Article published online: 2024-05-13

THIEME OPEN ACCESS

Original Article

Dietary Inflammatory Potential and its Association with Sleep Complaints in Institutionalized Older Adults: A Pilot Study

Letícia do Nascimento Maximiano Ferreira[1] Camila Maria de Melo[2] Lilian Barbosa Ramos[3] Henrique Salmazo da Silva[4] Anna Karla Carneiro Roriz[3] Sandra Maria Lima Ribeiro[1,5]

[1] Escola de Artes, Ciências e Humanidades, Universidade de São Paulo, São Paulo, SP, Brazil
[2] Department of Nutrition, Faculdade de Ciências da Saúde, Universidade Federal de Lavras, Lavras, MG, Brazil
[3] Escola de Nutrição, Universidade Federal da Bahia, Salvador, BA, Brazil
[4] Universidade Católica de Brasília, Brasília, DF, Brazil
[5] Faculdade de Saúde Pública, Universidade de São Paulo, São Paulo, SP, Brazil

Address for correspondence Letícia do Nascimento Maximiano Ferreira, PhD (e-mail: leticia.nascimento.ferreira@usp.br).

Sleep Sci

Abstract

Objective To evaluate the inflammatory potential of diets, the specific dietary contributors to said inflammatory potential, the nutritional adequacy of these diets, and the association between the dietary inflammatory potential and sleep complaints among residents of long-term care facilities.

Materials and Methods The present is a cross-sectional, quantitative, and exploratory study, with a convenience pilot sample from two long-term care facilities. To assess sleep complaints, the sleep domain of the Nottingham Health Profile was applied, as well as a question about daytime napping. To evaluate the inflammatory potential of the diet, the Dietary Inflammatory Index (DII) was calculated.

Results The participants presented energy and protein intakes below the recommendation. The intake of saturated fatty acids, omega 6, dietary fiber, vitamins D, E, B6, and magnesium were inadequate in some of the participants. The mean score on the DII was of 1.6, representing a more proinflammatory potential, due to insufficient intake of anti-inflammatory components. The foods with the most significant inflammatory effect consumed were whole milk and butter. On the other hand, those with less inflammatory potential were beans, beets, coffee, and sweet potatoes. No significant association was observed between the sleep complaints and the DII.

Conclusion The data showed inadequacy of many nutrients and a proinflammatory potential regarding the diet in the long-term care facilities. However, the DII was not significantly associated with sleep complaints in our sample. The present study highlights the need for greater attention to meal planning in these institutions.

Keywords
- dietary inflammatory index
- sleep issues
- older adults
- long-term care facilities

received
August 30, 2023
accepted
March 12, 2024

DOI https://doi.org/10.1055/s-0044-1786386.
ISSN 1984-0659.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

Poor sleep quality is present in approximately 72% of older adults residing in long-term care facilities (LTCFs), representing a higher prevalence when compared to community-dwelling older adults.[1,2] Low-grade chronic inflammation (LGCI), which is common among individuals in older age groups, can be one of the predisposing factors for sleep disorders, due to the effects of inflammatory molecules in the central nervous system, particularly in brain regions responsible for sleep regulation.[3] Diet can modulate inflammation by triggering mechanisms that either stimulate or resolve it, thereby characterizing pro- or anti-inflammatory dietary patterns respectively.[4]

The so-called Western dietary patterns are characterized by frequent consumption of foods high in energy density and with a high glycemic index, as well as high in saturated fatty acids, and containing low amounts of mono and polyunsaturated lipids, fiber, antioxidant vitamins, and bioactive compounds. This type of dietary pattern is linked to a low-grade, chronic, and systemic increase in proinflammatory markers, such as C-reactive protein (CRP), tumor necrosis factor alpha (TNF-a), and interleukin 6 (IL-6), thereby increasing the risk of developing non-communicable chronic diseases.[5] On the other hand, a diet based on whole grains, fruits, vegetables, fish, and low-fat dairy products is associated with a better health profile, partly due to the supply of nutrients that promote an anti-inflammatory state.[6] However, most published studies on the quantitative evaluation of LTCF diets have found insufficient consumption of energy, proteins, vitamins, and minerals, indicating a poor nutritional quality.[7–10]

Diet is a modifiable factor that directly influences LGCI, which, in turn, is related to sleep quality; therefore, evaluating the association between the inflammatory potential of diet and sleep complaints is of particular interest. Such an evaluation can provide important information about nutritional interventions to enhance sleep quality in older adults. Therefore, the objectives of the present study are to identify the features of diets offered in two Brazilian LTCFs, namely, their inflammatory potential, the specific dietary contributors to said inflammatory potential, and the nutritional adequacy of these diets, and to evaluate the association between the inflammatory potential of the diets and sleep complains among LTCF residents.

