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Factors associated with added sugar consumption of older adults from the region of Campinas-SP, Brazil

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Abstract *Adequate nutrition has a profound impact on older adults' health. Therefore, special attention should be given to the dietetic intake of added sugars, which in excess is associated with poorer control of chronic diseases in this phase. The aim of the study was to evaluate the prevalence of consumption of added sugars in older adults in the Campinas-SP region, its associated factors, and its main dietary sources. A cross-sectional study was conducted in the region of Campinas-SP, with a convenience sample of 586 older individuals. Intake was obtained using two 24-hour food recalls, and values >5% of total energy consumption were considered inadequate. The contribution of the groups and foods in relation to the total content of sugars was also calculated. A critical level of p<0.05 was considered. The average intake of added sugars was higher than recommended (7.0%), and this inadequacy was observed in more than half of the sample, being table sugar and honey the main dietary sources. The prevalence of inadequate consumption was higher among women (69.8%; p=0.004) and individuals with low weight (83.7%; p=0.014), and lower in those with diabetes (47.8%; p<0.001). Results indicate that health and nutrition actions should be developed to ensure adequate sugar intake at this stage.*

Key words *Older adults, Food consumption, Sugar, Recommended Dietary Allowances, Ultra-Processed Foods*

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Introduction

Brazil is undergoing an accelerated populational aging process due to epidemiological transitions in recent years. This is driven mainly by the complex change in health standards and disease, which are related to the decrease in mortality due to infectious diseases and increasing in noncommunicable diseases rates[1]. Currently, chronic noncommunicable diseases (CNCDs) are the main morbidity and mortality causes in the country, representing 74% of deaths in Brazil in 2016[2,3]. It is estimated that 39.5% of older Brazilians have some type of chronic disease, and almost 30% have two or more associated diseases[4].

Current Western dietary pattern is one of the main factors associated with the development of chronic diseases. It is marked by high consumption of foods rich in fats, salt, and sugar, with low nutritional density, usually from ultra-processed foods[5,6].

Regarding sugar, the term "added sugars" is used as a reference to a class of simple carbohydrates extracted from foods – such as sugarcane, corn, and honey – to be later used in preparations and processed foods. They are mainly composed of monosaccharides – glucose, fructose and galactose, and disaccharides – such as sucrose and lactose[7]. The World Health Organization recommends that its consumption should represent less than 5% of daily caloric intake[8]. Dietary guide for the Brazilian population highlights the necessity to avoid ultra-processed foods and sweetened beverages consumption (such as soft drinks, industrialized juices and sweets) since they contain large amounts of added sugars in their composition[9].

Older adults present an increased risk factor for CNCDs development due to the aging process itself. Also, they may have a natural loss of food flavors perception, which may compromise their nutritional status. That's because it implies a greater addition of sugar in preparations to enhance a taste that pleases the palate, leading to exaggeration in its quantity[10].

Considering that older adults are a population at risk for developing CNCDs and there are few studies in Brazil that evaluate their food consumption, especially in relation to sugars, it is important to investigate the prevalence of consumption of added sugars in older adults' diets and their associated factors to evaluate their consumption and allow development of more effective future public policies for this group.

In this sense, the objective of the present study is to evaluate the prevalence of consumption of added sugars in the diet of older adults in the region of Campinas-SP, their main dietary sources, and their associated factors.

Methods

Sample

The project used the database of the study "Evaluation of the prevalence of micronutrient deficiency among community-dwelling older adults in the metropolitan area of Campinas-SP" conducted between 2018 and 2019 in the cities of Campinas, Limeira, and Piracicaba. Participants were asked to answer a questionnaire containing socioeconomic, health, lifestyle, and nutritional questions. Anthropometric evaluation and blood sample collection were also performed. Details on the sample size and collection procedures can be found in the work of Rolizola *et al.*[11]. The research project was funded by the National Council for Research and Development (CNPq) under process number 408262/2017-6 and approved by the ethics committee under protocol CAAE 95607018.8.0000.5404.

