8	48	29·3	
Family income	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
Less than 2 minimum wages	131	79·4	120	75·0	122	74·9	0·53	119	73·0	125·	77·2	129·	79·1	0·44	123·	74·1	127·	80·4	123·	75·0	0·13
More or equal to 2 minimum wages	34	20·6	40	25·0	41	25·1		44	27·0	37	22·8	34	20·9		43·	25·9	31	19·6	41	25·0	
Smoking	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	125	75·8	130	81·2	126	77·3	0·64	130	79·7	128	79·0	123	75·5	0·81	133·	80·1	114	72·2	134	81·7	0·26
Former smoker	27	16·4	18	11·3	26	16·0		22	13·5	24	14·8	25	15·3		22·	13·3	28	17·7	21	12·8	
Smoker	13	7·8	12	7·5	11	6·7		11	6·8	10	6·2	15	9·2		11·	6·6	16	10·1	9·	5·5	
Physical activity level	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
Insufficiently active	42	25·4	24	14·9	30	18·4	0·08	33	20·1	35·	21·6	28·	17·2	0·54	33·	19·8	26	16·5	37	22·6	0·30
Active	123	74·6	137	85·1	133	81·6		131	79·9	127	78·4	135·	82·8		134·	80·2	132	83·5	127	77·4	
Diabetes mellitus diagnosis	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	147	89·1	144	89·4	151	92·6	0·48	151·	92·1	143	88·3	148·	90·8	0·49	156·	93·4	141·	89·2	145·	88·4	0·24
Yes	18	10·9	17	10·6	12	7·4		13	7·9	19·	11·7	15·	9·2		11·	6·6	17·	10·8	19·	11·6	
Hypertension diagnosis	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	106	64·2	122	75·8	123	75·5	0·03	120	73·2	111·	68·5	120·	73·6	0·59	118·	70·7	114	72·2	119·	72·6	0·89
Yes	59	35·8	39	24·2	40	24·5		44	26·8	51·	31·5	43·	26·4		49·	29·3	44	27·8	45	27·4	
Cancer diagnosis	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	159	96·4	159	98·8	152	93·2	0·04	156	95·1	157·	96·9	157·	96·3	0·66	162·	97·0	153	96·8	155·	94·5	0·37
Yes	6	3·6	2	1·2	11	6·8		8	4·9	5·	3·1	6·	3·7		5·	3·0	5·	3·2	9·	5·5	
Hypercholesterolemia diagnosis	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	127	77·0	132	82·0	130	79·7	0·42	134	81·7	121·	74·7	134·	82·2	0·18	129·	77·3	134	84·8	126·	76·8	0·13
Yes	38	23·0	29	18·0	33	20·3		30	18·3	41·	25·3	29·	17·8		38·	22·7	24	15·2	38·	23·2	
Obesity prevalence (BMI)	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
Non-obese (BMI < 30 kg/m²)	124	75·1	115	71·4	118	72·4	0·76	128	78·0	121	74·7	108	66·3	0·18	122	73·0	118	74·7	117	71·3	0·82
Obese (BMI ≥ 30 kg/m²)	41	24·9	46	28·6	45	27·6		36	22·0	41·	25·3	55·	33·7		45·	27·0	40	25·3	47·	28·7	
Prevalence of abdominal obesity (WC)	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	54	32·7	47	29·2	67	41·1	0·09	58	35·4	52	32·1	58	35·6	0·77	54·	32·3	54	34·2	60	36·6	0·55
Yes	111	67·3	114	70·8	96	58·9		106	64·6	110	67·9	105·	64·4		113	67·7	104	65·8	104	63·4	
Prevalence of abdominal obesity (WHR)	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
No	29	17·6	33	20·5	40	24·5	0·37	33	20·1	31	19·1	38	23·3	0·64	26·	15·6	35	22·1	41	25·0	0·03
Yes	136	82·4	128	79·5	123	75·5		131	79·9	131	80·9	125	76·7		141·	84·4	123	77·9	123·	75·0	

Table 3. (*Continued*)

Variables	Pattern 1 Ultra-processed beverages							Pattern 2 Alcoholic beverages							Pattern 3 Healthy beverages						
	1° tertile		2° tertile		3° tertile		P value†	1° tertile		2° tertile		3° tertile		P value†	1° Tertile		2° tertile		3° tertile		P value†
	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	
	n	%	n	%	n	%		n	%	n	%	n	%		n	%	n	%	n	%	
On medication and/or supplements in general							0·05							0·05							0·05
No	88	53·3	106	65·8	99	60·7		103	62·8	87	53·7	103	63·2		109	65·3	97	61·4	87·	53·0	
Yes	77	46·7	55	34·2	64	39·3		61	37·2	75	46·3	60	36·8		58·	34·7	61	38·6	77	47·0	

WC, waist circumference; WHR, waist-to-height ratio.
* Yellow, Indigenous and others.
† Pearson χ^2 test.
‡ Kruskal-Wallis test followed by the Bonferroni post-hoc test. Different superscript letters in the same row indicate a statistically significant difference.

of distilled and fermented beverages. Additionally, in the study by Rebholz *et al.*[5], the pattern of fruit/vegetable juice consumption was also identified, similar to the Healthy Beverages Pattern found in the present study.

