Social determinants of food group consumption based on Mediterranean diet pyramid: A cross-sectional study of university students

Roberto Martinez-Lacoba1,2,3*, Isabel Pardo-García1,2,3, Elisa Amo-Saus1,3, Francisco Escribano-Sotos1,2,3

1 Facultad de Ciencias Económicas y Empresariales, Universidad de Castilla-La Mancha (UCLM), Plaza de la Universidad, Albacete, Spain, 2 Centro de Estudios Sociosanitarios (CESS), Universidad de Castilla-La Mancha (UCLM), Albacete, Spain, 3 Members of the research group Economía, Alimentación y Sociedad (Economics, Food & Society Research Group)

* Current address: Facultad de Ciencias Económicas y Empresariales, Universidad de Castilla-La Mancha (UCLM), Plaza de la Universidad, Albacete, Spain

roberto.mlacoba@uclm.es

Considering food habits as a modifiable risk factor, an early intervention on youth people could avoid future health and social costs. We aim to determine the level of compliance with the recommendations of the Mediterranean diet pyramid according to social determinants in university students and to analyse the association of these social determinants (and their interaction with gender) with different food group consumption. We used the records of an electronic cross-sectional survey on university students (n = 593) from inland Spain. The results show, generally, that university students do not fully comply with the recommendations and that gender is the social determinant with the greatest effect on differences in food group consumption. Women have a lower consumption of dairy products, olives, nuts and seeds, red meat, and processed meat, sweets, eggs, alcoholic drinks and fast food; and a higher consumption of fruit, compared with men. Socioeconomic status, geographic area, and whether students cook for themselves have a limited influence on differences in food group consumption, which is inconsistent with the literature. Policy makers should consider this gender gap if they wish to implement a policy based on healthy diet, considering that other social determinants are also important, and could interact with gender.

Introduction

Economic, cultural, and social resources are known to contribute to the unequal distribution of health outcomes [1], and people with fewer economic resources have shorter life expectancies and suffer more illness than the wealthy [2]. Socioeconomic disparities have been shown to be associated with a greater level of all-cause mortality [3], and although treating current disease is an urgent priority, we should not disregard taking action on the underlying social determinants of health [4]. The literature has evidenced the importance of socioeconomic conditions on health and has demonstrated that socioeconomic adversity is a modifiable risk factor [5,6].

Diet and nutrition are important factors in the promotion and the maintenance of good health throughout the entire life course [7]. A healthy diet helps protect against malnutrition in all its forms as well as a range of noncommunicable diseases, including diabetes, heart...
disease, stroke and cancer [8]. However, diet is associated with individual, life-style, social, economic, and geographical factors, among others [9–14]. In other words, social and economic conditions can generate a social gradient in diet quality that contributes to health inequalities [2]. There is evidence showing that adverse childhood and adulthood socioeconomic status in older men is associated with poor diet quality [15]. In addition, most studies have shown that women follow a healthier dietary pattern than men [13,14,16–18], underlining differences in food habits. These inequalities in health—due to gender or material issues—are avoidable [4]; adequate policies could help counterbalance social and cultural behaviour.

In terms of a healthy dietary pattern, Mediterranean diet meets requirements from various perspectives. Mediterranean diet is a healthy dietary pattern that may improve individual health and also obtain social and environmental benefits, among others [19,20], but there is a clear shift away from this food pattern [21]. The westernization of diets—increased intake of meat, fat, processed foods, sugar and salt—is also driven by socioeconomic factors, among other variables [22], and lower-quality diets—usually more economical—tend to be selected by groups of lower socioeconomic status [23].

University students are an important group for the promotion of healthy dietary patterns, because unhealthy lifestyles—including unhealthy diet—are shaped in youth [24–26], and bad habits can compromise health across one’s life. There are different determinants of eating behaviour in university students [27]: individual and environmental (physical, social and macro) factors, and even the characteristics of the university. The literature has reported that parental socioeconomic position is associated with children’s dietary patterns [14,28], showing that higher parental occupation and education level are associated with higher diet quality [29]. Geographical factors can also interact with others in a complex manner, shaping dietary patterns [8]. Furthermore, young adults usually exhibit bad eating behaviours during the transition from adolescence to adulthood, such as skipping meals (or irregular meal consumption) and frequent snacking, among others, compromising diet quality [30,31]. For this reason, an early intervention in youth through food and health policies could help to combat different social gaps and to reduce future economic burden on health systems.

This work uses a sample of students that was used in an earlier work aiming to study the factors associated with an unhealthy diet [14]. That study analysed diet quality through the use of an index, while the current work has adopted a different approach, using new variables. The aim of this new study is dual. On the one hand, we investigate the level of compliance with the recommendations of the Mediterranean diet pyramid [32] based on individual food group consumption among university students according to social determinants, specifically gender, socioeconomic status, location of the family home, the degree course, and whether the students cook for themselves. On the other hand, we analyse how these social determinants and the interaction with gender may affect the consumption of different food groups, the aim being to illustrate problems related to the intake of these groups, and to encourage the elaboration of specific public policies in this regard.

**Methods**

**Design**

This study was conducted in the Autonomous Community of Castilla-La Mancha, located in central Spain. Students from the University of Castilla-La Mancha in the cities of Albacete, Ciudad Real, Cuenca, Talavera de la Reina and Toledo participated in the study. We conducted an electronic cross-sectional survey with university students. The design of the study can be consulted in a previous work [14]. The data were collected using the Survey Monkey software [33].
Participants and environment

A total of 1077 students participated in the study (n = 1077). The final non-probabilistic sample comprised 593 participants (n = 593, 249 men and 344 women). Fig 1 shows the data cleaning process [14]. The information about sample, inclusion and exclusion criteria of participants may be reviewed in our previous work [14].

Ethics approval and consent to participate

All the students were informed of the aims of the study and participated voluntarily. The completion of the questionnaire was considered to imply informed consent. The study worked with anonymised information. This research was conducted according to the guidelines laid down in the Declaration of Helsinki. The Clinical Research Ethics Committee of the Health Unit of Cuenca certified that the study doesn’t need ethics approval according to national guidelines (nr: 2018/P1018).

Variables included

The survey collected information on demographic (age, gender), socioeconomic (location of family home, parental occupation), and food habit characteristics, among others. Food habit data were collected using a food frequency questionnaire (FFQ) adapted from a questionnaire previously validated in Spanish adult population [34,35]. Participants were asked about their consumption of 141 foods divided into 12 groups: i) dairy products; ii) eggs, meat and fish; iii) vegetables; iv) legumes; v) cereal; vi) oils and fats; vii) fruit; viii) sweets and desserts; ix) beverages; x) spices; xi) precooked products; and xii) fast food (Table A in S1 Supporting Information). Individual foods included in the FFQ can be also seen in Table A in S1 Supporting Information. We readapted these food groups to those in the Mediterranean diet pyramid (Table B in S1 Supporting Information).

2.3.1. Food group consumption. The FFQ collected intake frequencies as follows: never or hardly never, one serving per day, 2 to 3 servings per day, 4 to 5 servings per day, 6 or more servings per day, 1 to 2 servings per week, 3 to 4 servings per week, 5 or more servings per week, and 1 to 3 servings per month. We calculated mean daily/weekly servings for each food group. The food groups and recommended consumption are based on the Mediterranean diet pyramid [32]. We added an alcoholic beverage group, with the recommended alcohol intake being based on other studies [36]. Fast food and precooked groups were also considered in the study. We assumed that recommended consumption of these two groups was null. There is evidence that shows fast food consumption has associations with an increased risk of different diseases [37,38]. The composition of the groups can be consulted in Table B in S1 Supporting Information.

2.3.2. Parental socioeconomic status. Parental occupations were adapted to the major groups in the International Standard Classification of Occupations (ISCO-08) (one digit) [39], which were then converted to the International Socio-Economic Index of occupational status (ISEI-08) [40]. The ISEI-08 is a continuous variable ranged between 10 and 88. This study considered either the father or mother’s occupation, whichever was the higher [41,42]. Self-employed parents were included in ISCO group 5 [43], and unemployed/non-working/retired parents were given the lowest ISEI-08 score (10 points). Mean ISEI scores were calculated when questionnaire occupations fitted two or more ISCO groups. The ISEI-08 was categorised into three groups (low, medium and high socioeconomic status), as follows: ISEI<36 (n = 250); 36≤ISEI<62 (n = 238); and ISEI≥62 (n = 105). This categorised variable is called SES (family’s socioeconomic status) in the study. Table C in S1 Supporting Information shows the results of this categorisation.
Fig 1. Data cleaning process.

