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Dietary inflammatory index and prevalence of overweight and obesity in Brazilian graduates from the Cohort of Universities of Minas Gerais (CUME project)

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Highlights

- The most pro-inflammatory diet was independently associated with a higher prevalence of overweight and obesity in individuals with high scholarity.
- A pro-inflammatory dietary pattern is accompanied for other unhealthy lifestyles that are risk factors to obesity and chronic diseases
- The study of dietary pattern index can be useful to establishment of risk association as well as prevention strategies for obesity and related-chronic diseases.

Dietary inflammatory index and prevalence of overweight and obesity in Brazilian graduates from the Cohort of Universities of Minas Gerais (CUME project)

Short running head: Dietary inflammatory index and overweight/obesity

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Abbreviations

CUME: Cohort of Universities of Minas Gerais

DII®: Dietary Inflammatory Index

FFQ: food frequency questionnaire

BMI: body mass index

RP: prevalence ratio

CI: confidence interval

NCD: chronic non-communicable diseases

UFV: Universidade Federal de Viçosa

UFMG: Universidade Federal de Minas Gerais

SUN: Seguimiento Universidad de Navarra

US: United States

IL-1β: *Interleukin 1 beta*

IL-2: *Interleukin-2*

IL-4: *Interleukin-4*

IL-6: *Interleukin-6*

IL-10: *Interleukin-10*

TNF-α: tumor necrosis factor-alpha

CRP: *C-reactive protein*

PREDIMED: PREvención con DIeta MEDiterránea

NHANES: National Health and Nutrition Examination Survey

SU.VI.MAX: Supplementation Study on Vitamins and Minerals Antioxidants

HELENA: Healthy Lifestyle in Europe by Nutrition in Adolescents

Abstract

Objectives: to evaluate the independent association of Dietary Inflammatory Index (DII®) score with overweight and obesity in Brazilians participants of the Cohort of Universities of Minas Gerais (CUME project).

Research Methods & Procedures: cross-sectional study with 3,151 graduates and postgraduates (2,197 women) with a mean (SD) age of 36.3 (± 9.4) years. Sociodemographic characteristics, lifestyle and anthropometric data were assessed by online self-reported questionnaire. In addition, a validated food frequency questionnaire (FFQ) with 144 food items was used to generate Energy-adjusted DII (E-DII) scores, which evaluated the inflammatory potential of the diet.

Results: the prevalence of overweight and obesity were 28.2% and 11%, respectively. Participants in the highest E-DII quartile (most pro-inflammatory diet) were more likely to be smokers/ex-smokers; sedentary; and consumers of fat, red and ultraprocessed meats, fats and oils (excluding olive oil), bottled fruit juices and soft drinks, sugars, sweets and higher overall caloric intake, when compared to the first quartile of E-DII. Both men and women in the fourth E-DII quartile had the highest prevalence of overweight and obesity (PR = 1.35;95% CI: 1.14-1.59 and PR = 1.97; CI: 1.20-3.22, respectively, in men; PR = 1.38; 95% CI: 1.17-1.65 and PR = 1.95; CI: 1.31-2.90, respectively, in women).

Conclusion: the most pro-inflammatory dietary pattern was associated with a higher prevalence of overweight and obesity, as well as other unhealthy lifestyles, including sedentariness, smoking, and obesogenic diet.

Key words: overweight, obesity, inflammation, diet, dietary inflammatory index

1. Introduction

Obesity, defined as excessive accumulation of body fat, is a chronic multifactorial disease considered public health problem in Brazil [1] and in the world [2]. In Brazil, overweight subjects increased from 42.6% in 2006 to 53.8% in 2016, and obesity rising from 11.8% to 18.9% in the same time [1]. By 2030, the number of overweight or obese people could reach 3.3 billion people worldwide [3].

In this sense, low-grade inflammation is recognized link between obesity and other chronic diseases (e.g. diabetes, metabolic syndrome, and cardiovascular diseases) [4–6]. At the same time, health dietary patterns as well as and specific dietary components (e.g. folate, unsaturated fatty acids, and polyphenols) have been highlighted for their anti or pro-inflammatory role and associated with comorbidities-related obesity [10–13]

In addition, global dietary indexes allow a more comprehensive evaluation of dietary patterns. Among them, DII emerged as a new tool to assess the inflammatory potential of the diet, and its relationship with cardiometabolic risk, such as excess body weight, in different populations has been well established [14]. In fact, most pro-inflammatory diet (higher DII values) has been associated to higher occurrence of metabolic disorders, cardiovascular diseases, and mortality [15–18]. However, the relationship between DII and chronic outcomes was little reported in the Brazilian population, just in specific groups, such as adolescents [19], young adults [20] or individual undergoing bariatric surgery [21].

