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ORIGINAL

# Consumption of ultra-processed foods and anthropometric indicators in adolescents, adults, and the elderly in a capital city in northeastern Brazil

# *Consumo de alimentos ultraprocessados e indicadores antropométricos em adolescentes, adultos e idosos de uma capital do Nordeste do Brasil*

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## ABSTRACT

### Objective

To evaluate the consumption of ultra-processed foods and associate it with anthropometric indicators in adolescents, adults, and the elderly.

### Methods

Cross-sectional, domiciliary, population-based study, comprising adolescents aged 10-19 years, adults aged 20-59 years, and elderly people aged 60 or older, residents of the urban area of the city of *Teresina, Piauí*. Demographic, socioeconomic, lifestyle, food consumption, and anthropometric data were collected. The analysis of variance test was used along with the Bonferroni post-hoc test and crude and adjusted linear regression with a 95% confidence interval (95% CI). The level of significance adopted was 5%.

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**Results**

There was no significant association between the consumption of ultra-processed foods and anthropometric variables in adults and the elderly. However, among adolescents, the results showed an inverse association, thus signaling a reduction in anthropometric indicators as the consumption of ultra-processed foods increases.

**Conclusion**

There was no association between the consumption of ultra-processed foods and anthropometric indicators in adults and the elderly; however, among adolescents, the results showed an inverse association, which encourages the development of new studies, especially longitudinal ones.

**Keywords:** Adolescents. Adult. Aged. Anthropometry. Processed foods.

## RESUMO

***Objetivo***

*Avaliar o consumo de alimentos ultraprocessados e associá-lo a indicadores antropométricos em adolescentes, adultos e idosos*

***Métodos***

*Estudo transversal, domiciliar, de base populacional, compreendendo adolescentes de 10-19 anos, adultos de 20-59 anos e idosos de 60 anos ou mais, residentes na zona urbana da cidade de Teresina, Piauí. Foram coletados dados demográficos, socioeconômicos, de estilo de vida, consumo alimentar e antropométrico. O teste de análise de variância foi utilizado juntamente com o teste post-hoc de Bonferroni e regressão linear bruta e ajustada com intervalo de confiança de 95% (IC95%). O nível de significância adotado foi de 5%.*

***Resultados***

*Não houve associação significativa entre o consumo de alimentos ultraprocessados e indicadores antropométricos em adultos e idosos, entretanto, entre os adolescentes, os resultados demonstraram uma associação inversa, sinalizando redução dos indicadores antropométricos à medida que se aumenta o consumo de ultraprocessados.*

***Conclusão***

*Não houve associação entre o consumo de alimentos ultraprocessados e indicadores antropométricos em adultos e idosos, entretanto, entre os adolescentes, os resultados demonstraram uma associação inversa, o que incentiva o desenvolvimento de novos estudos, especialmente, longitudinais.*

***Palavras-chave:*** *Adolescente. Adulto. Idoso. Antropometria. Alimentos processados.*

## INTRODUCTION

In Brazil, as well as in other economically emerging countries, a change in the pattern of food consumption has been recently observed. This trend includes the replacement of unprocessed or minimally processed foods and culinary preparations derived from these foods, with Ultra-Processed Foods (UPF). At the same time that it allows to meet the population's increasing demand, the increased processing of food had a great impact on human health and nutrition [1-3].

As for the degree of processing, foods can be classified as in natura (fresh) or minimally processed, those acquired for consumption without having undergone any changes after leaving nature or those that have undergone minimal changes. Processed foods, on the other hand, are products manufactured essentially with the addition of salt, sugar, or other substance for culinary use to an in natura or minimally processed food, which unfavorably alters the nutritional composition of the foods. Meanwhile, UPF have a high degree of industrial processing as well as high energy density, high fat, additives, sugar, and sodium, generally, which are characteristics associated with poor diet quality and excess body weight. Furthermore, UPF have unbalanced nutritional compositions and are deficient in micronutrients compared to unprocessed or minimally processed foods, which in turn are the basis for a nutritionally adequate diet, in qualitative terms [4-7].