Source: Martinez-Lacoba et al. (2018) (14)

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2.3.3. Family home. The questionnaire collected family home as follows: village with < 2,000 inhabitants; village with 2,001–5,000 inhabitants; small town with 5,001–15,000 inhabitants; small town with > 15,000 inhabitants; and city. The variable was categorised as follows: rural (village with < 2,000 inhabitants), suburban (village/small town with 2,001–15,000 inhabitants), and urban (small town with > 15,000 inhabitants and city). This categorisation was adapted from other study conducted in Spain [44].

2.3.4. Student cooks for him or herself or not. The questionnaire asked whether students cooked for themselves or not. The response was binomial (yes/no). We named this variable CFHS.

2.3.4. Health or Social Sciences degree. The questionnaire asked students about the degree course they were enrolled on. We categorised this variable into degrees related to Health Studies or Social Sciences, calling the variable “Degree”.

Missing data analysis
We performed a multiple imputation procedure to deal with missing data, under the missing at random assumption (MAR) [45,46]. We excluded from the missing data analysis participants (n = 153) who: a) did not complete the questionnaire; b) presented invalid data (i.e.: lack of attention, platform failure). We included participants who completed the questionnaire, despite their presenting extreme values (i.e. BMI > 35) or missing values in the data cleaning process. Variables included in the imputation model and results from pooled regression analyses with imputed values are presented in Table D in S1 Supporting Information, Table G in S1 Supporting Information, and Figs B-C in S1 Supporting Information.

Statistical analysis
For the statistical analysis, we conducted a one-way ANOVA (Welch’s ANOVA for unequal variances) and multiple linear regression. The independent variables were gender, family’s socioeconomic status, family home, whether the participant cooked for him or herself during the academic year, and the degree course. The dependent variables were food groups. We coded independent variables as dummies in the regression, obtaining the sum of the different comparisons equal to zero [47]. We studied the following comparisons: a) SES: (1) high and medium SES vs. low SES, (2) high SES vs. medium SES; b) family home: (1) urban and suburban vs. rural, (2) urban vs. suburban; c) whether the participant cooked for him or herself during the academic year; d) interaction effects for: gender and SES (1, 2), gender and family home (1, 2), gender and whether the participant cooked for him or herself, and gender and the degree course. Following this regression, we conducted another regression analysis for those dependent variables which presented significant interactions (p < 0.10) among the independent ones, excluding independent variables with non-significant effects (p > 0.10). The correlations between independent variables were analysed using Spearman’s Correlation Coefficient [48,49] and they are shown in Fig A in S1 Supporting Information. The dummy coding is shown in Table E in S1 Supporting Information.

All calculations were made using RStudio [50] and Excel spreadsheet [51].

Results
Table 1 shows the characteristics of the population by student gender. The students’ age, whether they cooked (or not) for themselves, and the degree course were previously shown in our earlier work [14]. In the present study, we also included the location of the family home, but using three categories that consider the size of the family home town. The socioeconomic status of the family is a new variable. The students mean age was 20.21 years (SD = 3.23) and
42% of respondents were male. Regarding socioeconomic status, low and medium SES were the broadest groups in both genders, but the low SES group was larger among women (45.93%). The percentage of students living in an urban area was 57.17%, followed by suburban (27.32%) and rural (15.51%) areas. In addition, the percentage of students cooking for themselves was 29.18%. Finally, the percentage of respondents studying health-related courses was 23.90%, showing significant differences between genders. Fig A in S1 Supporting Information shows the correlations between independent variables. The variables have little correlation ($|\rho| < 0.30$).

Tables 2–6 show mean differences in food group consumption for each social determinant. Table 7 shows and summarises whether students meet recommendations based on the Mediterranean diet pyramid [32]. Finally, Tables 8 and 9 shows results from the multiple regression with complete-case analysis. The results of the multiple linear regression with imputed data can be found in S1 Supporting Information. Figs D-O show the interaction effects between gender and the other social determinants across food groups and Table F in S1 Supporting Information summarises the information on these figures.

### Gender

Table 2 shows mean differences in the number of servings of food groups between men and women. Following the recommendations based on the Mediterranean diet pyramid [32], men failed to comply with the recommendations on olives, nuts and seeds; fruits; vegetables; olive oil; bread, pasta, rice, and other cereals; red meat and processed meat; sweets; and alcoholic beverages (Table 7). Women showed the same habits but complied with recommendations on fruit intake. Men consumed more dairy products, olives, nuts and seeds, red meat and processed food, sweets, eggs, alcohol and fast food compared to women, while women consumed more fruit (Table 2). The multiple regression analysis (Table 8) shows a positive association ($p < 0.05$) between being male and consumption of bread, pasta, rice, other cereals, eggs, 

### Table 1. Characteristics of the study sample.

|                          | All (n = 593) | Males (n = 249) | Females (n = 344) | P    |
|--------------------------|--------------|----------------|------------------|------|
| n (%)                    | 593 (100)    | 249 (41.99)    | 344 (58.01)      | 0.001|
| Age (mean, SD)           | 20.21 (3.23) | 20.42 (3.21)   | 20.06 (3.25)     | 0.176|
| Family's socioeconomic status (SES) (%) |               |                |                  |      |
| Low                      | 42.16        | 36.95          | 45.93            | 0.036|
| Medium                   | 40.13        | 43.77          | 37.50            | 0.146|
| High                     | 17.71        | 19.28          | 16.57            | 0.457|
| Family home              |              |                |                  |      |
| Rural                    | 15.51        | 15.26          | 15.70            | 0.976|
| Suburban                 | 27.32        | 26.51          | 26.91            | 0.776|
| Urban                    | 57.17        | 58.23          | 56.39            | 0.717|
| Cooks for him or herself during the academic year (%) |               |                |                  |      |
| Yes                      | 29.18        | 28.51          | 29.65            | 0.834|
| No                       | 70.82        | 71.49          | 70.35            |      |
| Degree course (%)        |              |                |                  |      |
| Health Sciences          | 23.90        | 14.10          | 31.10            | <0.001|
| Social Sciences          | 76.10        | 85.90          | 68.90            |      |

Note: Gender related-differences between means or percentages calculated using the $t$-Student test and $\chi^2$.

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legumes, and fast food. In addition, the fitted model for interaction effects (Table 9) also suggests a positive association between being male and alcohol consumption.

### Parental socioeconomic status

Table 3 shows mean differences in the number of servings of food groups between high, medium and low socioeconomic status (SES). Students comply with the recommendations on dairy products, potatoes, white meat, fish and seafood, eggs and legumes, despite socioeconomic position (Table 3). There is no difference in mean food group consumption across different categories. Students with high or medium SES exhibit a positive association between the consumption of red meat and fast food compared with students with low SES at 0.10 level of significance (Table 8). Interaction effects (Tables 8–9 and F) suggest that men in this social group present higher consumption of servings of bread, pasta rice, other cereals and legumes, and a lower consumption of alcoholic drinks. This means that men with low SES have a higher mean consumption of alcoholic beverages. This is also shown in Table 9 at 0.10 level of significance. Comparing men with high SES and medium SES, men in the former group show a lower consumption of precooked food. Being female with high/medium SES is negatively associated with the consumption of bread, pasta, rice, other cereals and legumes, but female students with high SES (in contrast to medium SES) show a higher consumption of precooked food.
Table 3. Mean differences in food group consumption by family’s socioeconomic status (n = 593).

| Food group                      | Servings<sup>a</sup> | SOCIOECONOMIC STATUS |   |   |   |
|--------------------------------|----------------------|----------------------|---|---|---|
|                                | Daily                | H (n = 105)          | M (n = 238) | L (n = 250) | P   |
|                                |                      | Mean (SD)            | Mean (SD)   | Mean (SD)   |     |
| Dairy products                 | 2                    | 2.77 (1.51)          | 2.98 (2.07) | 2.95 (2.16) | 0.663 |
| Olives, nuts, seeds            | 1–2                  | 0.35 (0.45)          | 0.34 (0.47) | 0.34 (0.50) | 0.968 |
| Herbs, spices, garlic, onions  |                     | 0.50 (0.66)          | 0.57 (0.74) | 0.60 (0.76) | 0.531 |
| Fruits                         | 3–6                  | 2.65 (2.07)          | 2.92 (2.46) | 2.97 (2.33) | 0.473 |
| Vegetables                     | ≥ 6                  | 2.52 (3.02)          | 2.23 (2.53) | 2.10 (1.93) | 0.330 |
| Olive oil                      | 3                    | 1.27 (1.04)          | 1.13 (0.86) | 1.18 (0.88) | 0.421 |
| Bread, pasta, rice, other cereals | 3–6                  | 2.29 (1.58)          | 2.29 (1.45) | 2.27 (1.37) | 0.985 |
| Weekly                         |                      |                      |             |             |     |
| Potatoes                       | ≤ 3                  | 1.30 (1.27)          | 1.40 (1.43) | 1.26 (1.62) | 0.564 |
| Red meat and processed meat    | < 2                  | 12.73 (10.01)        | 13.93 (9.10) | 12.01 (8.62) | 0.064 |
| Sweets                         | ≤ 2                  | 6.34 (7.08)          | 6.37 (6.23) | 6.42 (6.09) | 0.994 |
| White meat                     | 2                    | 3.09 (2.60)          | 3.67 (3.54) | 3.42 (3.44) | 0.325 |
| Fish, seafood                  | ≥ 2                  | 5.74 (4.65)          | 5.81 (4.21) | 5.37 (4.36) | 0.508 |
| Eggs                           | 2–4                  | 3.04 (4.30)          | 2.71 (2.91) | 2.76 (3.03) | 0.677 |
| Legumes                        | ≥ 2                  | 3.35 (2.01)          | 3.68 (2.94) | 3.39 (2.82) | 0.422 |