The following main research inclusion criteria were adopted: being 60 years of age or older, having agreed to participate in the study by signing the informed consent form (ICF), being a resident of one of the previous selected cities, being registered in the Family Health Strategy (FHS). Also, they should present minimal ability to understand study procedures and consent form with no need for an auxiliary informant. The exclusion criteria were: use of food supplements based on vitamins and/or minerals (since the main study aimed to assess the deficiency of some of these nutrients and their dietary consumption, not considering supplement usage), and being undergoing chemotherapy treatment or monitored by a home care program, since these conditions significantly alter food consumption.

From the total number of participants in the main study (n=611), 19 who did not have complete food consumption data and 6 individuals who did not answer the socioeconomic questionnaire were excluded, totaling a final sample of 586 participants.

Instruments and study variables

Twenty-four-hour recall (24HR) was used to evaluate older adults' food consumption. The tool is based on list and quantify all foods and bever-

ages consumed on the day before the interview. This method was chosen because of its fast and easy applicability, it does not alter food intake, and participant does not need to be literate[12].

Several methodological precautions were taken to minimize possible biases in food consumption assessment. All 24HR applicators were previously trained and qualified in the proper execution of the instrument, following recommended steps to perform it, which helped to minimize participants' memory bias. 24HR was applied on the day of research data collection, being reapplied via telephone between 20 and 30 days after first application, to obtain usual feeding variation. Personal or telephone data was not collected on Mondays to avoid collect Sunday consumption, which tends to be atypical. In the first 24HR, conducted personally, photos of portions and utensils were used to assist portion size estimation. At this moment, the participant received a material with the main household measures used to take home and serve as support in carrying out the second 24HR to minimize measurement bias.

Nutrition Data System for Research (NDRS) software was used to quantify nutritional value from foods consumed at 24HR[13]. To estimate usual added sugars intake, Multiple Source Method (MSM) was used, which is a statistical web-based modeling[14]. This method is a mixed model composed of three parts, which requires at least two days of short-term dietary measures (such as 24 hours) in a random subsample from target population. In the first stage, consumption probability of a food/nutrient in a day is estimated by logistic regression with random effects (probability model). Then, all data transformed to normality is used to estimate usual nutrient amount intake on consumption days by linear regression, also with random effects (quantity model). Finally, usual individual intake is calculated by multiplying food/nutrient consumption probability (step 1) by usual food intake amount (step 2).

Selected variables for present study are described below:

Sociodemographic: gender (male, female); age group (<75 years, ≥75 years); marital status (with a partner, without a partner - considering single, divorced, and widowed); education (0 to 8 years, 9 years or more); ethnicity (Caucasians, African Americans and Mixed Race, Others – South native American and Asian); monthly income (≤2 minimum wages, >2 minimum wages – considered the value reported at the time of the study: 2018 - R$ 954[15]; 2019 - R$ 998[16]).

Health: Body Mass Index -BMI (eutrophic, low weight, overweight – considering as cutoff points of the BMI those used by the Ministry of Health: low weight <22 kg/m², normal weight between 22 and 27 kg/m², and excess of weight >27 kg/m²)[17]; self-reported diabetes mellitus (without disease, with disease); physical activity (active, not active – adopting as active those who practiced 150 minutes or more of activities in the week and nonactive those who practiced less than 150 minutes of activities in week[18]); alcoholism (nonalcoholic, ex-alcoholic/alcoholic-being considered ex-alcoholic/alcoholic those who have ingested/ingest alcoholic beverage), smoking (no, ex-smoker/smoker).

Variable of interest: values obtained for added sugars intake were used by applying 24HR. Values recommended by the World Health Organization guidelines[8] were used to determine adequate intake, which suggests that simple sugars intake should be reduced to 5% of daily needs. In this case, individuals with sugar consumption rate above 5% of total calories consumed were considered with an inadequate sugar intake.

Foods ingested by participants in the first 24HR were coded and then organized into food groups or presented separately, considering their main sugar sources. This procedure was used to determine which foods/food groups most contributed to added sugar consumption in older adults' diet. Foods/food groups that most contributed to total nutrients in the diet were selected. For relative contribution (RC) calculation of added sugars dietary sources, a method proposed by Block *et al.*[19] was applied by using equation: RC = (Total food sugar (g)/100 (Total dietary sugar (g)) x 100.