Materials and Methods

Study Design and Sample

The present is a cross-sectional, quantitative, and exploratory pilot study, with convenience sample. The participants were older adults residing in two LTCFs located in the city of Salvador, state of Bahia, Northeastern Brazil. The study was conducted between January and March 2020. The inclusion criteria were participants aged $\geq$ 60 years, of either sex, who had been institutionalized for at least 6 months, and who provided informed consent. The exclusion criteria were subjects with sensory difficulties that hindered questionnaire comprehension, those presenting conditions such as aphasia, agnosia, or articulation and language problems that impeded communication, bedridden subjects, and those with untreated psychiatric disorders. The selection criteria for the LTCFs were as follows: public or philanthropic facilities, which occupied the same physical space for a minimum of two years, had a technical manager overseeing operations, and agreed to participate in the study. In total, 31 older adults were included.

Procedures

Trained interviewers conducted the data collection using an assessment protocol, comprising validated tools and questions about the residents' social, economic, and health conditions. When residents encountered difficulties in answering specific questions, their caregivers were consulted for assistance. Eligible participants who voluntarily agreed to participate in the study provided written informed consent.

Ethical approval was obtained from the Ethics in Research Committees of the School of Nutrition of Universidade Federal da Bahia (CAAE 18561419.5.1001.5023) and of Universidade Católica de Brasília (CAAE 18151019.1.1001.0029), in compliance with Resolution no. 466/2012 on research involving human beings of the National Health Council of the Brazilian Ministry of Health.

Measures

Sociodemographic and Health Characteristics

The sociodemographic characteristics (such as age, sex, skin color, level of schooling, and marital status) were self-reported. Medical diagnoses and medication use were evaluated based on the medical records of the residents. The activities of daily living (ADLs) were assessed by the Brazilian version of the Katz ADL index,[11] and the practice of physical activity was evaluated by the following question: "Do you practice any physical activity?".

Dependent Variables

Insomnia complaints were assessed by the sleep questions from the Nottingham Health Profile (NHP) instrument adapted for the Brazilian population.[12] The NHP is a self-administered tool with 38 questions and 6 main domains that encompass energy, pain, social interaction, sleep, emotional reactions, and physical skills, and it aims to assess quality of life in the older population.[13] The instrument was validated for the Brazilian population with older adults living in the community. However, due to its psychometric properties, the application of the NHP is recommended in older adults with a higher level of dependence, such as those who are hospitalized or institutionalized.[14] The yes/no questions regarding sleep were as follows: 1) Do you wake up at night and no longer fall asleep?; 2) Do you stay awake most of the night?; 3) Do you take a long time to fall asleep?; and 4) Do you sleep poorly at night? The NHP question about taking sleep medication was removed because this aspect was assessed by consulting the residents' medical records. Finally, a question regarding daytime napping was included due to its association with insomnia complaints.

Dietary Intake

Data on dietary intake was assessed by a food record that consisted of detailed recording of food intake from the first to the last meal of the day among 50% of the residents of each LTCF, who were randomly selected. The food record forms were applied by trained nutritionists from Monday to Friday and on one day of the weekend to guarantee the representativeness of the data. The food record form contained three columns describing the time the meal was eaten, the place, and the description of the food(s), drink(s) or dietary supplements consumed in household measures. In addition, the LTCF menus were assessed to record details of preparations that could not be obtained during the observation of the meals.

To analyze the nutrient composition of the food records, the Nutrition Data System for Research (NDSR, University of Minnesota Nutrition Coordinating Center, Minneapolis, MN, United States) software was used.[15] To quantify the flavonoids content of the diets, we used the food composition table provided by the United States Department of Agriculture (USDA)[16] and the Brazilian Table on Food Composition.[17] To evaluate the nutritional adequacy of the diets, the nutrient composition of the menus was compared to the dietary reference intakes (DRIs), and the macronutrient distribution ranges were compared to the acceptable macronutrient distribution range (AMDR).[18] Energy and protein requirements for older adults were assessed by the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines, which indicate the consumption of 30 kcal/kg/day and a protein supply of at least 1 g/kg/day.[19]