The data from this study demonstrated that those with higher adherence to the Ultra-processed Beverages Pattern (third tertile) had a higher prevalence of cancer. Furthermore, higher adherence to the Alcoholic Beverages Pattern was associated with a higher prevalence of obesity. Conversely, individuals in the second tertile of adherence to the Healthy Beverages Pattern had a lower prevalence of hypercholesterolemia compared with the first tertile, and individuals in the third tertile of adherence to this beverage pattern had also a lower prevalence of abdominal obesity estimated by the WHR.

Similar to our findings, the pattern of healthy beverage consumption identified in the study by Lee and Shin[7] was inversely associated with abdominal obesity and elevated triglycerides, indicating that the consumption of milk-based beverages and natural fruit juices may have a protective effect against obesity and dyslipidemias.

In this study, the Healthy Beverages Pattern was predominantly characterised by the intake of natural fruit juices and low-fat milk. Moderate fruit juice consumption can bring nutritional benefits and does not seem to have a negative impact on body weight measures[27]. In a review study, the consumption of fruit juice, in moderate doses consistent with the dietary guidelines of the USA and some European countries, approximately 75–224 ml per day, did not increase the risk of obesity or other NCCD[28]. Similarly, in a review of observational studies and randomised clinical trials, no statistical associations were found between regular fruit juice consumption and BMI or weight gain[29].

Natural fruit juices are sources of various micronutrients and bioactive compounds that can contribute to health maintenance, such as potassium, vitamin C, folate, carotenoids and polyphenols (hesperidin, quercetin, carotenoids, anthocyanins and punicalagin). These substances could even contribute to slower intestinal absorption of dietary sugars[28], which may reduce insulin spikes and prevent the accumulation of body fat.

Milk and dairy products are valuable sources of high-quality protein, promoting satiety and contributing significantly to the recommended adult intake of calcium. Calcium intake may modulate adipocyte lipid metabolism and enhance fatty acid absorption through its effects on intracellular calcium levels. Moreover, higher calcium intake has been linked to reduced lipogenesis and increased lipolysis through hormonal regulation[30]. Furthermore, milk and dairy products are also rich in compounds with antioxidant properties, including sulphur amino acids, whey proteins, vitamins A, E and C, or β-carotene[31].

Regarding the Alcoholic Beverages Pattern, this study showed that this pattern was associated with general obesity, which contrasts with findings from other studies[6,26], where adopting the Alcoholic Beverages Pattern was associated with a better cardiometabolic profile and lower body fat percentage.

However, alcohol has a relatively high energy content of 7·1 kcal per gram, while also stimulating appetite and limiting the development of satiety. Consequently, alcohol intake can be one of the main contributors to the development of overweight and obesity[32].

Table 4. Association between the beverages consumption patterns and the prevalence of non-communicable chronic diseases (*n* 489) (95 % confidence intervals)