Statistical analysis

Sugar consumption mean values (with their respective standard deviations) were described in terms of sociodemographic and health variables. Shapiro-Wilk normality test showed that statistical distribution did not adhere to normality. Therefore, for mean values comparison between independent variables groups, non-parametric tests were used: Mann-Whitney test for comparisons between 2 categories and Kruskal-Wallis for comparisons between 3 categories.

For consumption inadequacy analysis, added sugars total amount was categorized into adequate and not adequate (>5% of total calories consumed), and raw odds ratios (OR) of sugar inadequate consumption were estimated in rela-

tion to selected variables using logistic regression method. All statistical analysis were performed using Stata® software version 12, with p<0.05 significance level.

Results

Among participants, most were female (69%), aged between 60 and 74 years (78%), Caucasian (55%), with a partner (60%), with a family income of more than 2 minimum wages (68%) and education less than or equal to 8 years (72%). In addition, most of them were not physically active (53%) and overweight (60%). Data regarding sample characteristics are shown in Table 1.

Regarding food intake, an added sugars intake average intake of 104 kcal (26 g) was observed, which represents, on average, 7.0% of ingested calories. Table 2 shows mean values of added sugar intake as a percentage of total caloric intake, according to independent variables. Sugar intake was statistically higher among older women and those without a partner. Lower intake values were found in diabetic individuals. There were no significant differences in added sugars intake in relation to age, education, ethnicity, monthly income, and physical activity.

Regarding inadequacy prevalence, 66% of study population has a consumption of added sugars higher than 5% of total energy consumption of World Health Organization[13] indication. Table 3 shows inadequacy prevalence of sugar intake and odds ratio (with their respective confidence intervals - 95%) according to some selected characteristics. Regarding added sugars intake indication limited to 5% of daily caloric intake, higher inadequacy odds were found in females (OR: 1.70; p=0.004) and underweight (OR: 2.78; p=0.014). In contrast, diabetic individuals had lowest inadequacy odds (OR: 0.35; p<0.001).

Regarding main dietary sources of added sugars to older adults' diet evaluation, table sugar and honey were consumed in greatest amount (51% of all food sugars sources). Figure 1 shows main food sources of added sugars in relative contribution.

Table 1. Sample characterization of older adult residents in the cities of the region of Campinas (n=586).

Variable analyzed	N	(%)
Gender		
Male	179	30.55
Female	407	69.45
Age group		
<75 years	459	78.33
≥75 years	127	21.67
Marital status		
With partner	353	60.24
Without partner	233	39.76
Education		
0 to 8 years	423	72.18
9 years or more	158	26.96
Not informed	5	0.85
Ethnicity		
Caucasian	324	55.29
African Americans and Mixed Race	239	40.78
Others	23	3.92
Monthly Income		
≤2 MW[1]	130	22.18
>2 MW[1]	400	68.26
Not informed	56	9.56
Physical activity		
Active	276	47.10
Not active	310	52.90
BMI		
Eutrophic	185	31.57
Low weight	49	8.36
Overweight	352	60.07

[1]MW = Minimum Wage according to government data in force at the time of 2018/2019.

Source: Authors.

Discussion

In our study, an added sugars intake average of approximately 7.0% of total energy percentage was found. This value is similar to those obtained in Consumer Expenditure Survey (*Pesquisa de Orçamentos Familiares* - POF) of 2017 and 2018, in which it was found that added sugar consumption for female and male individuals aged 60 years or older, on average, increased from 5.1% of daily energy consumption in 2008-2009 to 8.8% in 2017-2018[20].

Corroborating present study, Bueno *et al.*[21], in a study that evaluated factors associated with added sugars intake in adults and older adults, indicated that daily energy average from added sugars among older adults was 8.4%. In contrast, this rate is higher than what was found in ANIBES study with individuals aged between 65 and 75 years (5.1%) conducted in Spain, which investigated sugar intake (added and intrinsic) in diet, according to gender and age group[22].

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Table 2. Average intake of added sugars, in % of total energy intake, according to some selected characteristics.