Subsequently, we used the dietary inflammatory index (DII), developed by Shivappa et al.[20] (2014) to assess the inflammatory potential of diet through 45 foods, nutrients, and bioactive parameters, resulting in a continuous score, in which higher values represent diets with greater inflammatory potential, and lower values represent diets with anti-inflammatory potential. In the present study, 36 of the 45 food parameters were included: energy, carbohydrate, protein, total fat, saturated fat, trans fat, cholesterol, monounsaturated fat, polyunsaturated fat, omega-3 fatty acids, omega-6 fatty acids, fiber, vitamin A, beta-carotene, vitamin D, vitamin E, vitamin C, thiamine, riboflavin, niacin, vitamin B6, folic acid, vitamin B12, magnesium, iron, zinc, selenium, caffeine, isoflavones, anthocyanidins, flavan-3-ols, flavanones, flavones, flavonols, garlic, and onion.

The index calculation was performed according to the authors' guidance, and it comprised the following steps: first, the intake of each DII food parameter for each individual (representing the individual daily mean intake) was estimated through the food record by the NDSR. Then, the z-score was calculated by subtracting the global daily mean intake from the individual daily mean intake and dividing this value by the global daily mean intake standard deviation (SD). After that, the z-score was converted into a percentile using a formula on the Microsoft Excel software (Microsoft Corp., Redmond, WA, United States). To achieve a symmetrical distribution with values centered at 0 and limited to -1 (maximum anti-inflammatory value) and +1 (maximum proinflammatory value), each percentile was multiplied by 2 and then subtracted by 1, resulting in a centered percentile. Finally, the centered percentile was multiplied by the overall inflammatory effect score, to obtain the food parameter-specific DII scores of each individual. To obtain the overall DII score for an individual, all of the food parameter-specific DII scores were added. The global daily mean intake, global daily mean intake SD, and the overall inflammatory effect score of each food parameter were consulted in the publication by Shivappa et al. (2014).[20]

Finally, the DII components that most contributed to an anti- or proinflammatory effect of the diet and the dietary contributors to the components with the highest and lowest inflammatory effect were evaluated. For the first part of this evaluation, the means of the inflammatory effect of each component were included and organized in ascending order to evaluate those that obtained the highest and lowest mean inflammatory effects (►**Table 3**). Subsequently, to identify the dietary contributors, a list with all the foods that were assessed by the food records was drawn up, and those that appeared in greater quantity for each component of the DII were evaluated.

Data Analysis

The Shapiro-Wilk test was applied to analyze the distribution of continuous data. The results of the descriptive analysis were expressed as mean ± SD values for the continuous variables, and as absolute and relative frequencies (percentages) for the categorical variables. The independent samples *t*-test was used to compare mean DII scores and sleep complaints. The statistical analyses were performed using the Stata (StataCorp LLC, College Station, TX, Unied States) software, version 14, adopting a significance level of 5%.

Results

Participants' Characteristics (n = 31)

The mean age of the participants was of 77.8(±10.7) years, 64.5% were women, the predominant skin color was black (63.3%), and half of the residents were single. More than half of the participants (51.6%) reported having had 5 to 8 years of schooling. Concerning medical diagnoses, 61.3% reported systemic arterial hypertension, 38.7%, diabetes mellitus, 25.8%, cardiovascular disease, and 9.7% reported major depressive disorder. The mean number of medicines used was of 4.3 per resident. Most were classified as independent regarding ADLs (58.1%) and 16.7% reported practicing physical activity. Insomnia complaints were reported by 68.4% of the residents, and the most prevalent was related to difficulty initiating sleep, followed by early awakening, non-restorative sleep, and difficulty maintaining sleep, and 35.5% of the sample were in the habit of napping in the daytime. Finally, the mean DII score was of +1.6, representing a more proinflammatory potential (►**Table 1**).

Dietary Adequacy

The quantitative nutrient analysis of the diets showed an adequate distribution of macronutrients, with 56% of total

Table 1 General characteristics of the study participants.

Variables (n)	Categories	n (%) or mean (±standard deviation)
Age in years (31)		77.8 (10.7)
Female sex (31)		20 (64.5)
Skin color (30)	White	5 (16.7)
	Black	19 (63.3)
	Other	6 (20)
Marital status (30)	Single	15 (50)
	Divorced	9 (30)
	Married	1 (3.3)
	Widowed	5 (16.7)
Years of schooling (31)	1–4	10 (32.3)
	5–8	16 (51.6)
	≥ 9	5 (16.1)
Systemic arterial hypertension (31)		19 (61.3)
Diabetes mellitus (31)		12 (38.7)
Cardiovascular disease (31)		8 (25.8)
Depression (30)		3 (9.7)
Number of medications (27)		4.3 (2.8)
Activities of daily living (31)	Independent	18 (58.1)
	1 or more limitations	13 (41.9)
Physical activity (30)		5 (16.7)
Waking up at night and being unable to fall back asleep (19)		5 (16.1)
Staying awake most of the night (19)		3 (9.7)
Taking a long time to fall asleep (19)		12 (38.7)
Sleeping poorly at night (19)		4 (12.9)
Daytime napping (19)		11 (35.5)
Dietary inflammatory index (30)		1.6