Non-communicable chronic diseases	Pattern 1 Ultra-processed beverages					Pattern 2 Alcoholic beverages					Pattern 3 Healthy beverages				
Hypertension	1° tertile	2° tertile	95 % CI	3° tertile	95 % CI	1° tertile	2° tertile	95 % CI	3° tertile	95 % CI	1° tertile	2° tertile	95 % CI	3° tertile	95 % CI
PR crude	Ref.	0·68	0·51, 0·89	0·69	0·48, 0·99	Ref.	1·17	0·79, 1·74	0·98	0·62, 1·56	Ref.	0·95	0·70, 1·28	0·93	0·69, 1·26
P		0·008		0·04			0·41		0·94			0·72		0·65	
PR model 1*	Ref.	0·89	0·64, 1·23	0·94	0·60, 1·47	Ref.	0·98	0·64, 1·50	0·98	0·60, 1·63	Ref.	0·97	0·72, 1·30	0·95	0·71, 1·25
P		0·45		0·78			0·91		0·95			0·81		0·69	
PR model 2†	Ref.	0·90	0·64, 1·27	0·90	0·55, 1·45	Ref.	1·00	0·65, 1·53	1·01	0·59, 1·73	Ref.	0·99	0·75, 1·31	0·92	0·71, 1·20
P		0·53		0·64			1·00		0·97			0·94		0·52	
Diabetes mellitus															
PR crude	Ref.	0·97	0·50, 1·86	0·67	0·29, 1·58	Ref.	1·48	0·70, 3·11	1·16	0·60, 2·23	Ref.	1·63	0·76, 3·52	1·76	0·92, 3·37
P		0·92		0·35			0·29		0·64			0·20		0·09	
PR model 1*	Ref.	1·67	0·91, 3·08	1·12	0·43, 2·89	Ref.	1·20	0·60, 2·39	1·05	0·53, 2·10	Ref.	1·38	0·67, 2·85	1·31	0·72, 2·40
P value		0·09		0·81			0·59		0·88			0·36		0·36	
PR model 2†	Ref.	1·63	0·87, 3·06	0·99	0·40, 2·45	Ref.	1·18	0·59, 2·34	1·10	058, 2·10	Ref.	1·54	0·73, 3·23	1·30	0·67, 2·53
P		0·12		0·98			0·63		0·76			0·24		0·42	
Hypercholesterolemia															
PR crude	Ref.	0·78	0·55, 1·11	0·88	0·59, 1·31	Ref.	1·38	0·94, 2·04	0·97	0·56, 1·68	Ref.	0·67	0·44, 1·01	1·02	0·64, 1·61
P		0·16		0·51			0·10		0·92			0·06		0·94	
PR model 1*	Ref.	0·92	0·59, 1·45	1·00	0·61, 1·65	Ref.	1·18	0·77, 1·82	0·81	0·44, 1·49	Ref.	0·61	0·40, 0·92	0·88	0·57, 1·36
P		0·72		0·99			0·44		0·48			0·02		0·56	
PR model 2†	Ref.	0·93	0·58, 1·48	0·99	0·61, 1·62	Ref.	1·19	0·77, 1·83	0·81	0·44, 1·51	Ref.	0·61	0·40, 0·93	0·88	0·57, 1·36
P value		0·74		0·98			0·41		0·50			0·02		0·55	
Obesity (BMI)															
PR crude	Ref.	1·15	0·79, 1·66	1·12	0·72, 1·72	Ref.	1·16	0·73, 1·83	1·54	0·90, 2·64	Ref.	0·94	0·62, 1·44	1·06	0·71, 1·58
P		0·44		0·60			0·51		0·11			0·78		0·75	
PR model 2†	Ref.	1·12	0·75, 1·66	1·28	0·81, 2·02	Ref.	1·24	0·78, 1·96	1·97	1·13, 3·44	Ref.	0·93	0·61, 1·42	1·10	0·72, 1·67
P		0·56		0·28			0·34		0·02			0·73		0·64	
Abdominal obesity (WC)															
PR crude	Ref.	1·06	0·91, 1·24	0·88	0·74, 1·05	Ref.	1·05	0·89, 1·24	0·99	0·81, 1·20	Ref.	0·97	0·86, 1·09	0·93	0·82, 1·05
P		0·45		0·14			0·58		0·89			0·60		0·21	
PR model 2†	Ref.	1·08	0·90, 1·29	0·94	0·77, 1·14	Ref.	1·03	0·89, 1·19	1·05	0·86, 1·27	Ref.	0·98	0·86, 1·11	0·97	0·84, 1·11
P		0·39		0·52			0·65		0·63			0·76		0·63	
Abdominal obesity (WHR)															
PR crude	Ref.	0·96	0·86, 1·08	0·91	0·82, 1·02	Ref.	1·01	0·89, 1·15	0·96	0·87, 1·06	Ref.	0·92	0·85, 1·00	0·89	0·81, 0·97
P		0·52		0·10			0·87		0·41			0·06		0·01	
PR model 2†	Ref.	1·00	0·89, 1·13	1·00	0·89, 1·13	Ref.	0·98	0·86, 1·10	1·00	0·89, 1·12	Ref.	0·91	0·83, 0·99	0·90	0·83, 0·97
P		0·97		0·93			0·69		0·96			0·04		0·007	
Cancer															
PR crude	Ref.	0·34	0·06, 1·99	1·86	0·65, 5·29	Ref.	0·63	0·63, 1·54	0·75	0·22, 2·56	Ref.	1·06	0·39, 2·85	1·83	0·74, 4·51
P		0·22		0·24			0·30		0·64			0·91		0·18	
PR model 1*	Ref.	0·58	0·10, 3·50	3·77	1·57, 9·07	Ref.	0·55	0·20, 1·48	1·21	0·45, 3·23	Ref.	1·26	0·38, 4·18	2·02	0·59, 6·95
P		0·54		0·004			0·22		0·70			0·70		0·25	
PR model 2†	Ref.	0·58	0·10, 3·49	3·91	1·64, 9·34	Ref.	0·53	0·20, 1·42	1·09	0·36, 3·31	Ref.	1·20	0·39, 3·66	2·10	0·60, 7·30
P		0·54		0·003			0·20		0·87			0·74		0·23	

PR, prevalence ratio; WC, waist circumference; WHR, waist-to-height ratio.
* Adjusted for age, sex, education, smoking, physical activity, WC, use of medications and/or dietary supplements in general, and Healthy, Bakery and Ultra-processed dietary patterns identified from the overall diet.
† Not adjusted for WC.