Individuals who consume large amounts of UPF have a 26% higher risk of being overweight and developing obesity compared to those who consume smaller amounts. The consumption of ultra-processed foods has increased among adolescents, adults, and elderly of both sexes; however, this increase seems to be more expressive among adolescents and adults when compared to the elderly [6-9].

Taking into account the role of food in controlling or triggering diseases, this study aimed to evaluate UPF consumption and its association with anthropometric indicators in adolescents, adults, and the elderly.

## METHODS

This is a cross-sectional study that is part of a larger research entitled "Population-Based Health Survey (ISAD) in the Municipalities of *Teresina* and *Picos*, *Piauí* (PI) (ISAD-PI)" that evaluated the living conditions and health situation of the urban population in the cities of *Teresina* and *Picos*, through home visits.

This study was composed of adolescents aged 10-19 years, adults aged 20-59 years, and elderly people aged 60 or over, of both sexes, from the city of *Teresina* (PI), Brazil in 2018-2019. Individuals residing in private households were considered eligible. Individuals residing in collective households, pregnant women, and those with any disabilities that made it difficult to apply the questionnaires or to carry out the anthropometric assessment were not included in this study.

For a better understanding of the methodology used in ISAD-PI on sample size, sampling plan and collection of variables, more information can be found in the study by Rodrigues [10].

### Sample size

*Teresina* is the capital of the State of *Piauí* and the city with the highest population density, a factor that was considered when choosing the city included in the research. In addition, the aforementioned city has a campus of the Federal University of *Piauí*, which made the logistics to calculate the sample size possible. The size of the population of *Teresina* (767.557) and the number of private households (210.093) were considered, as well as the stratification of the population, according to the age of the individuals to both sexes [11].

The distribution of sample means can be approximated by a normal distribution if n>30 and the population has any distribution; so, to ensure that a minimum of 30 individuals of each age group and both sexes participated in the sample, we estimated the number of households needed for each age group [10].

### Sampling plan

The study's sampling plan was carried out by a cluster sampling process, in two stages: Primary Sampling Units (PSU) and households [11]. To facilitate the estimation of the parameters of interest, we defined that 30 PSU in *Teresina* would be selected with equiprobability.

The second-stage sampling fraction can be written as: $\frac{b(M_i'/M_i)}{Mi'}$, whereby Mi' is the number of households in the PSU "i" obtained in the household listing activity carried out in the field. For this study, following the same sampling plan, adolescents, adults and the elderly, from 50% of the households included in the total sample, were systematically selected, forming a representative sub-sample of this population for obtaining a 24-h dietary recall [10].

This study was approved by the Ethics and Research Committee of the Federal University of *Piauí*, under Opinion nº 2.552.426.

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Demographic (age and sex), socioeconomic (income, occupation, education background, marital status), lifestyle (alcohol consumption and smoking status), food consumption, and anthropometric data (weight, height, waist circumference) were collected [10,12].

## Assessment of food consumption

The food consumption was obtained through a 24-hour dietary recall (24HR), using the multiple-pass method [13]. A second 24HR was conducted in 40% of the population, in an interval of two months, making use of the same procedures that were used during the first interview, in order to correct intrapersonal variability. The replication rate was chosen based on the research by Verly-Júnior *et al*. [14].

The cooking measurements reported by respondents were transformed in grams (g) or milliliters (mL) based on the study by Pinheiro [15]. The energy intake was estimated based on the Tables of Food Composition [16,2,17]. All foods were presented in kcal and the calorie percentage of ultra-processed food consumption was calculated in relation to the Total Energy Value.

All analyses were performed in the of the Stata software (version 14). Food items reported were categorized according to the NOVA food classification based on the extent and purpose of the processing of the food applied: unprocessed or minimally processed foods, processed foods, and ultra-processed foods [5].