Analyzed variable	N	Minimum/Maximum consumption in %*	Average Sugar Consumption in %* (95%CI)	P-value
Total	586	0.54/27.64	6.98 (6.67; 7.28)	-
Gender[1]			<0.001	<0.001
Male	179	0.54/16.53	6.15 (5.63; 6.66)	
Female	407	0.73/27.64	7.34 (6.97; 7.71)	
Age group[1]			0.868	0.868
<75 years	459	0.54/27.64	7.02 (6.66; 7.37)	
≥75 years	127	1.00/20.93	6.82 (6.22; 7.43)	
Marital status[1]			0.023	0.023
With partner	353	0.54/19.47	6.64 (6.27; 7.01)	
Without partner	233	0.54/27.64	7.49 (6.96; 8.01)	
Schooling[2]			0.454	0.454
0 to 8 years	423	0.54/27.64	7.15 (6.61; 7.69)	
9 years or more	158	0.94/19.50	6.90 (6.53; 7.28)	
Not informed	5	3.93/10.65	7.54 (5.43; 9.64)	
Etnicity[2]			0.780	0.780
Caucasian	324	0.54/27.64	6.90 (6.49; 7.31)	
African Americans and Mixed Race	239	0.73/25.20	7.04 (6.56; 7.52)	
Others	23	1.41/16.36	7.41 (5.87; 8.96)	
Physical activity[1]			0.967	0.967
Active	276	0.94/25.20	6.90 (6.49; 7.30)	
Not active	310	0.54/27.64	7.05 (6.59; 7.50)	
BMI[2]			0.084	0.084
Eutrophic	185	0.94/17.44	7.05 (6.53; 7.58)	
Low weight	49	1.39/20.93	7.90 (6.86; 8.93)	
Overweight	352	0.54/27.64	6.81 (6.40; 7.21)	
Diabetes mellitus[1]			<0.001	<0.001
Without disease	427	0.94/27.64	7.52 (7.17; 7.87)	
With disease	157	0.54/25.20	5.51 (4.92; 6.09)	

[1]Mann-Whitney test; 2Kruskall-Wallis test. * Considering the total energy consumption.

Source: Authors.

Regarding sugar intake inadequacy prevalence, 66% of older adults had inadequate intake in our study, values higher than those found in study conducted by Marinho *et al.*[23] that evaluated sugars intake and consumption determinants in a Portuguese national sample, where 36.1% of older adults showed inadequacy regarding 5% recommendation, as well as in Spanish population where rate inadequacy was 44.7%[24].

Regarding main dietary sources of added sugar, Bueno *et al.*[21] also observed that among foods responsible for added sugar in older adults' diet were table sugar, honey, and sweet and/or sweetened beverages. Together, they represent 70% of added sugars. In the Portuguese and Spanish populations, table sugar was also main dietary source, accounting for 30% and 25%, respectively, of added sugar intake in older adults' diets[22,23]. Conversely, among older adults in United States aged over 71 years, sweet bread (20.7%) and sweetened beverages (17.7%) were main dietary sources of added sugar, with this change from sweetened beverages to sweet baked products is explained as a reflection of a more peaceful eating routine that comes with retirement, either eating alone or meeting with other people for socialization[25].

There is also an important contribution of ultra-processed foods such as cookies, cakes, processed bread, and sausages for sugar consumption in older adults' diet, representing approximately 15% of calories consumed. In 2017-

Table 3. Inadequacy prevalence of added sugars intake and odds ratio (OR) with 95% confidence interval (95%CI) according to independent variables (n=586).

Analyzed variable	Inadequacy (%)	P-value	Odds Ratio[1] (95%CI)
Total	66.0		-
Gender	0.004	0.004	
Male	57.5		
Female	69.8		1.70 (1.18; 2.45)
Diabetes mellitus	<0.001	<0.001	
Without disease	72.6		-
With disease	47.8		0.35 (0.24; 0.50)
BMI	0.014	0.014	
Eutrophic	64.9		-
Low weight	83.7		2.78 (1.23; 6.27)
Overweight	64.2		0.97 (0.67; 1.41)

[1]Logistic regression test.

Source: Authors.