calories coming from carbohydrates, 16%, from proteins, and 28%, from lipids. The energy and protein adequacy recommendations were met; however, 50% of the residents presented energy intake values below the recommended levels, and 35%, values below the recommended levels for protein. Regarding fatty acids, the intake of saturated fats exceeded the AMDR, and the average consumption of omega 6 did not meet the adequate intake established by the DRIs. Mean dietary fiber intake did not meet the DRIs either. As for vitamins, the consumption of vitamins E and D among participants over 70 years of age, and that of vitamin B6 among females, did not meet the DRIs. Finally, regarding minerals, only magnesium did not meet the recommended dietary allowances. ►**Table 2** presents the quantitative description of the nutrients that make up the DII with the DRI values.[21]

Dietary Inflammatory Potential

Among the 45 components suggested for the DII calculation, 9 were excluded, as they were not present in the residents' diet: alcohol, ginger, saffron, turmeric, green/black tea, pepper, thyme/oregano, rosemary, and eugenol; the latter was not evaluated, as it was not present in the food composition tables. Thus, only the 36 aforementioned components were used to assess the inflammatory potential of the diets.

►**Table 3** presents the inflammatory effect attributed to the DII score and to each DII component in the analysis. The average score was of +1.6, indicating more proinflammatory diets, with the lowest score of -2 and the highest, +5.8. The greater inflammatory potential observed was due to the reduced intake of components with anti-inflammatory potential when compared to the global average daily intake described by Shivappa et al.[20] These components were: isoflavones, flavonols, vitamin E, polyunsaturated fatty acids , fiber, magnesium, niacin, caffeine, onion, vitamin A, omega-6 fatty acids, thiamine, and monounsaturated fatty acids. However, some components with a high inflammatory effect led to a more anti-inflammatory diet, as they were consumed in reduced amounts when compared to the global average daily intake: saturated fat, total fat, cholesterol, energy, trans fat, iron, and protein.

Table 2 Quantitative description of the nutrients that make up the DII with the intake reference values according to the DRIs (n = 31).

Nutrient/DII component	Mean(±SD)	DRI
Energy (kcal)	1,778.6(±593.9)	NA
Energy adequacy (kcal/kg/day)	31.3(±11.2)	30[b]
Carbohydrate (% kcal)	56	45–65[a]
Protein (% kcal)	16	10–35[a]
Protein adequacy (g/kg/day)	1.3(±0.5)	1[b]
Total fat (% kcal)	28	20–35[a]
Saturated fat (% kcal)	11.1	< 10[a]
Trans fat (g)	2.7(±1.7)	NA[c]
Cholesterol (mg)	174.1(±78.2)	NA[c]
Monounsaturated fats (g)	18.1(±7)	NA[d]
Polyunsaturated fats (g)	10.8(±4.7)	NA[d]
Omega 3 (g/day)	1.7(±0.5)/1.2(±0.4)	1.6/1.1 (man/woman)[e]
Omega 6 (g/day)	11.2(±4)/8.5(±4)	14/11 (man/woman)[e]
Fiber (g/day)	20.4(±6.3)/14.3(±6.2)	30/21 (man/woman)[e]
Vitamin A (μg/day)	1,096.4(±463)/1,062.1(±1,037.9)	900/700 (man/woman)[f]
Vitamin C (mg/day)	822.1(±841.8)/483.4(±802.2)	90/75 (man/woman)[f]
Vitamin D (μg/day)	10.2(±4)/8.7(±4)	10/15 (50–70 years old/> 70 years old)[e]
Vitamin E (mg/day)	4.1(±1.6)	15[f]
Thiamine (mg/day)	2.1(±0.3)/1.3(±0.5)	1.2/1.1 (man/woman)[f]
Riboflavin (mg/day)	2.7(±0.4)/1.9(±0.6)	1.3/1.1 (man/woman)[f]
Niacin (mg/day)	22.3(±5.5)/14(±5.6)	16/14 (man/woman)[f]
Vitamin B6 (mg/day)	1.8(±0.6)/1.3(±0.7)	1.7/1.5 (man/woman)[f]
Folic acid (μg/day)	579.1(±231.2)	400[f]
Vitamin B12 (μg/day)	4.7(±1.9)	2.4[f]
Iron (mg/day)	14.3(±6.1)	8[f]
Magnesium (mg/day)	317.5(±76.2)/216.5(±91.1)	420/320 (man/woman)[f]
Zinc (mg/day)	12.5(±4.4)/8.5(±4)	11/8 (man/woman)[f]
Selenium (μg/day)	106.9(±39.1)	55[f]