## Anthropometric assessment

The researchers were standardized for the assessment of anthropometric measurements through training conducted by the Laboratory of Nutritional Assessment of Populations of the Department of Nutrition, University of *São Paulo* [10,18]. The Body Mass Index (BMI) was calculated by the ratio of the body mass in kilograms to the height in square meters (kg/m2) of the subjects. Nutritional status classification of BMI-for-age for adolescents was performed according to the cutoff point described in Z-score, value adjusted for sex and age (<-3: marked thinness; ≥-3 and <-2: thinness; ≥-2 and ≤+1: eutrophy; ≥+1 and ≤+2: overweight; ≥+2 and ≤+3: obesity; >+3: severe obesity), recommended by the World Health Organization (WHO) and adopted by the Brazilian Ministry of Health [18,19]. The BMI classification for adults was carried out in accordance with the recommendation of the World Health Organization [20]. The value obtained for the elderly BMI was classified according to the values established by Lipschitz [21]. For the descriptive analysis of the nutritional status of individuals according to BMI, we considered the groups of Thinness/Eutrophy and Overweight/Obesity.

Concerning the classification of the adolescents' Waist Circumference (WC), we used the reference by Taylor *et al*. [22], compatible with the evaluated anatomical point, who were categorized according to the percentile curves, by age and sex [18,22]. Regarding the adults and elderly, the WC classification was performed following the WHO recommendations [23].

## Statistical analysis

All analyses were performed using the survey module of Stata software (version 14), and, in order for the results obtained to be representative of the total population of the city of *Teresina*, the complex sample was considered and the value of $p<0.05$ was adopted as significant. The analyses were performed separately for each age group, adolescents, adults, and elderly.

To compare the UPF consumption according to the demographic, social, and anthropometric categorical variables, the t-test for comparing two groups as well as Analysis of Variance (ANOVA) with the Bonferroni post-hoc test for three or more groups were used.

In order to evaluate the relation of anthropometric indicators (BMI and WC) to the percentage of UPF consumption, crude and adjusted linear regression models with a 95% confidence interval (95%CI) were used. Anthropometric variables were the study outcomes and two crude and adjusted models were built for each dependent variable (Model1: BMI and Model2: WC). The AUP consumption was the main independent variable. The adjustment variables considered were as follows: total diet energy (kcal), sex (male or female), age (years), education (years of education), alcohol consumption (no, never drank; yes, but quit consuming; yes, consumes) and smoking status (smokes or has smoked: yes; no). All adjustment variables were included in the adjusted linear regression simultaneously.

## RESULTS

The final sample consisted of 617 subjects, of which 120 were adolescents (19.4%), 365 adults (59.2%), and 132 elderly (21.4%) (Table 1). A higher proportion of female subjects was found among adolescents (56.7%), adults (67.1%), and the elderly (65.9%). Furthermore, most adolescents reported that they did not work (95.8%) and were single (93.9%); among adults, a large number reported that they worked (60.2%) and were married (59.5%); and among the elderly, the majority reported that they did not work (73.3%) and were married (56.5%) (Table 1).

**Table 1 -** Demographic characteristics, socioeconomic, lifestyle, and anthropometric, according to age. ISAD-PI, *Teresina* (PI), Brazil (2018-2019).