Other food groups of interest

| Alcohol drinks (daily)         | 1–2 AU/d             | 0.74 (1.48)          | 0.62 (0.99) | 0.78 (1.68) | 0.437 |
| Fast food (weekly)             | 0                    | 0.67 (0.46)          | 0.67 (0.45) | 0.60 (0.39) | 0.163 |
| Precooked food (weekly)        | 0                    | 1.09 (1.00)          | 1.06 (0.74) | 0.98 (0.93) | 0.420 |

Abbreviations: AU: Alcohol Units; H: high; M: medium; L: low; SES: socioeconomic status.

<sup>a</sup> Recommendations based on the Mediterranean diet pyramid and other studies (32,36).

Level of significance of the observed differences between means as assessed by one-way ANOVA.

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Location of family home

Table 4 shows mean differences in the number of servings of food groups between students with family homes in urban, suburban or rural areas. On the one hand, there are no differences in compliance with the recommendations depending on the location of the family home, except for fruit consumption in rural area (vs. urban area) (Table 7). There are mean differences in white meat consumption between urban and rural areas. Multiple linear regression results show there are no significant associations between food group consumption and the location of family home at 5% level of significance. At 0.10 level of significance, being from a family living in a rural area is positively associated with the consumption of white meat (compared with urban/rural area), while being from a family living in an urban area shows a positive association with sweet consumption (compared with suburban area).

Interaction effects (Table F) suggest that men from a family living in an urban or suburban area have a lower consumption of fast food; and, at 0.10 level of significance, those from a family living in an urban area (vs. a suburban area) have a higher consumption of bread, pasta, rice, other cereals and red meat and processed meat, and a lower consumption of eggs, but this effect was lost when we fitted the model (Table 9). On the other hand, being female from a family living in an urban or suburban area shows a positive association with the consumption of fast food; and women from a family living in an urban area vs. a suburban area also show a
positive association with the consumption of bread, pasta, rice, other cereals, eggs (effect lost in the fitted model), and a negative association with the consumption of red meat.

### Student cooks for him or herself or not

We analysed whether students cooked for themselves or not yielded differences in the mean number of servings across food groups (Table 5). Students who cook for themselves meet recommendations on fruit consumption, but there are no other differences in meeting recommendations. Participants who cook for themselves have lower consumption of bread, pasta, rice, other cereals and sweets, and higher level of consumption of eggs.

The results of the regression analysis indicate that students who do not cook for themselves show a positive association with the consumption of bread, pasta, rice, and other cereals (at 0.05 level of significance). At 0.10 level of significance, this group shows a positive association with the consumption of sweets. In addition, the results show that students who cook for themselves are positively associated with consumption of eggs. Interaction effects (Table F) show that men who cook for themselves have a higher consumption of potatoes and a lower consumption of legumes, while women who cook for themselves have a higher consumption of potatoes and a lower consumption of legumes.
Table 5. Mean differences in food group consumption depending on whether students cook for themselves or not (n = 593).

| Daily Food group                  | Servings* | Yes Mean (SD) | No Mean (SD) | P     |
|----------------------------------|-----------|---------------|--------------|-------|
| Dairy                            | 2         | 2.86 (1.91)   | 2.97 (2.06)  | 0.527 |
| Olives, nuts, seeds              | 1–2       | 0.29 (0.36)   | 0.37 (0.51)  | 0.059 |
| Herbs, spices, garlic, onions    | -         | 0.56 (0.81)   | 0.57 (0.71)  | 0.850 |
| Fruits                           | 3–6       | 3.05 (2.52)   | 2.83 (2.26)  | 0.312 |
| Vegetables                       | ≥ 6       | 2.33 (2.96)   | 2.18 (2.12)  | 0.500 |
| Olive oil                        | 3         | 1.21 (0.92)   | 1.16 (0.9)   | 0.601 |
| Bread, pasta, rice, other cereals| 3–6       | 2.07 (1.34)   | 2.37 (1.47)  | 0.020 |

Weekly

| Potatoes                         | ≤ 3       | 1.43 (1.85)   | 1.28 (1.31)  | 0.280 |
| Red meat and processed meat      | < 2       | 12.55 (9.54)  | 13.06 (8.91) | 0.541 |
| Sweets                           | ≤ 2       | 5.58 (4.81)   | 6.72 (6.82)  | 0.045 |
| White meat                       | 2         | 3.79 (3.52)   | 3.33 (3.27)  | 0.131 |
| Fish, seafood                    | ≥ 2       | 5.24 (3.92)   | 5.76 (4.51)  | 0.181 |
| Eggs                             | 2–4       | 3.32 (4.38)   | 2.57 (2.61)  | 0.037† |
| Legumes                          | ≥ 2       | 3.25 (2.92)   | 3.60 (2.67)  | 0.151 |

Other food groups of interest

| Alcoholic drinks (daily)         | 1–2 AU/d  | 0.77 (1.24)   | 0.68 (1.46)  | 0.484 |
| Fast food (weekly)               | 0         | 0.63 (0.44)   | 0.64 (0.42)  | 0.769 |
| Precooked food (weekly)          | 0         | 1.03 (1.11)   | 1.03 (0.76)  | 0.941 |

Abbreviations: AU: Alcohol Units; CFHS: cooks for him or herself

* Recommendations based on the Mediterranean diet pyramid and other studies [32,36]

Level of significance of the observed differences between means as assessed by one-way ANOVA or Welch’s ANOVA (†)

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**Degree course**

Table 6 shows food group consumption by degree course: Health Studies or Social Sciences. Students enrolled on a health-related degree course meet recommendations on fruit consumption, but show the same behaviour as students enrolled in Social Sciences in the rest of food groups. There are significant mean differences in consumption of olive oil, bread, pasta, rice, other cereals, and alcoholic drinks between Health and Social Sciences students, showing that Health Sciences students have a higher consumption of olive oil and cereals, and a lower alcohol consumption. The results of the regression show that students studying health-related courses are positively associated with the consumption of olive oil, bread, pasta, rice and other cereals, and negatively with the consumption of alcohol. Interaction effects suggest that women studying health-related courses have a higher consumption of vegetables, while consumption among their male peers is lower, comparing both analyses with social sciences students.

**Results of multiple imputation**

We performed two additional regressions with imputed data (m = 5 and m = 30 subsets). Table G in S1 Supporting Information shows a summary of the results of these regressions compared with complete-case regression at 0.10 level of significance. The comparison partially confirms the results from our complete-case analysis. Regarding gender, the association with the consumption of olives, nuts, and seeds, bread, pasta, rice and others, eggs, and fast food is
confirmed by the three analyses. The association with red meat and legume consumption is confirmed by two analyses. The association with the consumption of fast food is confirmed in the case of families with high or medium socioeconomic status in all analyses, and red meat consumption is confirmed in two of them. The three analyses confirmed white meat consumption (urban/suburban vs. rural areas) and sweet consumption (urban vs. suburban areas). The consumption of bread, pasta, rice, and others, and eggs is confirmed by the three analyses in the cooking habits variable, and sweet consumption in two of them. The three analyses also confirmed the consumption of bread, pasta, rice and other cereals, and alcoholic drinks among health and social science students. As regards interactions, they are wholly confirmed for only two regressions: i) gender and socioeconomic position (high/medium vs. low socioeconomic position) interact with the consumption of bread, pasta, rice, and others; ii) gender and degree course interact with the consumption of olive oil.