Abbreviations: DII, dietary inflammatory index; DRI, dietary reference intake; NA, not applicable; SD, standard deviation.
Notes: [a]Acceptable macronutrient distribution range (AMDR); [b]European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines; [c]As low as possible, while consuming a nutritionally adequate diet; [d]No specific recommendation; [e]Adequate intake (AI); [f]Recommended dietary allowances (RDAs).

Association between the DII and Sleep Complaints

►Table 4 presents the association analysis between the mean DII scores and sleep complaints. There was no significant difference between the mean DII scores in the groups with and without sleep complaints.

Discussion

We explored the adequacy and inflammatory feature of diets, as well as the association between the dietary inflammatory potential and sleep complaints in a population of older adults, residents of one public and one philanthropic LTCF from the city of Salvador, Brazil. For the quantitative assessment of the diets, the intake of energy, protein, saturated fat, omega 6, fiber, vitamins E, D, and B6, and magnesium were inadequate when compared to the DRIs. Regarding the inflammatory proprieties, the mean DII score was of +1.6, with insufficient intake of components with anti-inflammatory properties. Among the foods consumed, those with a more proinflammatory potential were whole milk and margarine, and the foods with a more anti-inflammatory profile were beans, beets, coffee, and sweet potatoes. Finally, no significant association was found between the DII and sleep complaints.

Regarding the nutritional adequacy of diets, the present study found that the average intake of energy and protein was adequate; however, half of the residents did not meet the required quantity of calories, and one third of them did not

Table 3 Inflammatory effect of DII components and dietary contributors to the inflammatory potential of the diet (n = 31).

DII component	Inflammatory effect	Dietary contributor
Vitamin D (mcg)	−0.18	Whole milk
Saturated fat (g)	−0.16	Whole milk
Folic acid (mcg)	−0.14	Fortified cereal flour
Total fat (g)	−0.13	Whole milk
Selenium (mcg)	−0.12	Noodles
Cholesterol (mg)	−0.08	Whole milk
Omega 3 (g)	−0.08	Soybean oil
Beta-carotene (mcg)	−0.08	Potato
Vitamin C (mg)	−0.05	Acerola cherry juice
Energy (kcal)	−0.05	Whole milk
Flavonones (mg)	−0.03	Orange
Trans fat (g)	−0.02	Margarine
Riboflavin (mg)	−0.02	Whole milk
Carbohydrate (g)	−0.02	Sugar
Garlic (g)	−0.01	NA
Vitamin B6 (mg)	−0.01	Banana
Iron (mg)	0	Fortified cereal flour
Protein (g)	0	Beef
Monounsaturated fat (g)	0.01	Whole milk
Zinc (mg)	0.01	Beef
Vitamin B12 (mcg)	0.01	Whole milk
Thiamine (mg)	0.01	Bread
Omega 6 (g)	0.02	Soybean oil
Vitamin A (retinol equivalent)	0.03	Potato
Anthocyanidins (mg)	0.03	Acerola cherry juice
Onion (g)	0.03	NA
Caffeine (g)	0.08	Coffee
Niacin (mg)	0.10	Beef
Magnesium (mg)	0.13	Whole milk
Fiber (g)	0.14	Bean
Polyunsaturated fat (g)	0.14	Soybean oil
Flavan-3-ols (mg)	0.26	Coffee
Flavones (mg)	0.38	Beetroot
Vitamin E (mg)	0.40	Soybean oil
Flavonols (mg)	0.41	Sweet potato
Isoflavones (mg)	0.59	Coffee

Abbreviations: DII, dietary inflammatory index; NA, not applicable.

consume the adequate amount of protein. Previous studies[7,22] have found similar energy and protein intake despite an adequate distribution of macronutrients. One of the reasons that can lead to insufficient intake of nutrients in LTCF residents is a poor acceptance of food, which can be explained by age-related factors, such as anorexia of aging. The best strategy found in previous studies[9] to increase the energy intake among institutionalized older adults, without changing the volume of meals, is to offer meals with increased energy density in the same portion sizes. Besides, we found insufficient intake of fiber in the present study. There is scientific evidence[23] that fiber intake by older adults is insufficient, but the inadequacy is more pronounced among those living in LTCFs. The low amount of fiber in the diet offered at LTCFs may be due to the poor intake of fruits and vegetables. In the present study, we found a daily intake of

Table 4 Association analysis between the mean DII scores and sleep complaints (n = 19).