| Variables | Adolescents | | Adults | | Elderly | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Age group | 120 | 19.4 | 365 | 59.2 | 132 | 21.4 |
| Sex | | | | | | |
| Male | 52 | 43.3 | 120 | 32.9 | 45 | 34.1 |
| Female | 68 | 56.7 | 245 | 67.1 | 87 | 65.9 |
| Family income* | | | | | | |
| <2MW | 91 | 75.8 | 229 | 62.9 | 73 | 55.7 |
| >2MW | 29 | 24.2 | 135 | 37.1 | 58 | 44.2 |
| Employed | | | | | | |
| Yes | 5 | 4.2 | 219 | 60.2 | 35 | 26.7 |
| No | 115 | 95.8 | 145 | 39.8 | 96 | 73.3 |
| Marital status | | | | | | |
| Married | 5 | 6.0 | 216 | 59.5 | 74 | 56.5 |
| Single / widowed | 78 | 93.9 | 147 | 40.5 | 57 | 43.5 |
| Education | | | | | | |
| 0 to <11 years | 69 | 57.5 | 88 | 24.1 | 91 | 68.9 |
| ≥12 and ≤14 years | 41 | 34.1 | 161 | 44.1 | 24 | 18.2 |
| >14 years | 10 | 8.3 | 116 | 31.8 | 17 | 12.9 |
| Alcohol consumption | | | | | | |
| Yes | 105 | 87.5 | 120 | 32.8 | 58 | 44.3 |
| Yes, but quit | 5 | 4.2 | 79 | 21.7 | 39 | 29.8 |
| No, never | 10 | 8.3 | 165 | 45.3 | 34 | 25.9 |
| Smoke or have smoked | | | | | | |
| Yes | - | - | 306 | 84.1 | 79 | 60.31 |
| No | - | - | 58 | 15.9 | 51 | 39.7 |
| BMI† | | | | | | |
| Thinness /Eutrophia | 86 | 71.7 | 136 | 37.3 | 67 | 50.8 |
| Overweight‡ | 34 | 28.3 | 229 | 62.7 | 65 | 49.2 |
| WC§ | | | | | | |
| Without risk | 106 | 83.3 | 142 | 38.9 | 30 | 22.7 |
| With risk | 14 | 16.7 | 223 | 61.1 | 102 | 77.3 |

Note: ISAD-PI-CAPITAL (2018-2019) – Health Survey of *Piauí* – Capital. MW: Minimum Wage – *reference equivalent to R$998.00 based on the year 2019; †BMI: Body Mass Index – BMI-for-age Z-score, for adolescents [18,19], BMI for adults [20], BMI for the elderly [21]; ‡Overweight and obesity; §WC: adolescents [18,22] and for adults and elderly [23].

A higher level of education was observed among the adults when compared to the elderly. In general, the majority of elderly (68.9%) had between 0 and 11 years of education, whereas among adults the majority had between 12 and 14 years of education (44.1%) (Table 1).

With regard to anthropometric data, it was observed that overweight was higher among adults (62.7%), followed by the elderly (49.2%) and adolescents (28.3%). When analyzing the WC, it was possible to show that most adults and elderly presented risk classification for cardiovascular disease (Table 1).

Table 2 shows the average percentage contribution of UPFs to the total caloric value – calorie/day, according to demographic, social and anthropometric variables, in relation to age group. The average percentage contribution was significantly different between adolescents, adults, and the elderly, being higher for adolescents (26.4%) and lower for the elderly (16.2%). In addition, the UPF consumption was significantly higher among adults with more than 14 years of education ($p$<0.001) and significantly higher among the elderly who do not smoke.

**Table 2 -** Contribution of ultra-processed food (%) to total caloric value per day, according to demographic, social, lifestyle, and anthropometric variables as well as to age group. ISAD-PI, *Teresina* (PI), Brazil (2018-2019).