The results of a study conducted with NHANES data (2003–2012) demonstrated a positive association between excessive alcohol consumption (equal to or greater than five drinks) and BMI in men, while individuals who consumed alcohol moderately had higher BMI compared with former drinkers[33]. Thus, the contrasting results observed between studies may be related to the amount of alcohol consumed and the type of alcoholic beverage consumed, as the consumption of beverages such as wine is generally not associated with increased body weight[32]. In the present study, no participant reported wine consumption.

The higher adherence to the Ultra-processed Beverages Pattern observed in this study was positively associated with a higher prevalence of cancer in the sample. Most of the beverages constituting this pattern were sugar-sweetened beverages, such as ultra-processed dairy beverages and industrialised juices. Similar results were reported in the NutriNet-Santé cohort study conducted with French individuals, which found a positive association between the intake of sugar-sweetened beverages and the overall risk of cancer, including breast cancer[34].

The consumption of sugar-sweetened beverages may increase the risk of certain types of cancer by contributing to excess adiposity[3]. However, this association remained even after adjustments for WC in the present study, suggesting that other mechanisms beyond excess weight may be involved in this relationship. Even in the absence of weight gain, other mechanisms such as oxidative stress, inflammation and insulin resistance can also be promoted by sugar intake. High sugar intake increases postprandial glucose responses, stimulating the production of pro-oxidant molecules and inducing DNA damage, thereby increasing the risk of cancer[34]. Furthermore, many ultraprocessed beverages may contain caramel colourings, such as methylimidazole, which are known carcinogens[35].

Despite the results obtained, it is important to note that, in some cases, such as the association between the consumption of ultra-processed beverages and cancer, significantly wide CI were observed, which can be attributed to the limitation of the analytical sample divided into tertiles based on cancer status, with only nineteen individuals diagnosed with the disease. This division resulted in small subgroups, affecting the precision of the estimates. Therefore, the interpretation of these results must take this limitation into account, emphasising the need for future studies with larger and more representative samples to confirm such observations.

The lack of association observed between beverage consumption patterns and the prevalence of hypertension and diabetes can be explained by factors such as different biological mechanisms between NCCD, which affect how beverage consumption impacts each condition differently, as well as the influence of uncontrolled confounding factors such as genetics, family history and differences in disease control and treatment adherence. Moreover, given the cross-sectional nature of the study, a larger number of people diagnosed with hypertension and diabetes may have a greater impact on the average consumption of beverages, resulting from a possible reverse causality.

The limitations of this study include the use of the R24h to assess food consumption, as it is prone to memory bias and may lead to underestimation or overestimation of intake. Additionally, the study did not collect data on plain water consumption, a significant confounding variable that could impact the intake of other beverages as well as the risk of NCCD. Another limitation is the potential for underdiagnosis due to self-reporting of NCCD. Furthermore, the cross-sectional nature of the study does not allow for the establishment of clear cause-and-effect relationships, focusing instead on prevalence rather than incidence. On the other hand, it is noteworthy that only a few studies have evaluated the impact of beverage consumption on health using this methodological approach, since the analysis of beverage consumption patterns provides a more accurate representation of overall drinking behaviour and is easier to understand and communicate, especially in clinical, public health or research contexts, facilitating the implementation of recommendations and interventions based on beverage consumption patterns.

Conclusion

The data from this study showed that beverage consumption patterns can be associated with NCCD regardless of factors such as age, sex, education, smoking, physical activity level, WC, use of medications and/or dietary supplements, and overall diet quality as estimated by food consumption patterns.

In light of this, it is important to conduct more studies investigating the impact of beverage consumption patterns on population health, rather than focusing on research that evaluates specific types of beverages in isolation. This is especially crucial given the current scarcity of studies employing this methodological approach, which provides a more comprehensive understanding of how different types of beverages collectively influence health outcomes. Focusing on broader patterns rather than isolated beverage types contributes significantly to addressing gaps in current research methodologies.

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Supplementary material

For supplementary material/s referred to in this article, please visit https://doi.org/10.1017/S0007114524002083

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