In this cross-sectional study, we aimed to evaluate the independent association of DII scores with overweight and obesity at baseline in participants of the Cohort of Universities of Minas Gerais (CUME project) [22]. Our hypothesis is that higher DII score (more pro-inflammatory diet) would be related to the higher prevalence of overweight or obesity, after accounting for several confounders.

2. Materials/Subjects and Methods

2.1. Cohort of Universities of Minas Gerais: CUME project

The CUME project is a concurrent open cohort whose objective is to evaluate the impact of the Brazilian dietary pattern and the nutritional transition on NCD in adults ≥ 18 years old, graduates and postgraduates at the *Universidade Federal de Viçosa (UFV)* or the *Universidade Federal de Minas Gerais (UFMG)*, institutions located in the state of *Minas Gerais*, Brazil [22].

The cohort methodology has been previously described [22]. Briefly, potential volunteers were invited by e-mail and directed to the CUME's virtual page (www.projetocume.com.br). Self-reporting online questionnaire consisted of two parts and they were sent separately, within one-week interval. The first stage consisted of questions related to sociodemographic, anthropometric, lifestyle, and health-related data. In the second stage, participants completed the food frequency questionnaire (FFQ) and additional questions related to dietary practices and consumption of specialty products [22].

The CUME project was designed in accordance with the experience of the team as researchers of the study *Seguimiento Universidad de Navarra* (SUN project), which is developed in Spain, whose objective is to analyze the influence of the Mediterranean diet on health outcomes [23].

2.2. Study population

The present study is a cross-sectional analysis of baseline data from the CUME project [22]. Of the 4,986 volunteers who answered the baseline CUME questionnaire from March to August 2016, 3,151 were included in the present study. Inclusion criteria were residency in Brazil over the last year and baseline questionnaire completion, including FFQ.

The study was approved by the Human Research Ethics Committees of UFMG and UFV (nº 596 741-0/2013). All participants read the informed consent form and indicated online agreement (with an online command) before responding to the questionnaire [22].

2.3. Food consumption and DII Computation

In order to evaluate food consumption and calculate the Energy-adjusted DII (E-DII) score, a 144-items FFQ was applied, which was previously validated for the Brazilian population [24]. Each participant reported the frequency of consumption of a food (daily, weekly, monthly or annual), the number of times it consumed (0 to 9 or more times) and the portion size, appropriate to each food. Moreover, they answered questions related to daily dietary practices, such as number of meals per day; intake visible fat of meats; addition of salt and sugar in ready meals, among others. To enhance self-completion of the FFQ, the team developed a photographic album with 96 images of food and serving utensils to facilitate the visualization of portions of food and to obtain a reliable response regarding consumption.

The nutrient intake was calculated using daily intake of each food item and its nutrient composition, according to the Brazilian Food Composition Table [25]. Where data were lacking in the Brazilian tool, the US Department of Agriculture Table [26] was used. The Brazilian Carotenoid Composition Table in Foods [27] and the Phenol-Explorer database [28] were used for estimation of β-carotene and flavonoids, respectively.

DII scores were calculated using a scoring algorithm based on a review of 1,943 articles linking 45 food parameters and six inflammatory biomarkers (IL-1β, IL-4, IL-6, IL-10, TNF-α, and CRP). Then, food parameters were assigned to positive score (+1) if the effect was pro-inflammatory, and assigned to negative score (-1) if the effect was anti-inflammatory, while zero was assigned if the parameter did not generate significant changes in the inflammatory biomarkers, as previously detailed [14]. DII density scores, which adjust for energy intake also were calculated; prior to standardization with the global intakes the parameters were each converted to 1,000 kcal of energy intake, and energy intake as food parameters was excluded from the actual E-DII calculation. These scores were based on a similar algorithm that used an energy-adjusted global database [29,30]. Positive DII® and E-DII scores represent food patterns with the most pro-inflammatory potential, while negative DII® and E-DII values represent food patterns with the most anti-inflammatory potential. The DII® has been construct validated with several inflammatory markers in various studies [14,31].

The E-DII scores in the present study were based on 35 food parameters available from the FFQ: energy intake, carbohydrate, protein, total fat, cholesterol, saturated fat, trans fat, monounsaturated and polyunsaturated fat, omega 3,omega 6, fiber, alcohol, niacin, thiamine, riboflavin, vitamin B12, vitamin B6, folic acid, vitamin A, vitamin C, vitamin D, vitamin E, iron, selenium, magnesium, zinc, caffeine, β-carotene, flavonol-3-ol, flavones, flavonols, flavonoids, anthocyanidins and isoflavones.