| Variables | Adolescents | | Adult | | Elderly | |
|---|---|---|---|---|---|---|
| | UPF% (A) | *p*-value | UPF% (A) | *p*-value | UPF% (A) | *p*-value |
| Age group | 26.4[c] | <0.001 | 20.9[b] | <0.001 | 16.2[a] | <0.001 |
| Sex | | | | | | |
| Male | 24.9 | 0.423 | 20.0 | 0.551 | 12.6 | 0.071 |
| Female | 27.6 | | 21.2 | | 18.1 | |
| Family income* | | | | | | |
| <2SMW | 25.5 | 0.319 | 20.1 | 0.254 | 14.8 | 0.278 |
| > 2MW | 29.4 | | 22.3 | | 18.0 | |
| Employed | | | | | | |
| Yes | 20.8 | 0.490 | 21.0 | 0.929 | 15.4 | 0.483 |
| No | 26.7 | | 20.8 | | 17.7 | |
| Marital status | | | | | | |
| Married | 27.1 | 0.919 | 20.9 | 0.963 | 14.4 | 0.219 |
| Single / widowed | 26.1 | | 21.0 | | 18.0 | |
| Education | | | | | | |
| 0 to <11 years | 28.1 | 0.420 | 15,5[a] | 0.001 | 15.7 | 0,581 |
| ≥12 and ≤14 years | 23.3 | | 20.8[b,a] | | 15.4 | |
| >14 years | 27.6 | | 25.0[c] | | 20.1 | |
| Alcohol consumption | | | | | | |
| Yes | 25.2 | 0.916 | 19.6 | 0.477 | 13.9 | 0.493 |
| Yes, but quit | 29.5 | | 21.3 | | 15.1 | |
| No, never | 26.4 | | 22.3 | | 17.8 | |
| Smoke or have smoked | | | | | | |
| Yes | | | 20.2 | 0,756 | 11.7 | 0.014 |
| No | | | 21.0 | | 18.8 | |
| BMI[†] | | | | | | |
| Thinness/ Eutrophia | 26.5 | 0.929 | 21.7 | 0.518 | 16.9 | 0.596 |
| Overweight[‡] | 26.2 | | 20.4 | | 15.4 | |
| WC[§] | | | | | | |
| Without risk | 26.9 | 0.545 | 21.5 | 0.607 | 11.6 | 0.083 |
| With risk | 24.1 | | 20.5 | | 17.5 | |

Note: ANOVA with Bonferroni post-hoc test (equal letters showed no statistical difference) and t-test. ISAD-PI-CAPITAL (2018-2019) – Health Survey of *Piauí* – Capital. MW: Minimum Wage – *reference equivalent to R$ 998.00 based on the year 2019; [†]BMI: Body Mass Index – BMI-for-age Z-score, for adolescents [18,19], BMI for adults [20], BMI for the elderly [21]; [‡]Overweight and obesity; [§]WC: adolescents [18, 22] and for adults and elderly [23]. UPF: Ultra-Processed Food; A: Average

Table 3 presents the association of the anthropometric indicators with the percentage of UPF consumption through crude and adjusted linear regression. We observed an inverse association between UPF consumption and anthropometric variables (BMI: β= -0.04; 95% CI= -0.06; -0.01; *p*=0.002; WC: β= -0.07; 95% CI: -0.11; -0.02; *p*=0.008) only in adolescents.

**Table 3 -** Association of anthropometric indicators with the percentage of consumption of ultra-processed foods, according to age group. ISAD-PI, *Teresina* (PI), Brazil (2018-2019).

| Variables | Adolescents | | Adult | | Elderly | |
|---|---|---|---|---|---|---|
| | UPF% β(95%) | *p*-value | UPF% β(95%) | *p*-value | UPF% β(95%) | *p*-value |
| Crude analysis | | | | | | |
| Model1: BMI* | -0.04 (-0.06; -0.02) | 0.003 | -0.01 (-0.05;0.03) | 0.497 | 0.01 (-0.04; 0.05) | 0.803 |
| Model2: WC† | -0.08(-0.014; -0.02) | 0.012 | -0.04 (-0.12;0.03) | 0.265 | -0.02 (-0.13;0.09) | 0.782 |
| Adjusted analysis | | | | | | |
| Model1: BMI* | -0.04 (-0.06; -0.01) | 0.002 | -0.00 (-0.04;0.03) | 0.873 | 0.01 (-0.04; 0.05) | 0.695 |
| Model2: WC† | -0.07 (-0,11; -0.02) | 0.008 | -0.01 (-0,09;0.06) | 0.687 | 0.03 (-0,09; 0.16) | 0.592 |

Note: Crude and adjusted linear regression per total diet energy (kcal), sex, age, education, alcohol consumption and smoking. ISAD-PI-CAPITAL (2018-2019) - Health Survey of *Piauí* - Capital. *BMI: Body Mass Index; †WC: Waist Circumference. UPF: Ultra-Processed Foods.

## DISCUSSION

The UPF consumption showed an important contribution to the total energy value of the studied population. Greater availability and low cost contribute to the increase in UPF consumption, which is increasingly accessible to all age groups, especially among populations in the urban area, where there is a regular insertion of these foods in the usual diet [6,9], a fact that is demonstrated by the similarity in UPF consumption regardless of family income.