**Discussion**

This study had two main objectives, which we addressed by means of two analyses. First, we studied the level of compliance with the recommendations of the Mediterranean diet pyramid, stratifying a university sample by five social determinants: gender, socioeconomic status, location of family home, whether the student cooks for him or herself, and the degree course. In this analysis, we included the study of mean differences in food group consumption. Second, we studied differences in food group consumption according to these social determinants and

| Table 6. Mean differences in food group consumption by degree course (n = 593). |
|---|---|---|---|
| **Daily** | **Food group** | **Servings**<sup>a</sup> | **Health Sciences** Mean (SD) | **Social Sciences** Mean (SD) | **P** |
| | Dairy | 2 | 2.85 (1.90) | 2.96 (2.06) | 0.589 |
| | Olives, nuts, seeds | 1–2 | 0.36 (0.46) | 0.34 (0.48) | 0.691 |
| | Herbs, spices, garlic, onions | - | 0.56 (0.68) | 0.57 (0.76) | 0.878 |
| | Fruits | 3–6 | 3.02 (2.05) | 2.85 (2.43) | 0.458 |
| | Vegetables | ≥ 6 | 2.56 (2.11) | 2.12 (2.47) | 0.059 |
| | Olive oil | 3 | 1.48 (1.07) | 1.08 (0.82) | <0.001<sup>†</sup> |
| | Bread, pasta, rice, other cereals | 3–6 | 2.57 (1.50) | 2.19 (1.41) | 0.005 |
| **Weekly** | Potatoes | ≤ 3 | 1.39 (1.33) | 1.30 (1.53) | 0.536 |
| | Red meat and processed meat | < 2 | 12.07 (8.80) | 13.17 (9.18) | 0.210 |
| | Sweets | ≤ 2 | 5.85 (6.74) | 6.55 (6.18) | 0.251 |
| | White meat | 2 | 3.00 (2.07) | 3.61 (3.65) | 0.061 |
| | Fish, seafood | ≥ 2 | 5.59 (3.85) | 5.62 (4.50) | 0.952 |
| | Eggs | 2–4 | 5.59 (3.85) | 5.62 (4.50) | 0.952 |
| | Legumes | ≥ 2 | 3.57 (2.82) | 3.48 (2.73) | 0.739 |
| **Other food groups of interest** | Alcoholic drinks (daily) | 1–2 AU/d | 0.29 (0.54) | 0.83 (1.56) | <0.001<sup>†</sup> |
| | Fast food (weekly) | 0 | 0.60 (0.40) | 0.65 (0.43) | 0.229 |
| | Precooked food (weekly) | 0 | 0.93 (0.75) | 1.06 (0.91) | 0.107 |

Abbreviations: AU: Alcohol Units; CFHS: cooks for him or herself
a. Recommendations based on the Mediterranean diet pyramid and other studies [32,36]
Level of significance of the observed differences between means as assessed by one-way ANOVA or Welch’s ANOVA (<sup>†</sup>)

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the interaction with gender of socioeconomic status, location of family home, whether the students cook for themselves, and the degree course. To develop this analysis, we performed multiple regression analysis using both complete-case data and imputed data. Our participants had similar ages to those in other studies in university population [31,52–54].

The results from the first analysis indicate, generally, that university students do not fully comply with the recommendations. These results coincide with other studies in the case of fruits and vegetables consumption [55], but not in fish consumption. In addition, in our study female students and participants (both gender) with the family home located in a rural area moderately comply with the recommendations on fruits. Most students, regardless of social determinants, do not comply with the recommendations on daily consumption of olives, nuts and seeds, fruits, vegetables, olive oil, bread, pasta, rice and other cereals, which is consistent with another study [52]. The weekly recommended consumption of red meat and processed meat and sweets is not satisfied, coinciding with the findings of another study using different dietary guidelines [52]. Low compliance with the recommendations of the Mediterranean diet pyramid has been assessed in other studies [56,57], showing that adherence to the Mediterranean dietary pattern is declining among adults and shifting towards a less healthy Western dietary pattern. The loss of the Mediterranean dietary pattern has significant implications in individual health and healthcare systems. It has been widely reported that greater adherence to Mediterranean diet may improve health status [20], and thus promoting the Mediterranean diet is a key point for public health policy not only due to individual health outcomes, but also for its social, economic and environmental benefits [19].

### Table 7. Compliance with the recommendations of the Mediterranean diet pyramid (n = 593).

| Food group                        | Servings* | Gender | SES | Family home | CFHS | Degree Course |
|-----------------------------------|-----------|--------|-----|-------------|------|---------------|
| Dairy                             | 2         | M W H  | Med. | L U SU R     | Yes  | No HE SO      |
| Olives, nuts, seeds              | 1–2       |        |      |             |       |               |
| Herbs, spices, garlic, onions    | NA        |        |      |             |       |               |
| Fruits                            | 3–6       |        |      |             |       |               |
| Vegetables                        | ≥ 6       |        |      |             |       |               |
| Olive oil                         | 3         |        |      |             |       |               |
| Bread, pasta, rice, other cereals| 3–6       |        |      |             |       |               |
| Weekly                            |           |        |      |             |       |               |
| Potatoes                          | ≤ 3       |        |      |             |       |               |
| Red meat and processed meat      | < 2       |        |      |             |       |               |
| Sweets                            | ≤ 2       |        |      |             |       |               |
| White meat                        | 2         |        |      |             |       |               |
| Fish, seafood                     | ≥ 2       |        |      |             |       |               |
| Eggs                              | 2–4       |        |      |             |       |               |
| Legumes                           | ≥ 2       |        |      |             |       |               |
| Other food groups of interest     |           |        |      |             |       |               |
| Alcoholic drinks (daily)          | 1–2 AU/d  |        |      |             |       |               |
| Fast food (weekly)                | 0         |        |      |             |       |               |
| Precooked food (weekly)           | 0         |        |      |             |       |               |

Abbreviations: AU: Alcohol Units; CFHS: Cooks for him or herself; H: High; HE: Health Studies; L: Low; M: Men; Med.: Medium; R: Rural; SES: socioeconomic status; SO: Social Sciences SU: Semiurban; U: Urban; W: Women

a. Recommendations based on the Mediterranean diet pyramid and other studies [32,36]

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The results of the second analysis indicate that gender is the social determinant with the largest effect on mean differences in food group consumption. Many works have shown that gender is associated with food habits [13,14,16–18,52,54,58], and, as we indicated in the Introduction section, women usually exhibit better food habits [13,14,16–18]. In the case of male students, our study shows they have a higher intake of dairy products, olives, nuts and seeds, red meat and processed meat, sweets, eggs, alcoholic drinks and fast food. Despite women not complying with most of the Mediterranean diet recommendations, they appear to have healthier dietary patterns than men, according to the literature.

The multiple regression analysis confirms these results for the groups of olives, nuts, seeds (at 0.10 level of significance), bread, pasta, rice and others, red meat, eggs, legumes, and fast food, but not for the alcoholic drinks and sweets. This suggests that other variables could influence the consumption of sweets, and alcoholic drinks. In our analysis, we found interactions with socioeconomic position for the alcoholic drink food group. However, the fitted models for

Table 8. Multiple regression analysis of food groups based on the Mediterranean diet pyramid, social determinants and interactions.