Sleep complaints	DII – mean(±SD)		*p*-value*
	With sleep complaints	Without sleep complaints	
Waking up at night and being unable to fall back asleep	1.06(±0.59)	2.89(±0.48)	0.09
Staying awake most of the night	1.31(±0.54)	2.78(±0.8)	0.28
Taking a long time to fall asleep	2.7(±0.77)	0.87(±0.56)	0.07
Sleeping poorly at night	1.37(±0.61)	2.21(±0.2)	0.50
Daytime napping	2.51(±1.74)	0.84(±0.65)	0.09

Abbreviations: DII, dietary inflammatory index; SD, standard deviation.
Note: *Independent samples *t*-test.

vegetables of 2 servings, and a daily intake of fruits of 0.5 servings, which do not meet the World Health Organization recommendations.[24]

Regarding the assessment of micronutrient intake in LTCFs, previous studies[8,14,25,26] have found insufficient intake of vitamins D, E, B6, and magnesium, as observed in the current study. Studies[27] have shown that the low intake of vitamins by older adults may be due to poor quality of the diet and little diversity of food consumed, corroborating the findings of the present study. Moreover, the inadequate intake of magnesium can be explained by the significant reduction of this nutrient in dietary patterns, as a result of the decrease in consumption of non-processed foods and the increase in consumption of ultra-processed foods, which lack magnesium, due to the loss of this nutrient during food processing.[28] A multicenter study conducted in Canada[29] investigated the nutritional, environmental, and behavioral aspects of LTCF diets, and found that most institutionalized older adults did not consume the recommended levels of micronutrients. However, no evidence was found on the inflammatory potential of LTCF diets, as the studies that investigated the diet offered in these institutions limited the quantitative description of nutrients and the biological and institutional factors that interfere with the food consumption of residents.

The hypothesis of an association between the dietary inflammatory potential and sleep complaints is grounded in the positive correlation observed regarding diet, sleep, and inflammation. However, this hypothesis was not confirmed by the present work, which partially differs from previous research conducted on different populations. For instance, Masaad et al.[30] (2021) investigated the association between energy-adjusted DII (E-DII) and sleep quality, measured by the Pittsburgh Sleep Quality Index (PSQI), in college students aged 18 to 30 years, and found no statistically significant association between the two measures. However, among the PSQI domains, a positive association was found between daytime dysfunction and the E-DII.[30] Lopes et al.[31] (2019) studied the same relationship in patients aged 18 to 60 years with obstructive sleep apnea, and, likewise, they did not find a significant association between the DII and the PSQI. However, they[31] observed a positive and significant association between daytime sleepiness measured by the Epworth Sleepiness Scale and the inflammatory potential of the diet.

On the other hand, most previous research on this topic found a significant relationship between sleep and the dietary inflammatory potential. In a study[32] conducted among female university students aged 18 to 30 years, a positive and significant association was found between the DII and the PSQI, in the models with and without adjustment for age, income, energy consumption, and physical activity level. However, when the DII was treated as a continuous variable and not categorized into quartiles, significance was observed only for the adjusted model.[32] Another study[33] with the same objective and conducted only with women found that the participants with higher DII scores had worse sleep quality evaluated by the PSQI.[33] Godos et al.[34] (2019) conducted the same study with adults and older adults from Southern Italy and observed that participants in the highest quartile of the DII were less likely to have adequate sleep quality.[34] Similarly, Wirth et al.[35] (2020) investigated whether an improvement in the E-DII score after 3 months of intervention with nutritional guidance, physical exercise, and stress reduction would be associated with an improvement in sleep parameters measured by actigraphy. They[35] found that switching to a more proinflammatory diet profile was associated with increased arousal after sleep onset (WASO) and reduced efficiency (percentage of time asleep after sleep onset). Finally, Kase et al.[36] (2021) investigated this association in 30,121 adults aged 20 years or older, participating in the United States National Health and Nutrition Examination Survey (NHANES) 2005-2016, using a questionnaire with closed-ended questions about reporting sleep complaints to physicians and sleep duration. The authors[36] found that more proinflammatory diets were associated with a greater likelihood of short- and long-term sleep, after controlling for major confounders. Meanwhile, the E-DII was not significantly associated with self-reported sleep complaints after controlling for depressive symptoms, arthritis, and lifestyle factors.[36]