2.4. Determination of overweight and obesity

The participants reported their current weight and height by completing online questionnaire. The BMI (kg/m^2) was calculated as body weight (in kilograms) divided by height (in meters) squared. The weight-status of the adults was classified according to the criteria defined by the World Health Organization [32], as being normal weight ($18.5\ kg/m^2 \leq BMI < 25\ kg/m^2$), overweight ($25\ kg/m^2 \leq BMI < 30\ kg/m^2$) or obese

(BMI ≥ 30 kg/m²). For participants ≥ 60 years of age the weight-status was classified according to the Pan American Health Organization [33], being normal weight (23 kg/m² < BMI < 28 kg/m²), overweight (28 kg/m²) or obese (BMI ≥ 30 kg/m²). A validation study of a subsample of 172 CUME participants at baseline compared self-reported height and weight with and measured height and weight and obtained adequate correlation coefficients [Intraclass Correlation Coefficients of 0.989 (95% CI: 0.985-0.992) and 0.995 (95% CI: 0.993-0.996) for height and weight, respectively, and kappa coefficient of 0.882 between obesity diagnosis based on self-reported and measured data, indicates almost perfect agreement] [22,34].

2.5. Assessment of other variables

Information on the practice of physical activity (yes or no), smoking (never smoked or ex-smokers and smokers), age (years), sex (male or female), and subject area of concentration (health science, human science, exact and agrarian sciences) also was collected.

2.6. Statistical analysis

Based on a previous study published that investigated the relationship between DII and Overweight/Obesity cases [28], with a similar population to the CUME project, a minimal sample of 1,426 participants was calculated for this study, using a 95% confidence level, 80% statistical power; ratio exposed/unexposed of 1; prevalence of overweight/obesity equal to 20% in individuals in the 1st quartile of the inflammatory diet index (most anti-inflammatory) and obesity prevalence ratio of 1.32.

The database was written in SPSS® software version 20.0. All analyzes were performed with Stata® version 13.0 (Stata-Corp, College Station, Texas) and statistical significance was set at α=5% (p values <0.05).To control for the effect of caloric intake on nutrients and food groups evaluated, models were adjusted by the residual nutrient method [35]. In order to evaluate the associations between E-DII score and nutrient intake, food groups, BMI and prevalence of overweight and obesity, participants were categorized by E-DII quartile.

The comparisons of sociodemographic characteristics and BMI among E-DII quartiles were made with Pearson's chi-square test for categorical variables and ANOVA for continuous variables. When a significant difference was detected, the Bonferroni *post hoc* test was applied to correct multiple comparisons.

Multiple linear regression analyses were performed with adjustment for sex, age, BMI, smoking and physical activity to compare the consumption of macro and micro nutrients, food groups and feeding practices among the E-DII quartiles.

Finally, Poisson regression multivariate models, adjusted for age, smoking, physical activity and graduation area, for male and female groups, and additional adjusted for sex, for total sample, were fitted to evaluate the association of a pro-inflammatory diet with overweight and obesity. Prevalence Ratio (PR) and 95% Confidence Intervals (95% CI) were estimated using the first E-DII (anti-inflammatory) quartile as the reference category.

3. Results

Of the 3,151 participants in the CUME project, 30.3% were male and 69.7% female, with a mean (SD) of 36.3 (± 9.4) years, since only 3.0% of the population had more than 60 years old. The E-DII score had a mean (SD) of -0.12 (1.63) and ranged from -5.48 to +4.55. The prevalence of overweight was 28.2% and obesity was 11.0%. Among the overweight participants, 42.6% were male and 57.4% were female (p <0.001).

The total energy intake of subjects are around 3,000 kcal/day in all E-DII quartiles ($p < 0.001$).

Table 1 shows the main sociodemographic characteristics of the participants according to E-DII quartile. The individuals included in the last quartile (most pro-inflammatory) were more likely to be ex-smokers or smokers, sedentary and consume more alcohol compared to those included in the first quartile (most anti-inflammatory). Regarding the graduation area, participants included in the first quartile were more likely to be in the area of health science.

Women were represented in higher proportion than men in all quartiles. Unlike men, however, their frequency decreased as E-DII scores became most pro-inflammatory (Table 1). Furthermore, BMI values were significantly higher in the highest E-DII quartile, compared to the first quartile, for both men and women (Figure 1).