| Food group                        | Gender | Socioeconomic position | Family home | CFHS | Degree | Interactions |
|-----------------------------------|--------|------------------------|-------------|------|--------|--------------|
| Daily                             |        |                        |             |      |        |              |
| Dairy                             | 0.043  | -0.054                 | 0.047       | 0.051| 0.035  | -0.020       | -0.013       | -0.048       | -0.072       | 0.065       | 0.037       | -0.010       | -0.037       |
| Olives, nuts, seeds               | 0.127† | -0.018                 | 0.005       | -0.070| 0.060  | -0.068       | 0.058        | -0.016       | 0.009        | 0.036       | 0.044       | 0.049        | 0.079        |
| Herbs, spices, garlic, onions     | 0.064  | -0.060                 | -0.033      | 0.067| 0.059  | 0.013        | 0.002        | 0.043        | 0.017        | -0.025      | 0.056       | -0.003       | -0.003       |
| Fruits                            | -0.046 | -0.030                 | -0.040      | -0.011| 0.026  | 0.039        | 0.036        | -0.012       | <0.001       | 0.029       | -0.050       | -0.024       | 0.070        |
| Vegetables                        | -0.100 | 0.057                  | 0.045       | 0.060| 0.067  | 0.066        | 0.025        | 0.042        | 0.013        | 0.005       | 0.031       | 0.024       | -0.104†      |
| Olive oil                         | 0.001  | 0.008                  | 0.058       | -0.045| 0.032  | 0.024        | 0.197†       | -0.043       | 0.041        | 0.010       | -0.077†      | 0.015        | 0.017        |
| Bread, pasta, rice, other cereals | 0.140* | 0.007                  | <0.001      | -0.053| 0.033  | -0.087*      | 0.130***     | 0.118*       | 0.041        | 0.010       | -0.077†      | 0.015        | 0.017        |
| Weekly                            |        |                        |             |      |        |              |
| Potatoes                          | -0.009 | 0.028                  | -0.026      | -0.031| 0.045  | 0.039        | 0.042        | -0.009       | -0.032       | 0.001       | 0.018       | -0.115*      | 0.064        |
| Red meat and processed meat       | 0.120† | 0.085†                 | -0.050      | -0.039| -0.045| -0.020       | 0.004        | 0.053        | 0.016        | 0.052       | 0.081†      | 0.033        | 0.072        |
| Sweets                            | 0.066  | -0.039                 | -0.006      | -0.048| 0.082† | -0.081†      | -0.032       | -0.032       | 0.023        | 0.051       | 0.048        | 0.009        | 0.022        |
| White meat                        | 0.093  | 0.028                  | -0.061      | -0.079†| -0.049| 0.054        | -0.032       | 0.017        | -0.040       | 0.016       | 0.015       | 0.090†       | 0.056        |
| Fish, seafood                     | -0.066 | 0.034                  | -0.014      | -0.025| 0.004  | -0.059       | -0.008       | -0.043       | -0.061       | 0.001       | 0.027       | -0.022       | 0.011        |
| Eggs                              | 0.272***| 0.032                 | 0.052       | -0.022| -0.036| 0.106*       | 0.023        | 0.021        | 0.067        | 0.050       | -0.078†      | 0.025        | 0.029        |
| Legumes                           | 0.139**| 0.031                  | -0.047      | -0.067| 0.035  | -0.039       | 0.027        | 0.091*       | -0.036       | -0.035      | -0.013       | 0.121*       | -0.025       |
| Other food groups of interest     |        |                        |             |      |        |              |
| Alcoholic drinks                  | 0.056  | -0.067                 | 0.032       | 0.006| 0.029  | 0.010        | -0.162***     | -0.096*      | -0.028       | 0.007       | 0.041       | -0.036       | -0.061       |
| Fast food                         | 0.182**| 0.079†                 | 0.003       | -0.059| 0.008  | -0.010       | -0.021       | 0.049        | -0.005       | -0.099*     | -0.016       | -0.022       | 0.007        |
| Precooked food                    | -0.054 | 0.06                   | 0.011       | -0.022| 0.017  | 0.010        | -0.064       | -0.040       | -0.098*      | 0.035       | -0.013       | 0.005        | 0.034        |

Data reported as standardised beta coefficients (β'). Abbreviations: CFHS: Cooks for him or herself; SES: socioeconomic status.

†P<0.10; ††P<0.05; †††P<0.01; ††††P<0.001

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interactions showed a positive association between being male and alcohol consumption, with the interaction effect being maintained with socioeconomic position. This last analysis also shows a positive association between being female and vegetable consumption and a positive interaction with studying health-related courses. These results in men coincide with other studies in university and adult population for the case of red meat [52,59,60]. Other studies also indicate that men have a higher consumption of alcoholic drinks [53,60,61], eggs [52,61], and sweets [52]. In addition, in the case of female students, fruit consumption is higher than among their male counterparts [52,54,59,61].

Our results indicate that socioeconomic status, geographic area, whether the students cook for themselves, and the degree course have a limited influence on differences in food group consumption. Socioeconomic status shows no differences in any of the food groups, which is inconsistent with the previous literature in adult population [9,62–64]. However, the interaction with gender in the regression analyses show differences in bread, pasta, rice and other

| Food group          | Gender | Socioeconomic position | Family home | CFHS   | Degree | Interactions          |
|---------------------|--------|------------------------|-------------|--------|--------|-----------------------|
|                     |        |                        |             |        |        | Gender x SES (1)     |
|                     |        |                        |             |        |        | Gender x SES (2)     |
|                     |        |                        |             |        |        | Gender x Family home (1) |
|                     |        |                        |             |        |        | Gender x Family home (2) |
|                     |        |                        |             |        |        | Gender x CFHS     |
|                     |        |                        |             |        |        | Gender x Degree     |
| Dairy               | -      | -                      | -           | 0.029  | -0.080† | 0.122**               |
|                     |        |                        |             |        |        | 0.108*               |
|                     |        |                        |             |        |        | -0.077†               |
| Olives, nuts, seeds | -      | -                      | -           | -      | -      | -                    |
| Herbs, spices, garlic, onions | - | -                      | -           | -      | -      | -                    |
| Fruits              | -      | -                      | -           | -      | -      | -                    |
| Vegetables          | -0.102†| -                      | -           | -      | 0.033  | -                    |
|                     |        |                        |             |        |        | -0.103†               |
| Olive oil           | -      | -                      | -           | -      | -      | -                    |
| Bread, pasta, rice, other cereals | 0.113*  | 0.001                | -           | 0.029  | -0.080† | 0.122**               |
|                     |        |                        |             |        |        | 0.108*               |
|                     |        |                        |             |        |        | -0.077†               |
| Weekly              |        |                        |             |        |        |                      |
| Potatoes            | -0.036 | -                      | -           | -      | 0.040  | -                    |
|                     |        |                        |             |        |        | -0.128**               |
| Red meat and processed meat | 0.073†  | 0.080†               | -           | -      | -0.043 | -                    |
|                     |        |                        |             |        |        | 0.098*               |
| Sweets              | -      | -                      | -           | -      | -      | -                    |
| White meat          | 0.089* | -                      | -           | -      | -0.085* | -0.056               |
|                     |        |                        |             |        |        | 0.040*               |
| Fish, seafood       | -      | -                      | -           | -      | -      | -                    |
| Eggs                | 0.239***| -                      | -           | -      | -0.032 | 0.100*               |
|                     |        |                        |             |        |        | -0.074               |
| Legumes             | 0.145* | 0.046                  | -           | -      | -0.027 | -0.009*              |
|                     |        |                        |             |        |        | 0.048*               |
| Other food groups of interest |        |                        |             |        |        |                      |
| Alcoholic drinks    | 0.137**| -0.066                 | -           | -      | -      | -                    |
|                     |        |                        |             |        |        | -0.135**              |
|                     |        |                        |             |        |        | -0.076†              |
| Fast food           | 0.177***| 0.070†                | -           | -      | -0.055 | -                    |
|                     |        |                        |             |        |        | -0.090*              |
| Precooked food      | -0.036 | -0.006                 | -           | -      | -      | -                    |
|                     |        |                        |             |        |        | -0.087*              |

Data reported as standardised beta coefficients (β’). Abbreviations: CFHS: Cooks for him or herself; SES: socioeconomic status.

P < 0.10;

P < 0.05;

P < 0.01;

P < 0.001

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cereals, legumes, alcoholic drinks, and precooked food. Geographical differences, measured by location of the family home - urban, suburban, or rural - have been found for white meat consumption, where students whose families live in rural areas show a higher consumption comparing with urban areas. The limited influence of geographic area has been reported in another study [61]. Moreover, the interaction effect of geographic area with gender shows there are differences in consumption of bread, pasta, rice and others, red meat, eggs and fast food. However, when the fitted models were studied, the interaction of family home with egg consumption was lost. Students who cook for themselves have a lower consumption of bread, pasta, rice and other cereals, sweets, and a higher consumption of eggs. In addition, the interaction of gender with this variable shows differences in consumption of potatoes, white meat and legumes. Studying Health or Social Sciences degree courses shows differences in the consumption of olive oil, bread, pasta, rice, and others, and alcoholic drinks, which are confirmed by the regression analysis. Students of Social Sciences show higher consumption of alcoholic drinks, supported by an article with similar results [65]. The lack of notable differences between the two student profiles (Health and Social Sciences) was unexpected, because a previous work found that studying a non-health related course was associated with an unhealthy diet [14]. This could be explained because that particular work used an index and not the overall consumption of food groups. However, and coinciding with our results, a study on a sample of Health Science students showed that studying health-related courses did not guarantee better choices in food habits [66].

Despite our results being partly inconsistent with other results in the previous literature on social determinants [9,67], they do coincide in the low adherence to Mediterranean diet and we have previously discussed the importance of this dietary pattern. In a previous work [14], 47.90% of students exhibited an unhealthy dietary pattern, which was equivalent to low adherence to Mediterranean diet, and the results of this new work and the earlier one coincide in the importance of developing healthy food habits among university students.