The differences in results among the studies may be due to several factors, including differences in the methods used to assess sleep, which consequently result in the investigation of different sleep parameters, such as quality, duration, and cycles, among others; differences in the sociodemographic characteristics of the populations, as studies were carried out with university students, adults, older adults and adults with obstructive sleep apnea, who have different eating habits and biological conditions; differences in sample size, which may difficult to reach statistical significance; and differences in the method of evaluating the dietary inflammatory potential, as some studies used the E-DII. The latter represents a modification of the DII, incorporating energy intake into its computation. This adaptation aims to account for the potential confounding effect of total energy consumption on the inflammatory potential of the diet, to obtain a more accurate representation of the inflammatory impact of specific dietary patterns, regardless of the total caloric intake.[37]

The results of the present study may contribute to improving the quality of the meals served in LTCFs, aiming for a diet with more anti-inflammatory potential. However, some limitations need to be considered. The present study consisted of a small pilot sample; therefore, the results cannot be generalized, but it presents the need for further studies on this topic with representative samples. The assessment of sleep complaints was based on a quality of life questionnaire, which included questions related to sleep quality. Still, it was not validated for exclusive use in the investigation of sleep complaints. Finally, no association was found between exposure and outcome. However, studies with null results should not be discarded, as omitting them generates an overvaluation of positive findings, which may result in bias.

Conclusion

Our data showed an inadequacy in the intake of many nutrients in the diet offered at LTCFs, such as a lack of calories, proteins, micronutrients, and a more proinflammatory profile, due to the poor intake of foods with an anti-inflammatory effect. Moreover, we did not find any significant associations between the inflammatory potential of diets and sleep complaints. The present study highlights the need for greater attention to meal planning in these institutions.

Funding
The present work was supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq; under grant number 420859/2018-7) and Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES; under grant number 001).

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Valenza MC, Cabrera-Martos I, Martín-Martín L, Pérez-Garzón VM, Velarde C, Valenza-Demet G. Nursing homes: impact of sleep disturbances on functionality. Arch Gerontol Geriatr 2013;56(03):432–436
2 Martins da Silva R, Afonso P, Fonseca M, Teodoro T. Comparing sleep quality in institutionalized and non-institutionalized elderly individuals. Aging Ment Health 2020;24(09):1452–1458
3 Dantzer R, O'Connor JC, Freund GG, Johnson RW, Kelley KW. From inflammation to sickness and depression: when the immune system subjugates the brain. Nat Rev Neurosci 2008;9(01):46–56
4 Christ A, Lauterbach M, Latz E. Western Diet and the Immune System: An Inflammatory Connection. Immunity 2019;51(05):794–811
5 Norde MM, Collese TS, Giovannucci E, Rogero MM. A posteriori dietary patterns and their association with systemic low-grade inflammation in adults: a systematic review and meta-analysis. Nutr Rev 2021;79(03):331–350
6 Tsigalou C, Konstantinidis T, Paraschaki A, Stavropoulou E, Voidarou C, Bezirtzoglou E. Mediterranean Diet as a Tool to Combat Inflammation and Chronic Diseases. An Overview. Biomedicines 2020;8(07):201
7 Rodríguez-Rejón AI, Ruiz-López MD, Artacho R. Dietary Intake and Associated Factors in Long-Term Care Homes in Southeast Spain. Nutrients 2019;11(02):266
8 Grando FCS, Ribeiro CSG. Análise centesimal do cardápio de uma instituição de longa permanência de idosos: Pinhais (PR). Geriatr Gerontol Aging. 2013;7(04):279–285
9 Milà Villarroel R, Abellana Sangrà R, Padró Massaguer L, Farran Codina A. Assessment of food consumption, energy and protein intake in the meals offered in four Spanish nursing homes. Nutr Hosp 2012;27(03):914–921
10 Buckinx F, Allepaerts S, Paquot N, et al. Energy and nutrient content of food served and consumed by nursing home residents. J Nutr Health Aging 2017;21(06):727–732
11 Lino VTS, Pereira SRM, Camacho LAB, Ribeiro Filho ST, Buksman S. Adaptação transcultural da Escala de Independência em Atividades da Vida Diária (Escala de Katz). Cad Saude Publica 2008;24(01):103–112
12 Teixeira-Salmela LF, Magalhães LdeC, Souza AC, Lima MdeC, Lima RCM, Goulart F. Adaptação do Perfil de Saúde de Nottingham: um instrumento simples de avaliação da qualidade de vida. Cad Saude Publica 2004;20(04):905–914
13 Hunt SM, McKenna SP, McEwen J, Backett EM, Williams J, Papp E. A quantitative approach to perceived health status: a validation study. J Epidemiol Community Health 1980;34(04):281–286
14 Passos JP, Ferreira KS. Caracterização de uma instituição de longa permanência para idosos e avaliação da qualidade nutricional da dieta oferecida. Aliment Nutr 2010;21(02):241–249
15 Nutrition Coordinating Center. Nutrition Data System for Research (NDSR). University of Minnesota
16 Haytowitz DB, Wu X, Bhagwat S. USDA Database for the Flavonoid Content of Selected Foods, Release 3.3. U.S. Department of Agriculture, Agricultural Research Service. Nutrient Data Laboratory Home
17 Tabela brasileira de composição de alimentos (TBCA). Tabelas Complementares – Flavonoides Universidade de São Paulo (USP). Food Research Center (FoRC)
18 Institute of Medicine. Dietary Reference Intakes: Applications in Dietary Planning. Washington (DC): National Academy Press; 2003
19 Volkert D, Beck AM, Cederholm T, et al. ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr 2019;38(01):10–47
20 Shivappa N, Steck SE, Hurley TG, Hussey JR, Hébert JR. Designing and developing a literature-derived, population-based dietary inflammatory index. Public Health Nutr 2014;17(08):1689–1696
21 Institute of Medicine. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. The National Academies Press; 2006
22 Keller HH, Carrier N, Slaughter SE, et al. Prevalence and Determinants of Poor Food Intake of Residents Living in Long-Term Care. J Am Med Dir Assoc 2017;18(11):941–947
23 Bogacka A, Heberlej A, Usarek A, Okoniewska J. Diet and nutritional status of elderly people depending on their place of residence. Rocz Panstw Zakl Hig 2019;70(02):185–193
24 World Health Organization (WHO) Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. 2003