In relation to food consumption according to E-DII scores, the intake of dairy, white and lean meats, fish/shellfish and eggs, whole grains, legumes, olive oil and oilseeds, fruits, vegetables and natural fruit juices was significantly higher in the first quartile (most anti-inflammatory) and the consumption of red, fat and ultraprocessed meats, fats and oils with the exception of olive oil, industrial juices, soft drinks, sugars and sweets was higher in the last quartile (most pro-inflammatory) (Table 2).

The last quartile (most pro-inflammatory) was positively associated with higher prevalence of overweight (Table 3) and obesity (Table 4), regardless of confounding factors, including sex, age, smoking, physical activity and graduation area. When the sample was stratified by sex, the results were similar for both outcomes (Tables 3 and 4).

4. Discussion

In the present study participants of CUME project in the most pro-inflammatory E-DII quartile had higher BMI values and higher prevalence of overweight and obesity compared to those in the lower (most anti-inflammatory) E-DII quartiles.

Our results are in agreement with those obtained in studies conducted in other populations. In the Spanish SUN cohort, with 7 027 individuals having a mean age of 37.4 years, the most pro-inflammatory DII was also associated with a higher risk of weight gain and a greater risk for overweight and obesity, independently of total caloric intake, physical activity, history of obesity and baseline weight [31]. In the *PREvención con DIeta MEDiterránea* (PREDIMED) trial (also in Spain), with 7,236 subjects with cardiometabolic risk, the authors also observed that participants with a most pro-inflammatory diet (higher DII scores) presented higher values of BMI independently of total caloric intake, age, diabetes, hypertension, smoking, physical activity, educational level and marital status [36]. A positive correlation between BMI and DII values was reported in a review by Ruiz-Canela [37] et al that included data from: 1) the PREDIMED; 2) SUN; 3) the Geelong Osteoporosis Study (n=1363 Australian men ≥18 years); 4) the Supplementation Study on Vitamins and Minerals Antioxidants (SU.VI.MAX) study (n=7 743 French women between 35 and 60 years old and Frenchmen 45 to 60 years old); 5) and the National Health and Nutrition Examination Survey (NHANES) (n=1,734 Americans with previously diagnosed cardiovascular disease) [38]. Altogether, these outcomes support the hypothesis that a more pro-inflammatory diet is related to the prevalence of overweight and obesity.

In this context, the origin of inflammation during obesity is not yet fully understood [39]. The inflammation is recognizably induced by adiposity, but this relationship could be bidirectional, creating a vicious cycle of positive feedback [40]. In addition, excess of specific nutrients and some foods that have been associated with inflammation [41–44] may exacerbate the effects of adiposity. Furthermore, the most pro-inflammatory DII (highest quartile) in this study was associated with the most unhealthy eating habits (e.g., higher consumption of red, fat and ultra-processed meats, and fats, soft drinks, sugar and sweets) and the lowest DII quartile was associated with the healthiest diet (e.g., higher consumption of dairy products, white and lean meats, fish/shellfish and eggs, whole grains, legumes, olive oil, fruits, and vegetables). In fact, dietary patterns provides one of the best approaches to understanding the relationship between diet and disease, since it allows for evaluating the inflammatory potential of diet, taking into account the potential synergies of different foods [45,46]. Given this, it is not surprising that diet quality tends to be better among those individuals with lower relative weight [47]. In turn, our results also point to a possible solution to control chronic systemic inflammation. While 8 of the parameters that comprise the DII are pro-inflammatory, 37 are anti-inflammatory. This latter group is characterized by being colorful, flavorful, nutrient-dense and calorie-sparse [14]. So, emphasis on consuming these constituents will not only reduce inflammation, but it is likely that it will lead to weight loss.

In the cross-sectional study of *Healthy Lifestyle in Europe by Nutrition in Adolescents* (HELENA), conducted with 3,528 adolescents, Shivappa et al [48] found that the consumption of food items that tended to increase DII include bread and rolls, chocolate, margarine, butter and animal fats, and vegetable lipids, carbonated soft drinks, meat and cakes, pies, biscuits, and sugar/honey/jam; and had lower consumption of vegetables (excluding potatoes), fruits, fruits and vegetable juices, and fish. In addition, higher serum concentrations of IL-1, 2 and TNF-αwere observed in adolescents with higher DII scores. Studies using DII® scores for analysis also have reported positive associations of unhealthy diets (pro-inflammatory DII) with increased

IL-6, IL-1, TNF-α and CRP concentrations and lower concentrations of IL-10; whereas in healthy diets (anti-inflammatory DII) the concentrations of these markers were uniformly lower [31,35,49,50]. Thus, we can conclude that a diet considered healthy tends to be associated with lower DII® (more anti-inflammatory) scores, which concomitantly will influence the non-occurrence of the subclinical inflammatory process.