The high UPF consumption among adolescents found in this study, in comparison to the consumption among adults and the elderly, corroborates the temporal trends in the consumption profiles of the population. High UPF consumption among adolescents may be related to how frequently they eat out, skip meals or substitute them for industrialized preparations that are easily accessible, such as fast food [7-8].

The high UPF consumption among adults with more years of education found in this study, may be related to several factors. The involvement of advertising when choosing food was addressed in the Food Guide for the Brazilian Population, since education and access to information are interrelated issues, due to the media exploitation, which propagates the practice of UPF consumption, leading consumers to think that processed foods would necessarily be healthier [5-6].

We expected to find a significant association between higher UPF consumption and higher BMI and WC. Nevertheless, in adults and the elderly, there was no significant association between UPF consumption and the anthropometric indicators evaluated. Another cross-sectional study conducted in the United Kingdom showed similar results, finding no positive association between UPF consumption and BMI. The authors justify this fact by the joint analysis of the two groups of processed and ultra-processed foods [24].

Furthermore, we observed an inverse association between UPF consumption and the anthropometric indicators assessed in adolescents, thus signaling a reduction in anthropometric indicators as the consumption of ultra-processed products increases. Similarly, other studies have also found an inverse association between UPF consumption and BMI levels, where it was observed that adolescents with appropriate BMIs had higher UPF consumption compared to those who were overweight [25-27].

The reverse causality in this study may be associated with possible changes in eating habits and lifestyle, underreporting or omission of food items during the interview. It is also important to consider that adolescents with high BMI levels may be in the process of dietary re-education and, therefore, consuming less UPF. Furthermore, it should be noted that the BMI does not distinguish fat from lean body mass; and, in the case of restrictive diets, the BMI may also decrease due to the reduction of lean body mass [25-27].

In contrast to the findings of this study, UPF consumption was associated with the incidence of obesity in a 9-year follow-up cohort study of adult university students in Spain, and with increased BMI and obesity in cross-sectional studies with representative samples of American and Canadian adults and Brazilian adolescents and adults [1,28,8,7,29].

This study had some limitations. The present study is cross-sectional, and it is not possible to interpret the associations of cause and effect between the variables, suggesting the need for longitudinal studies. In this sense, possible reverse causality may be associated with changes in eating behaviors and lifestyle or underreporting of information. Another limitation refers to the use of the 24-hour recall, which relies on the interviewees' memory. In addition, the lack of the physical activity variable to adjust the models is also a limitation.

It is known that in studies of dietary intake assessment, several factors can affect the quality of information, including sex, age, level of education, the individual being concerned with social approval and the individual's own perception of healthy eating habits [6,30].

Among the strong points of this study, it is worth underlining that the data obtained on UPF consumption corroborate the temporal trends in consumption profiles by the Brazilian population. Therefore, they are consistent with the scientific literature.

## CONCLUSION

This study was conducted in a representative sample of adolescents, adults, and elderly people to verify the contribution of the UPF consumption associated with the nutritional status. There was no significant association between the UPF consumption and anthropometric variables in adults and elderly; however, among adolescents, the results highlighted an inverse association, which encourages the development of new studies, mainly longitudinal ones.

The UPF consumption is undoubtedly a public health issue, which, in addition to the negative impact on the nutritional quality of diets, has been associated with excess body weight and the occurrence of diseases. Thus, the importance of monitoring the consumption of ultra-processed products is highlighted as well as the expansion of public policies and governmental actions aimed at reducing UPF consumption in order to promote quality of life to the population.

## CONTRIBUTORS

JM CRISÓSTOMO contributed to the conception and design, data collection, analysis and interpretation of data, and revision of the manuscript. LARL RODRIGUES and PCAF VIOLA contributed to the statistical analysis and interpretation of the data. LM NASCIMENTO contributed to the data interpretation and manuscript revision. KMG FROTA contributed to the conception and design, analysis, interpretation of data, revision, and approval of the final version of the article.

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