The previous work [14] aimed to analyse the association of individual and social characteristics of the sample with quality of diet, categorising an index of adherence to the Mediterranean diet as healthy/unhealthy diet [36,68]. The previous work [14] aimed to analyse the association between the individual and social characteristics of the sample and quality of diet, categorising an index of adherence to the Mediterranean diet as healthy/unhealthy diet [36,68]. We decided to adopt a different approach in this work because the previous study presented a knowledge gap that we wish to fill. Despite an index usually being a good indicator and showing a general picture of the food habits in the study sample through a global score, it does not clearly show in what food groups decision makers should improve public policies. The previous work studied individual characteristics of the sample (such body mass index), but in this work we focus on social determinants, disregarding the former. For this reason, we followed a different approach in order to show which food groups pose (or not) a problem in the pursuit of a healthier dietary pattern, which could improve long-term health. This new approach may facilitate the elaboration of public policies in some particular groups of students for a specific food group.

Following our results, policy makers should make an effort to promote the Mediterranean diet among university population due to its many benefits [19,20], as students do not fully comply with the recommendations on different food groups. In addition, they should to address the gender gap in the consumption of unhealthy foods, such as sweets, alcoholic drinks and fast food (men showed a higher consumption of these groups), and in healthy foods, such as vegetables or fruits, where men showed a lower consumption, but legumes consumption is higher among men with a better socioeconomic position and who also cook for themselves. Regarding other social determinants, knowledge of healthy food habits should be improved.
among Social Science students considering the interaction with gender. Despite our results not showing a substantial association with socioeconomic position, it should be considered since previous literature has shown the influence of socioeconomic status on food habits. In addition, and concerning family home, policy efforts may not be necessary.

This study is not without limitations and the results should be interpreted with caution. First, self-reported food consumption by FFQ can give rise to measurement error [69]. Second, given the characteristics of food frequency questionnaires a memory and social desirability bias might have influenced the results. Third, we could not assess the recommended servings of herbs, spices, garlic and onions because of a lack of information in dietary guideline. A further limitation regards the sample. The final sample represented 4% of the population (593/15,278). Using multiple imputation techniques, we were working with 924 students, who represented 6% of the population. In addition, we did not distinguish between students by year of study (i.e.: first, second- or third-year students).

However, the study has certain strengths. To address FFQ measurement error, we used the criterion of recommended intake in kilocalories, which has no substantial differences from other methods [70,71]. In addition, we dealt with the missing data by using a multiple imputation technique. The multiple regression with the imputed data confirms partially the results from the multiple regression with complete-case analysis and produced comparable standard errors.

The absence of substantive differences by socioeconomic status, geographic area, whether the students cook for themselves, and the degree course could have various explanations. The study population was young and, as noted in a particular study [22], there is a global "nutrition transition" around, which is associated with different diseases and is related to the westernization of diets, and our sample could be affected by these changes. In addition, studies examining socioeconomic disparities usually focus on adult or adolescent populations, and their behaviour may differ from that of a university population. Moreover, university students are a group with special characteristics: small age range, first life stage with more permissive parental control, changes in physical environment, generational socio-cultural norms and values, among others [27]. However, the weak or non-existent in three of four social determinants in our university sample is still important. If policy makers wish to implement a policy based on healthy diet (e.g. Mediterranean diet) in a university population, they must focus their attention on the gender gap (here, the case of women is partially more favourable). Evidently, policy makers should also not forget the social gradient in diet quality. Public policies and health strategies could shape the material conditions of society, helping to improve populations’ long-term health.

**Conclusion**

This study shows that university students do not fully comply with recommendations on the Mediterranean diet pyramid. In addition, gender is the social determinant with the largest effect on food group consumption. Women have a lower consumption of dairy products, olives, nuts and seeds, red meat, and processed meat, sweets, eggs, alcoholic drinks and fast food, and a higher consumption of fruit, compared with men. Despite our study showing that socioeconomic status, geographic area, and if students cook for themselves have a limited influence on differences in food group consumption, a large body of literature has reported a social gradient in food habits. For this reason, and following our results, in order to avoid future health costs, policy makers should consider the gender gap when implementing policies based on a healthy diet, without forgetting the importance of the other social determinants.
**Supporting information**

**S1 Supporting information.** This file includes:

- Multiple regression outputs of complete-case analysis, and multiple imputation analyses (m = 5 and m = 30 subsets).
- Table A. Foods and food groups collected in questionnaire.
- Table B. Food groups in the Mediterranean diet pyramid and foods from the FFQ.
- Table C. Occupations collected in the questionnaire: ISCO, ISEI-08 and SES.
- Table D. Variables sorted by percentage of missing.
- Table E. Independent variables: dummy coding.
- Table F. Summary of interactions between gender and the other social determinants across food groups.
- Table G. Results from complete-case and imputed data regressions.
- Fig A. Correlation across independent variables.
- Fig B. Density plots of food groups after imputation of values: complete-case analysis and multiple imputation (m = 5).
- Fig C. Density plots of food groups after imputation of values: complete-case analysis and multiple imputation (m = 30).
- Fig D. Interaction effect between SES (1) and gender in the food group “Bread, pasta, rice, and other cereals” (n = 593).
- Fig E. Interaction effect between SES (1) and gender in the food group “Legumes” (n = 593).
- Fig F. Interaction effect between SES (1) and gender in the food group “Alcoholic drinks” (n = 593).
- Fig G. Interaction effect between SES (2) and gender in the food group “Precooked” (n = 593).
- Fig H. Interaction effect between family home (1) and gender in the food group “Fast food” (n = 593).
- Fig I. Interaction effect between family home (2) and gender in the food group “Bread, pasta, rice, and other cereals” (n = 593).
- Fig J. Interaction effect between family home (2) and gender in the food group “Red meat and processed meat” (n = 593).
- Fig K. Interaction effect between family home (2) and gender in the food group “Eggs” (n = 593).
- Fig L. Interaction effect between CFHS and gender in the food group “Potatoes” (n = 593).
- Fig M. Interaction effect between CFHS and gender in the food group “White meat” (n = 593).
- Fig N. Interaction effect between CFHS and gender on Legumes food group (n = 593).
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Author Contributions

Conceptualization: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Data curation: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Formal analysis: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Investigation: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Methodology: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Resources: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Software: Roberto Martinez-Lacoba.

Supervision: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Validation: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Visualization: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Writing – original draft: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

Writing – review & editing: Roberto Martinez-Lacoba, Isabel Pardo-Garcia, Elisa Amo-Saus, Francisco Escribano-Sotos.

References

1. Abel T. Cultural capital and social inequality in health. J Epidemiol Community Health. 2008; 62. https://doi.org/10.1136/jech.2007.066159 PMID: 18572429

2. Wilkinson R, Marmot M. Social determinants of health: the solid facts [Internet]. 2nd ed. Wilkinson R, Marmot M, editors. Copenhagen: World Health Organization; 2003. Available: http://www.euro.who.int/__data/assets/pdf_file/0005/98438/e81384.pdf

3. Vathesatogkit P, Batty GD, Woodward M. Socioeconomic disadvantage and disease-specific mortality in Asia: Systematic review with meta-analysis of population-based cohort studies. J Epidemiol Community Health. 2014; 68: 375–383. https://doi.org/10.1136/jech-2013-203055 PMID: 24407596

4. Marmot M. Social determinants of health inequalities. Lancet. 2005; 365: 1099–1104. https://doi.org/10.1016/S0140-6736(05)71146-6 PMID: 15781105

5. Stringhini S, Carmeli C, Jokela M, Avendaño M, Muennig P, Guida F, et al. Socioeconomic status and the 25 x 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1.7 million men and women. Lancet. 2017; 389: 1229–1237. https://doi.org/10.1016/S0140-6736(16)32880-7 PMID: 28159391
6. Urbanos-Garrido RM. Social inequalities in health: Measuring the contribution of housing deprivation and social interactions for Spain. Int J Equity Health. 2012; 11. Available: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&PAGE = reference&D = emed11&NEWS = N&AN = 2013035806

7. World Health Organization, Food and Agriculture Organization of the United Nations. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation [Internet]. Series 916. Geneva: World Health Organization; 2003. Available: http://apps.who.int/iris/bitstream/10665/42665/1/WHO_TRS_916.pdf

8. World Health Organization. Healthy diet [Fact Sheet No394] [Internet]. 2015. Available: http://www.who.int/mediacentre/factsheets/fs394/en/

9. Darmon N, Drewnowski A. Does social class predict diet quality? Am J Clin Nutr. 2008; 87: 1107–1117. https://doi.org/10.1093/ajcn/87.5.1107 PMID: 18469226

10. Fransen HP, Boer JMA, Beulens JWJ, Wit GA De, Bueno HB, Hoekstra J, et al. Associations between lifestyle factors and an unhealthy diet. Eur J Public Health. 2017; 27: 274–278. https://doi.org/10.1093/eurpub/ckw434 PMID: 27744349