Our study also found that other attributes of healthier lifestyle among those who consumed a most anti-inflammatory diet: i.e., they were more likely to be nonsmokers, non-alcohol users and physically active, as has been reported by previous studies [31,51,52]. This combination of factors can result in a better quality of life and reduce the risk of developing future problems as chronic inflammation, obesity and other chronic NCDs [53–55].

On other hand, our sample is predominantly composed of young adults (only 3.0% of the population has ≥ 60 years old) and all participants graduated from university. Other studies have found associations between healthier (most anti-inflammatory) diet and higher educational attainment (more than 4 years of college) among older people [56,57].

The strengths of the present study are: a large sample size that guarantees a high statistical power; use of a validated instrument to measure the inflammatory potential of the diet; control of important confounding factors in the analysis; the high level of education of our participants, which guarantees us better reliability of the self-reported information and ensures a degree of homogeneity, reinforcing the internal validity of our study and reducing the sources of confusion related to education. Moreover, we validated self-reported weight, height and BMI in a subsample of our cohort study [22,34]; and originality, because it is the second study of the DII® in relation to food intakes and cardiometabolic outcome in the Brazilian population and the third study in South American. The other two studies, two were in Argentina, where higher DII scores were associated with increased of cases of colorectal [58] cancer and prostate [59] and the others were, one in northeastern Brazil, where IBD was positively correlated with BMI in people with progressive multiple sclerosis [60] and the other a cross-sectional study (nested within a cohort) in Ribeirão Preto, São Paulo, where the DII was evaluated in young adults and had no association with insulin resistance or metabolic syndrome in either sex [20].

Some potential limitations of our study need to be recognized: the use of BMI as an indicator of adiposity does not allow us to differentiate lean mass of fat mass, or even total adiposity of central adiposity, despite being a tool widely used in epidemiological studies, due to its easy measurement and good correlation with body fat [61]. We did not measure inflammatory markers in plasma to assess their association with E-DII scores in the sample studied, due to the nature of online data collection. However, such association has previously been proven [62–64]. In this context, Garcia-Arellano et al [9] point out that the use of DII could help in the study of associations between food exposures and clinical events, with lower costs and avoidance of blood collection. Finally, the analysis of physical activity was classified only as its practice or not practice, since the study does not yet present the evaluation by the Brazilian version of the International Physical Activity Questionnaire (IPAQ) [65] or the Global Physical Activity Questionnaire (GPAQ) [66], but we emphasize that the non-practice of physical activity contributes to the presence of obesity. In conclusion, the most pro-inflammatory dietary pattern was associated with a higher prevalence of overweight and obesity in men and women participating in the baseline study of the CUME study. E-

DII scores also were associated with other unhealthy lifestyle characteristics, including sedentariness, smoking, and obesogenic diet.

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Competing Interests

All authors declared no competing financial interests in relation to the work described.

Statement of Authorship

TMSO, AMP, HHMH and JB participated in the study design and data collection. TMSO performed the statistical analysis and drafted the manuscript. AMP and HHMH guided TMSO in article writing, critical review, statistical analysis and data interpretation. NS obtained the E-DII score from the data delivered to it, obtained by TMSO, member of the CUME research group. JB, NS, JRH and MAMG performed critical review of the article. All authors have approved the final version of this article submitted.