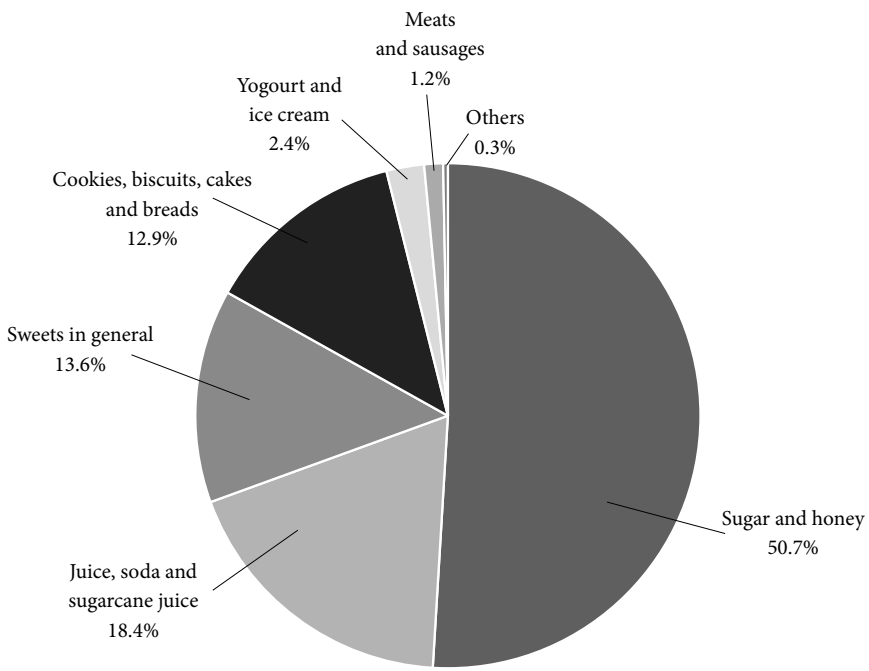

Figure 1. Main foods that contributed to added sugars consumption among older adults according to relative contribution.

Source: Authors.

2018's Consumer Expenditure Survey (POF), prevalence of bread, cookies, cakes, and sausages consumption among older adults was, on average, 52.7%, 14.4%, 11.3%, and 1.6%, respectively. Among older adults, it is common to substitute main meals based on culinary preparations (especially dinner) for snacks made, for example, by bread, milk, cookies/biscuits, and other ultra-processed foods such as sausages and ham[20].

In this context, special attention should be given older adults' diet, since ultra-processed food consumption, such as soft drinks, cookies,

and treats, negatively influences food quality, increasing energy density, sugar levels, saturated and trans-fat and leading to reduced fiber levels, thus increasing risks of overweight, obesity, and mortality from cardiovascular diseases[26].

Considering analysis between groups, a higher sugar consumption and inadequacy rate were observed among women, that were 70% more likely to have inadequate consumption than men. These results were also evidenced by Bueno *et al.*[21], where females had a higher sugar percentage in diet than males (8.7% and 7.8%, respectively).

In 2017-2018's POF, Brazilian women also had a higher percentage of total caloric added sugars intake than men, 9.3% versus 8.3%, respectively[20]. According to Ferreira and Magalhães[27], this situation can be explained by the inequality and social devaluation faced by Brazilian women, imposing an insufficient dietary pattern from the nutritional point of view, marked by reduced access to natural foods, such as vegetables and fruits, and increased choice of denser and cheaper foods, such as those rich in sugars.

In our study, it was also observed that participants without partners had a higher sugar contribution in their diet when compared to married individuals. According to Locher and Sharkey[28], living with a partner is consistently reported as an adequate predictor of nutritional health among older adults. Women, especially widows, may be vulnerable to nutritional problems because they do not have necessary financial resources for an adequate diet or present a lower diet desire to cook for themselves because they have no one to cook for. And thus they opt for more practical and hyper-palatable meals with higher sugar content.

It was also found that diabetic individuals had a lower added sugar intake and lower inadequacy rates. Several studies indicate that high sugar consumption can lead to the development of several diseases, such as obesity and diabetes mellitus[29].