11. Nilsen SM, Krokstad S, Holmen TL, Westin S. Adolescent s’ health-related dietary patterns by parental socioeconomic position, the Nord-Trøndelag health study (HUNT). Eur J Public Health. 2010; 20: 299–305. https://doi.org/10.1093/eurpub/ckp137 PMID: 19767399

12. McInerney M, Csizmadia I, Friedenreich CM, Uribe FA, Nettel-Aguirre A, McLaren L, et al. Associations between the neighbourhood food environment, neighbourhood socioeconomic status, and diet quality: An observational study. BMC Public Health. BMC Public Health; 2016; 16: 984. https://doi.org/10.1186/s12889-016-3631-7 PMID: 27833380

13. Beck KL, Jones B, Ullah I, McNaughton SA, Haslett SJ, Stonehouse W. Associations between dietary patterns, socio-demographic factors and anthropometric measurements in adult New Zealanders: an analysis of data from the 2008/09 New Zealand Adult Nutrition Survey. Eur J Nutr. Springer Berlin Heidelberg; 2017; https://doi.org/10.1007/s00394-017-1421-3 PMID: 28378296

14. Martinez-Lacoba R, Pardo-Garcia I, Amo-Saus E, Escrivan-Sotos F. Socioeconomic, demographic and lifestyle-related factors associated with unhealthy diet: a cross-sectional study of university students. BMC Public Health; 2018; 18. https://doi.org/10.1186/s12889-018-6149-3 PMID: 30404995

15. Atkins JL, Ramsay SE, Whincup PH, Morris RW, Lennon LT, Wannamethee SG. Diet quality in older adults. Age Ageing; 2006; https://doi.org/10.1093/ageing/afj067 PMID: 16449042

16. Ne´ do E, Paulik E. Association of smoking, physical activity, and dietary habits with socioeconomic variables: A cross-sectional study in adults on both sides of the Hungarian-Romanian border. BMC Public Health. BioMed Central Ltd; 2017; https://doi.org/10.1017/S1368980010000604 PMID: 25827229

17. Bertin M, Touvier M, Dubuisson C, Dufour A, Havard S, Lafay L, et al. Dietary patterns of French adults: associations with demographic, socio-economic and behavioural factors. J Hum Nutr Diet. 2015; 29: 241–254. https://doi.org/10.1111/jhn.12315 PMID: 25891903

18. Boylan S, Lallukka T, Lahelma E, Pikhart H, Malyutina S, Pajak A, et al. Socio-economic circumstances and food habits in Eastern, Central and Western European populations. Public Health Nutr. 2011; 14: 678–687. https://doi.org/10.1017/S1368980010002570 PMID: 20843403

19. Dermiri S, Berry E, Serra-Majem L, La Vecchia C, Capone R, Medina F, et al. Med Diet 4.0: the Mediterranean diet with four sustainable benefits. Public Health Nutr. 2017; 20: 1322–1330. https://doi.org/10.1017/S1368946516003177 PMID: 28003037

20. Martinez-Lacoba R, Pardo-Garcia I, Amo-Saus E, Escrivan-Sotos F. Mediterranean diet and health outcomes: a systematic meta-review. Eur J Public Health. 2018; 28: 955–961. https://doi.org/10.1093/eurpub/cky113 PMID: 29992229

21. Garcia Cabrera S, Herrera Fernández N, Rodríguez-Hernández C, Nissenson M, Román-Viñas B, Serra-Majem L. KIDMED test; prevalence of low adherence to the Mediterranean Diet in children and young; a Systematic Review. Nutr Hosp. 2015; 32: 2390–2399. https://doi.org/10.3305/nh.2015.32.6.9828 PMID: 26667685

22. Kearney J. Food consumption trends and drivers. Philos Trans R Soc B Biol Sci. 2010; 365: 2793–2807. https://doi.org/10.1098/rstb.2010.0149 PMID: 20713385

23. Darmon N, Drewnowski A. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: A systematic review and analysis. Nutr Rev. 2015; 73: 643–660. https://doi.org/10.1093/nutrit/nvu027 PMID: 25837238

24. Johansen A, Rasmussen S, Madsen M. Health behaviour among adolescents in Denmark: Influence of school class and individual risk factors. Scand J Public Health. 2006; 34: 32–40. https://doi.org/10.1080/14034940510032158 PMID: 16449042
25. Vuille JC, Schenkel M. Social equalization in the health of youth: The role of the school. Eur J Public Health. 2001; 11: 287–293. https://doi.org/10.1093/eurpub/11.3.287 PMID: 11582609

26. Chourdakis M, Tzellos T, Papazisis G, Toulis K, Kouvelas D. Eating habits, health attitudes and obesity indices among medical students in northern Greece. Appetite. 2010; 55: 722–725. https://doi.org/10.1016/j.appet.2010.08.013 PMID: 20801179

27. Deliens T, Clarys P, De Bourdeaudhuij I, Deforce B. Determinants of eating behaviour in university students: A qualitative study using focus group discussions. BMC Public Health. 2014; 14: 1–12. https://doi.org/10.1186/1471-2458-14-1

28. Béghin L, Dauchet L, De Vuyst T, Cuenca-García M, Manios Y, Toti E, et al. Influence of parental socio-economic status on diet quality of European adolescents: Results from the HELENA study. Br J Nutr. 2014; 111: 1303–1312. https://doi.org/10.1017/S0007114513003796 PMID: 24330831

29. Rydén PJ, Hagfors L. Diet cost, diet quality and socio-economic position: How are they related and what contributes to differences in diet costs? Public Health Nutr. 2014; 14: 1680–1692. https://doi.org/10.1017/S1368980014001922 PMID: 21255480

30. Thorpe MG, Kestin M, Riddell LJ, Keast RSJ, Sarah A. Diet quality in young adults and its association with food-related behaviours. Public Health Nutr. 2013; 17: 1767–1775. https://doi.org/10.1017/S1368980013001924 PMID: 23866858

31. Al-Rethaia AS, Fahmy A- EA, Al-Shawaiat NM. Obesity and eating habits among college students in Saudi Arabia: a cross sectional study. Nutr J. 2010; 9. https://doi.org/10.1186/1475-2891-9-39 PMID: 20849655

32. Bach-Faig A, Berry EM, Lairon D, Reguant J, Trichopoulou A, Demini S, et al. Mediterranean diet pyramid today. Science and cultural updates. Public Health Nutr. 2011; 14: 2274–2284. https://doi.org/10.1017/S1368980011002515 PMID: 22166184

33. SurveyMonkey. SurveyMonkey: Free online survey software & questionnaire tool. In: www.surveymonkey.com [Internet]. 2012. Available: http://www.surveymonkey.com/

34. Vioque J, Navarrete-Muñoz E-M, Gimenez-Monzó D, García-de-la-Hera, Granado F, Young IS, et al. Reproducibility and validity of a food frequency questionnaire among pregnant women in a Mediterranean area. Nutr J. 2013; 12. Available: http://www.nutritionj.com/content/12/1/26

35. Willet WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschi J, et al. Reproducibility and validity of a semiquantitative food frequency questionnaire. Am J Epidemiol. 1985; 122: 51–65. https://doi.org/10.1093/oxfordjournals.aje.a114086 PMID: 4014201

36. Sofi F, Macchi C, Abbate R, Gensini GF, Casini A. Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score. Public Health Nutr. 2013; 17: 2769–2782. https://doi.org/10.1017/S1368980013003169 PMID: 24476641

37. Pereira MA, Kartashov AI, Ebbeling CB, Van Horn L, Slattery ML, Jacobs PDR, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. Lancet. 2005; 365: 36–42. https://doi.org/10.1016/S0140-6736(04)17663-0 PMID: 15639678

38. Fraser LK, Edwards KL, Cade JE, Clarke GP. Fast food, other food choices and body mass index in teenagers in the United Kingdom (ALSPAC): A structural equation modelling approach. Int J Obes. Nature Publishing Group; 2011; 35: 1325–1330. https://doi.org/10.1038/ijo.2011.120 PMID: 21712805

39. International Labour Organization. International Standard Classification of Occupations: Structure, group definitions and correspondence tables [Internet]. Geneva: International Labour Organization; 2012. Available: http://www.ilo.org/public/english/bureau/statISCO/docs/resol08.pdf

40. Ganzeboom HBG, Treiman D. Occupational Status Measures for the New International Standard Classification of Occupations ISCO-08; With a Discussion of the New Classification. 2010; Available: http://www.harryganzeboom.nl/isol/isol2010c2-ganzeboom.pdf