25 Engelheart S, Akner G. Dietary intake of energy, nutrients and water in elderly people living at home or in nursing home. J Nutr Health Aging 2015;19(03):265–272
26 Assis BS, Jairza JMB, Lopes JA, et al. Micronutrient intake in elderly living in nursing homes. Nutr Hosp 2018;35(01):59–64
27 Dror DK, Allen LH. Vitamin E deficiency in developing countries. Food Nutr Bull 2011;32(02):124–143
28 Razzaque MS. Magnesium: Are We Consuming Enough? Nutrients 2018;10(12):10
29 Keller HH, Lengyel C, Carrier N, et al. Prevalence of inadequate micronutrient intakes of Canadian long-term care residents. Br J Nutr 2018;119(09):1047–1056
30 Masaad AA, Yusuf AM, Shakir AZ, et al. Sleep quality and Dietary Inflammatory Index among university students: a cross-sectional study. Sleep Breath 2021;25(04):2221–2229
31 Lopes TVC, Borba MES, Lopes RVC, et al. Association between inflammatory potential of the diet and sleep parameters in sleep apnea patients. Nutrition 2019;66:5–10
32 Bazyar H, Zare Javid A, Bavi Behbahani H, et al. The association between dietary inflammatory index with sleep quality and obesity amongst iranian female students: A cross-sectional study. Int J Clin Pract 2021;75(5, e14061)e14061
33 Setayesh L, Yarizadeh H, Majidi N, et al. The negative relationship of dietary inflammatory index and sleeping quality in obese and overweight women. Int J Vitam Nutr Res 2023;93(03):219–225
34 Godos J, Ferri R, Caraci F, et al. Dietary Inflammatory Index and Sleep Quality in Southern Italian Adults. Nutrients 2019;11(06):1324
35 Wirth MD, Jessup A, Turner-McGrievy G, Shivappa N, Hurley TG, Hébert JR. Changes in dietary inflammatory potential predict changes in sleep quality metrics, but not sleep duration. Sleep 2020;43(11):1–9
36 Kase BE, Liu J, Wirth MD, Shivappa N, Hebert JR. Associations between dietary inflammatory index and sleep problems among adults in the United States, NHANES 2005-2016. Sleep Health 2021;7(02):273–280
37 Hébert JR, Shivappa N, Wirth MD, Hussey JR, Hurley TG. Perspective: The Dietary Inflammatory Index (DII)-Lessons Learned, Improvements Made, and Future Directions. Adv Nutr 2019;10(02):185–195