Declaration

JRH owns controlling interest in Connecting Health Innovations LLC (CHI), a company planning to license the right to his invention of the dietary inflammatory index (DII) from the University of South Carolina in order to develop computer and smart phone applications for patient counseling and dietary intervention in clinical settings. NS is an employee of CHI. The subject matter of this paper will not have any direct bearing on that work, nor has that activity exerted any influence on this project.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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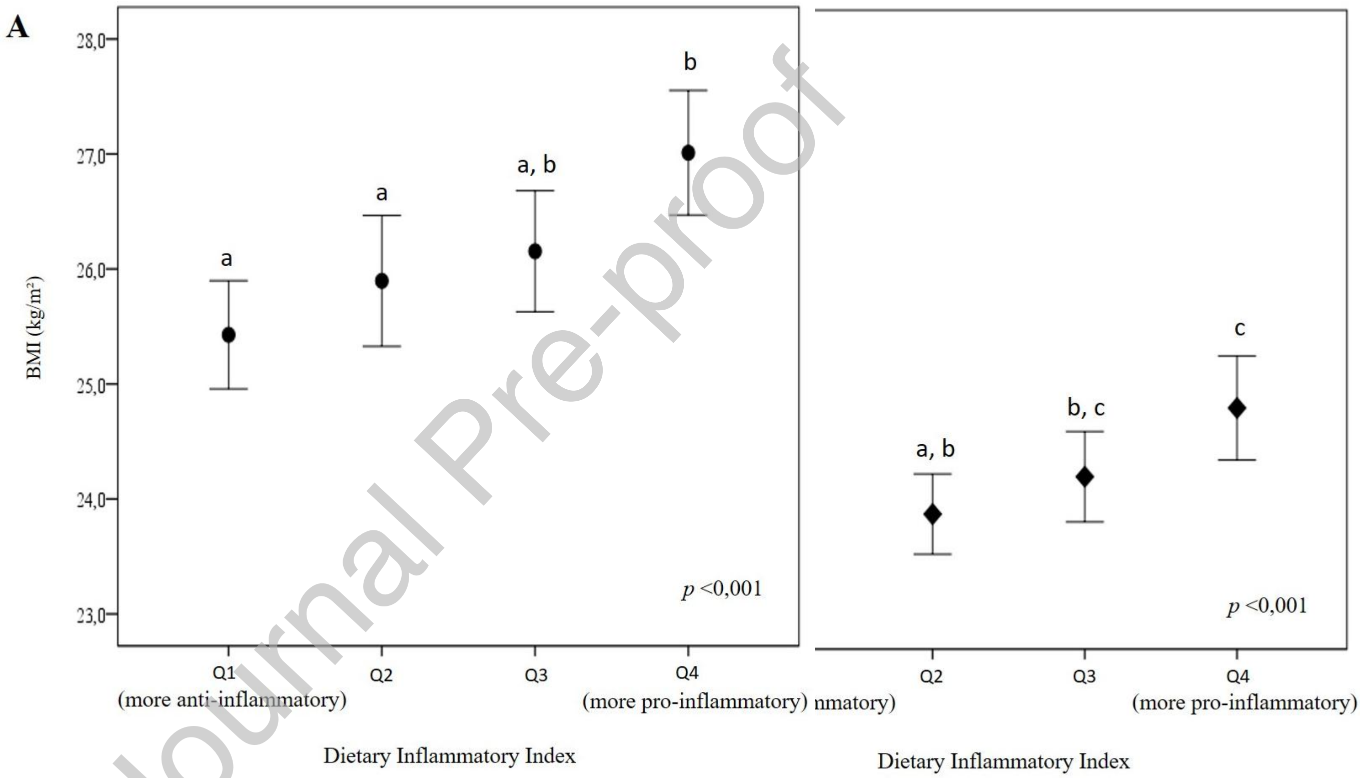

Figure 1. Body Mass Index values according to E-DII for men (A) and women (B) participants in the CUME project (n=3 151), 2016.
p value of ANOVA.
p value <0.05: different letters (a, b and c) mean statistical differences, according to Bonferroni post hoc to correct multiple comparisons.
Q = quartile.

Table 1. Sociodemographic characteristics according to E-DII of the participants of the CUME project (n = 3151), 2016.

Características	**E-DII**				
	Q1 (-5.48, -1.37) (most anti-inflammatory)	**Q2 (-1.37, -0.26)**	**Q3 (-0.26, 1.08)**	**Q4 (1.08, 4.55) (most pro-inflammatory)**	***p* value**
	n = 787	n = 788	n = 788	n = 788	
Sex [n (%)]					
Male	205 (26.1)	215 (27.3)	247 (31.4)	287 (36.4)	**< 0.001**
Female	582 (73.9)	573 (72.7)	541 (68.6)	501 (63.6)	
Age, years [mean (SD)]	36.5 ± 9.9	36.8 ± 10.0	35.7 ± 8.8	36.1 ± 8.9	**0.040**
Marital status [n (%)]					
Married or stable union	413 (52.7)	410 (52.6)	403 (51.8)	392 (50.5)	0.840
Single, separated/divorced, widower	370 (47.2)	371 (47.4)	377 (48.2)	390 (49.5)	
Smoking [n (%)]					
Never smoked	660 (83.8)	626 (79.4)	610 (77.4)	603 (76.5)	**0.001**
Ex-smokers and smokers	127 (16.2)	162 (20.6)	178 (22.6)	185 (23.5)	
Alcoholic beverage consumption [n (%)]					
No	253 (32.2)	229 (29.1)	172 (21.8)	202 (25.7)	**< 0.001**
Yes	534 (67.8)	559 (70.9)	616 (78.2)	586 (74.3)	
Physical activity practice [n (%)]					
Yes	642 (81.6)	625 (79.3)	570 (72.4)	538 (68.3)	**< 0.001**
No	145 (18.4)	163 (20.7)	218 (27.6)	250 (31.7)	
Graduation area [n (%)]					
Health Science	305 (38.7)	297 (37.7)	267 (33.9)	255 (32.3)	**0.020**
Human Science	271 (34.4)	250 (31.7)	262 (33.2)	288 (36.5)	
Exact Science	141 (17.9)	156 (19.8)	163 (20.7)	139 (17.6)	
Agrarian Science	70 (8.9)	85 (10.8)	96 (12.2)	106 (13.4)	