Diabetic individuals often report difficulties in adhering to proposed diets due to various associated meanings and negative emotions, such as pleasure loss in eating associated with food restriction feeling. Although such practices as eliminating sugar or limiting consumption of foods containing carbohydrates are described much more frequently by diabetics as an important part of individual's dietary for disease control[30]. Similarly, in a study that researched an association between dietary quality and socioeconomic factors, health, and nutrition of older adults residents in the city of Viçosa-MG, a positive association was found between diabetes mellitus historic and "better diet quality", although it was not evaluated whether older adults with better diet quality had adequate disease control[31].

Thus, even though diet adequacy process is difficult for older adults with diabetes, participants in our study showed greater attention to nutritional guidelines, at least in relation to sugar intake. These findings agree with results from a study conducted by Virtanen *et al.*[32] comparing male older adults' diets with diabetic and non-diabetic men in Finland, Netherlands, and Italy. Results indicated that diabetic men ingested less added sugar than nondiabetic men in all three countries.

Regarding BMI, 83.7% of older adults with low weight had inadequate sugar intake. Aging anorexia is one of the main causes of inadequate food consumption, characterized by reduced appetite and low food intake, which can occur by decreasing energy demand. Older adults may have a lower physiological appetite, consume less food per meal and slowly, influencing early satiety and decreased daily energy intake, causing negative energy balance and, consequently, body weight loss. In addition, aging anorexia may be influenced by lower food palatability. This may motivate an overall reduction in food interest and a choice of less varied diets from a nutritional point of view, with an increase in more palatable foods with higher sugar amount[33,34].

Although in present study no association was found between added sugar intake and educational level and age, other studies indicated a higher sugar consumption among individuals with lower educational levels[31,35] and among older adults[36]. Furthermore, despite dental prostheses usage, dysphagia and changes in taste are factors that may interfere with food preferences among older adults, in our study no significant differences were observed between these variables and average sugar consumption in population (not shown data).

Present study has some limitations that should be considered when interpreting its results. First, method used to assess food consumption (24HR) is susceptible to memory bias, which may be compromised among older adults interviewed, although all applicators were subjected to training and used photographic manuals at the time of interview to minimize possible errors. It is also important to mention that 24HR is a method that describes interviewee's current

food consumption and may not be suitable for estimating habitual consumption. However, it is considered that this bias was minimized considering that: 1) foods (sugars) and portions estimation undergo less variation than specific nutrients, especially micronutrients; 2) older adults tend to have a monotonous diet most of the time, with little variation between days[37]; 3) in literature, it is stated that if sample is large enough, as the one studied here, even a single day of consumption per individual can be used to estimate usual population average consumption, eliminating extreme values due to population distribution, and, to estimate the intra-individual daily variation, it is usually statistically more efficient to increase the number of individuals in sample than to increase number of days above 2 days per individual[38,39]; and 4) usual consumption adjustment method used (MSM) is developed exactly to estimate usual consumption from a limited number of records.

In addition, this is a cross-sectional study, and it is not possible to search for cause-and-effect relationships. However, it is an important method to verify population data, as it can generate hypotheses, possible associated factors, and guide future longitudinal research and/or proposals for intervention. Besides that, studied population is community-dwelling older adults, and it is not possible to generalize results observed here to other populations.

Conclusion

The present work presented relevant results that characterized and quantified eating behavior of older adults with a focus on added sugars intake, showing that older adults had a consumption of added sugars above recommended. This consumption is higher among women, in individuals without a partner and with low weight, and lower in people with diabetes. Furthermore, it was observed that among main dietary sources were table sugar and honey. Thus, it was evidenced that socioeconomic and health factors are determinants in food quality and in added sugars intake by older adults, showing the importance of studies on food consumption in this group as a way of identifying main factors associated with inadequacy and expanding the knowledge about their eating habits. These findings can help in new guidelines formulation, nutritional strategies, and interventions, both at the individual level and in public policies, aimed at ensuring an improvement in the food quality of this population, which has highest rates in prevalence of CNCDs.

Collaborations

JNB Silva Júnior worked on data collection, data analysis and manuscript writing. CN Freiria contributed to data collection, database preparation, data analysis and manuscript revision. GM Silva participated in data collection, database preparation and manuscript revision. LP Corona contributed to the study design, analysis plan, research coordination, and manuscript revision. All authors read and approved the final manuscript.

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