41. Schulz W. Measuring the socio-economic background of students and its effect on achievement in PISA 2000 and PISA 2003. Annual Meetin of the American Educational Research Association. San Francisco; 2005. Available: https://files.eric.ed.gov/fulltext/ED493510.pdf

42. OECD. Glossary of Statistical Terms [Internet]. 2007 [cited 1 Jan 2018]. Available: https://stats.oecd.org/glossary/download.asp

43. Domingo-Salvany A, Bacigalupo A, Carrasco JM, Espelt A, Ferrando J, Borrell C. Propuestas de clase social neoweberiana y neomarxista a partir de la Clasificación Nacional de Ocupaciones 2011. Gac Sanit. 2013; 27: 263–272. https://doi.org/10.1016/j.gaceta.2012.12.009 PMID: 23394892

44. Cebrián F, Cebrián A. Los desequilibrios en la estructura urbana de Castilla-La Mancha. Papeles Geogr. 2000; 32: 45–59. Available: http://revistas.um.es/geografia/article/view/47311

45. Buuren S van, Groothuis-Oudshoorn K. mice: Multivariate Imputation by Chained Equations in R. J Stat Softw. 2011; 45. https://doi.org/10.18637/jss.v045.i01
46. Pedersen AB, Mikkelsen EM, Cronin-Fenton D, Kristensen NR, Pham TM, Pedersen L, et al. Missing data and multiple imputation in clinical epidemiological research. Clin Epidemiol. 2017; 9: 157–166. https://doi.org/10.2147/CLEP.S129785 PMID: 28352203

47. Stockburger DW. Multivariate statistics: concepts, models and applications [Internet]. 3rd Web Ed. David W. Stockburger; 2016. Available: http://psychstat3.missouristate.edu/Documents/MultiBook3/mbk.htm

48. Mangiafico SS. An R Companion for the Handbook of Biological Statistics, version 1.3.2. [Internet]. 2015. Available: rcompanion.org/documents/RCompanionBiostatistics.pdf

49. McDonald JH. Handbook of Biological Statistics. 3rd ed. Baltimore, Maryland, U.S.A.: Sparky House; 2009. https://doi.org/10.1017/CBO9781107415324.004

50. RStudio Team. RStudio: Integrated Development for R. [Internet]. Boston, MA: RStudio, Inc.; 2015. Available: http://www.rstudio.com/

51. Microsoft. Excel 2016 [Internet]. Redmond, Washington: Microsoft Corporation; 2016. Available: https://products.office.com/es-es/excel

52. Moreno-Gómez C, Romaguera-Bosch D, Tauler-Riera P, Bennasar-Veny M, Pericas-Beltran J, Martinez-Andreu S, et al. Clustering of lifestyle factors in Spanish university students: the relationship between smoking, alcohol consumption, physical activity and diet quality. Public Health Nutr. 2012; 15: 2131–2139. https://doi.org/10.1017/S1368980012000080 PMID: 22314203

53. García-Meseguer MJ, Burriel FC, García CV, Serrano-Ureña R. Adherence to Mediterranean diet in a Spanish university population. Appetite. 2014; 78: 156–164. https://doi.org/10.1016/j.appet.2014.03.020 PMID: 24681406

54. El Ansari W, Stock C, Mikolajczyk RT. Relationships between food consumption and living arrangements among university students in four European countries—A cross-sectional study. Nutr J. 2012; 11: 1–7. https://doi.org/10.1186/1475-2891-11-1

55. Baldini M, Pasqui F, Bordoni A, Maranesi M. Is the Mediterranean lifestyle still a reality? Evaluation of food consumption and energy expenditure in Italian and Spanish university students. Public Health Nutr. 2008; 12: 148–155. https://doi.org/10.1017/S1368980008002759 PMID: 18503726

56. Leon-Munoz LM, Guallar-Castillon P, Graciani A, Lopez-Garcia E, Mesas AE, Aguiler MT, et al. Adherence to the Mediterranean Diet Pattern Has Declined in Spanish Adults. J Nutr. 2012; 142: 1843–1850. https://doi.org/10.3945/jn.112.164616 PMID: 22875552

57. Bibiloni M del M, Martínez E, Llull R, Pons A, Tur JA. Western and Mediterranean dietary patterns among Balearic Islands’ adolescents: Socio-economic and lifestyle determinants. Public Health Nutr. 2012; 15: 683–692. https://doi.org/10.1017/S1368980011002199 PMID: 21899802

58. Godsos J, Zappalà G, Bernardini S, Giambini I, Bes-Rastrollo M, Martínez-Gonzalez M. Adherence to the Mediterranean diet is inversely associated with metabolic syndrome occurrence: a meta-analysis of observational studies. Int J Food Sci Nutr. 2016; 68: 138–148. https://doi.org/10.1080/09637486.2016.1221900 PMID: 27557591

59. Míguez Bernárdez M, Castro Sobrino L, Collins Greene A, De la Montaña Miguel J. Variaciones en la dieta de universitarios gallegos (campo de Ourense) con relación al patrón cardioprotector de la dieta mediterránea [Variations of the diet of Galician university students (Ourense campus) in relation to the pattern of the cardioprotect. Nutr Hosp. 2013; 28: 2099–2106. https://doi.org/10.3305/nutr PMID: 24506388

60. Deshmukh-Taskar P, Nicklas TA, Yang S-J, Berenson GS. Does Food Group Consumption Vary by Differences in Socioeconomic, Demographic and Lifestyle Factors in Young Adults? The Bogalusa Heart Study. J Am Diet Assoc. 2007; 107: 223–234. https://doi.org/10.1016/j.jada.2006.11.004 PMID: 17258958

61. Samaniego-Vaesken M de L, Partearroyo T, Ruiz E, Aranceta-Bartrina J, Gil Á., González-Gross M, et al. The Influence of Place of Residence, Gender and Age Influence on Food Group Choices in the Spanish Population: Findings from the ANIBES Study. Nutrients. 2018; 10. https://doi.org/10.3390/nu10040392 PMID: 29565820

62. Hupkens CL, Knibbe RA, Drop MJ. Social class differences in food consumption. Eur J Public Health. 2000; 10: 108–113.

63. Galobardes B, Morabia A, Bernstein MS. Diet and socioeconomic position: does the use of different indicators matter? Int J Epidemiol. 2001; 30: 334–340. https://doi.org/10.1093/ije/30.2.334 PMID: 11369739

64. Michels N, Vynckier L, Moreno LA, Beghin L, de la O A, Forsner M, et al. Mediation of psychosocial determinants in the relation between socio-economic status and adolescents' diet quality. Eur J Nutr. Springer Berlin Heidelberg; 2017; https://doi.org/10.1007/s00394-017-1380-8 PMID: 28160091
65. Pérez-Gallardo L, Mingo Gómez T, Bayona Marzo I, Ferrer Pascual MÁ, Márquez Calle E, Ramírez Domínguez R, et al. Calidad de la dieta en estudiantes universitarios con distinto perfil académico. Nutr Hosp. 2015; 31: 2230–2239. https://doi.org/10.3305/nh.2015.31.5.8614 PMID: 25929398

66. Rizo-Baeza M, González-Brauer N, Cortés E. Calidad de la dieta y estilos de vida en estudiantes de Ciencias de la Salud. Nutr Hosp. 2014; 29: 153–7. https://doi.org/10.3305/nh.2014.29.1.6761 PMID: 24483974

67. De Irala-Estévez J, Groth M, Johansson L, Oltersdorff U, Prättälä R, Martínez-González M. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. Eur J Clin Nutr. 2000; 54: 706–714. https://doi.org/10.1038/sj.ejcn.1601080 PMID: 11002383

68. Sofi F, Dinu M, Pagliai G, Marcucci R. Validation of a literature-based adherence score to Mediterranean diet: the MEDIT-LITE score. Int J Food Sci Nutr. 2017; 68: 757–762. https://doi.org/10.1080/09637486.2017.1287884 PMID: 28276908

69. Freedman LS, Schatzkin A, Midhune D, Kipnis V. Dealing with dietary measurement error in nutritional cohort studies. J Natl Cancer Inst. 2011; 103: 1086–1092. https://doi.org/10.1093/jnci/djr189 PMID: 21653922

70. Willett W. Nutritional epidemiology. Oxford: Oxford University Press; 1998. https://doi.org/10.1093/academic/9780195122978.001.0001

71. Rhee JJ, Sampson L, Cho E, Hughes MD, Hu FB, Willett WC. Comparison of methods to account for implausible reporting of energy intake in epidemiologic studies. Am J Epidemiol. 2015; 181: 225–233. https://doi.org/10.1093/aje/kwu308 PMID: 25665533