p value of ANOVA or chi-square test, for continuous or categorical variables, respectively.
Q = quartile.

Table 2. Daily food consumption according to E-DII of the participants of the CUME project (n = 3151), 2016.

Daily consumption E-DII	**Q1 (-5.48, -1.37) (most anti-inflammatory)**	**Q2 (-1.37, -0.26)**	**Q3 (-0.26, 1.08)**	**Q4 (1.08, 4.55) (most pro-inflammatory)**	***p* trend***
	n = 787	n = 788	n = 788	n = 788	
Energy intake(kcal)	2 899 ± 1 483	3 072 ± 1 735	3 155 ± 1 471	3 330 ± 1 573	**<0.001**
Carbohydrate, %TCV	50.7 ± 7.8	50.1 ± 9.5	49.5 ± 9.3	49.9 ± 12.8	0.131
Protein, %TCV	19.0 ± 4.5	18.8 ± 5.9	18.7 ± 4.6	18.3 ± 5.7	**0.002**
Lipid, %TCV	30.2 ± 6.3	31.0 ± 7.3	31.7 ±7.5	31.9 ± 10.3	**< 0.001**
FAMonounsaturated, %TCV	14.3 ± 4.3	13.8 ± 4.8	13.5 ± 4.8	12.6 ± 5.7	**< 0.001**
FAPolyunsaturated, %TCV	5.8 ± 2.0	5.4 ± 2.1	5.4 ± 2.4	4.6 ± 2.4	**< 0.001**
FASaturated, %TCV	7.9 ± 2.2	8.6 ± 3.0	9.0 ± 3.2	9.4 ± 4.6	**< 0.001**
Food Groups (g/day)					
Dairy products	274.5 ± 207.5	266.2 ± 207.7	258.1 ± 199.8	253.4 ± 232.2	**0.01**
Red, fat and ultraprocessed meats	115.8 ± 82.0	125.5 ± 99.0	142.4 ± 110.7	156.4 ± 153.4	**<0.001**
White and lean meats, fish/shellfish and eggs	133.7 ± 117.6	121.6 ± 159.3	107.9 ± 116.5	91.5 ± 128.0	**<0.001**
Refined cereals (breads and noodles)	131.0 ± 89.6	142.9 ± 94.3	147.8 ± 99.5	149.2 ± 117.6	0.05
Whole grains (breads, oats and rice)	63.3 ± 58.8	53.7 ± 55.1	46.4 ± 53.5	34.9 ± 51.5	**<0.001**
Legumes	115.5 ± 122.3	72.7 ± 96.5	66.8 ± 73.2	42.1 ± 46.1	**<0.001**
Fats and oils, excluding olive oil	14.1 ± 12.3	16.3 ± 14.9	18.0 ± 15.5	18.6 ± 17.8	**<0.001**

Olive oil	4.6 ± 3.6	4.2 ± 3.3	4.2 ± 4.3	3.9 ± 4.4	**0.003**
Fruits	766.6 ± 467.5	569.2 ± 333.4	397.7 ± 298.3	224.4 ± 241.1	**<0.001**
Vegetables, excluding potatoes	261.4 ± 169.7	199.5 ± 110.0	154.7 ± 93.4	109.1 ± 84.9	**<0.001**
Natural fruit juice	153.9 ± 143.4	130.2 ± 124.6	106.7 ± 118.2	85.8 ± 126.8	**<0.001**
Industrial juices and soft drinks	100.5 ± 142.1	110.7 ± 152.8	133.4 ± 165.9	138.8 ± 192.9	**0.002**
Alcoholic beverage	93.0 ± 136.7	95.6 ± 173.5	108.2 ± 193.2	92.7 ± 145.9	0.15
Oilseeds	18.2 ± 23.2	15.7 ± 29.9	13.5 ± 29.6	9.6 ± 22.5	**<0.001**
Sugars and sweets	33.2 ± 33.7	34.9 ± 37.7	39.4 ± 39.0	40.5 ± 51.1	**0.001**
Preparation of the refined cereal base and fried foods	61.9 ± 59.0	69.8 ± 72.2	75.6 ± 79.8	69.4 ± 102.0	0.49

*$p<0.05$: for the multiple linear regression model, adjusted for sex (male or female), age (years), BMI (kg/m²), smoking (never smoked or ex-smokers and smokers).
Data are expressed as mean ± SD.
Q = quartile.

Table 3. Prevalence ratio (PR) for overweight*'†according to E-DII of the participants of CUME project (n = 3151), 2016.

	Simple Poisson Regression		**Adjusted Poisson Regression** [b, c]	
Total	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.15 (1.01 – 1.33)	**0.036**	1.13 (0.98 – 1.29)	0.08
3º	1.26 (1.11 – 1.44)	**0.001**	1.22 (1.07 – 1.39)	**0.002**
4° (most pro-inflammatory)	1.50 (1.32 – 1.70)	< **0.001**	1.39 (1.23 – 1.57)	< **0.001**
Male	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.08 (0.90 – 1.32)	0.381	1.08 (0.89 – 1.31)	0.40
3º	1.10 (0.91 – 1.32)	0.310	1.10 (0.91 – 1.32)	0.31
4° (most pro-inflammatory)	1.35 (1.14 – 1.59)	< **0.001**	1.35 (1.14 – 1.59)	< **0.001**
Female	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.19 (0.99 – 1.43)	0.064	1.14 (0.95 – 1.36)	0.14
3º	1.32 (1.10 – 1.58)	**0.002**	1.30 (1.10 – 1.55)	**0.003**
4° (most pro-inflammatory)	1.46 (1.22 – 1.74)	< **0.001**	1.38 (1.17 – 1.65)	< **0.001**

* Overweight for BMI ≥ 25 kg/m² (WHO, 1998) and BMI ≥ 28 kg/m² (PAHO, 2002).
† Total sample shows 1233 overweight individuals, male group 525 and female group 708.
[b] Adjusted for age (years),smoking (neversmokedor ex-smokers and smokers), physical activity (yes or no) and graduation area (health, human, exact and agrarian sciences) for male and female groups.
[c] Additional adjustment for sex (male or female), for total sample.

Table 4. Prevalence ratio (PR) for obesity*'† according to E-DII of the participants of CUME project (n = 3151), 2016.

	Simple Poisson Regression		**Adjusted Poisson Regression** [b, c]	
Total	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.63 (1.17 – 2.27)	**0.004**	1.56 (1.12 – 2.17)	**0.008**
3º	1.78 (1.28 – 2.47)	< **0.001**	1.68 (1.21 – 2.31)	**0.002**
4° (most pro-inflammatory)	2.24 (1.64 – 3.06)	< **0.001**	1.99 (1.46 – 2.71)	< **0.001**
Male	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.65 (0.97 – 2.81)	0.064	1.63 (0.96 – 2.77)	0.07
3º	1.70 (1.01 – 2.85)	**0.043**	1.70 (1.01 – 2.84)	**0.04**
4° (most pro-inflammatory)	1.99 (1.22 – 3.26)	< **0.001**	1.97 (1.20 – 3.22)	< **0.001**
Female	**PR (95% CI)**	***p* value**	**PR (95% CI)**	***p* value**
E-DII (quartile)				
1º (most anti-inflammatory)	1 (ref.)		1 (ref.)	
2º	1.60 (1.05 – 2.44)	**0.028**	1.51 (0.99 – 2.29)	0.05
3º	1.75 (1.16 – 2.66)	**0.008**	1.65 (1.09 – 2.50)	**0.02**
4° (most pro-inflammatory)	2.24 (1.50 – 3.36)	< **0.001**	1.95 (1.31 – 2.90)	**0.001**

* Obesity for BMI ≥ 30 kg/m² (WHO, 1998; PAHO, 2002).

† Total sample presents 347 individuals with obesity, male group 144 and female 203.

[b] Adjusted for age (years), smoking (never smoked or ex-smokers and smokers), physical activity (yes or no) and graduation area (health, human, exact and agrarian sciences) for male and female groups.

[c] Additional adjustment for sex (male or female), for total sample.