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A brief assessment of eating habits and weight gain in a Mediterranean cohort

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Abstract

Assessment of eating habits (EH) through closed questions could be an alternative tool to assess diet as a predictor of weight change in epidemiological studies. The aim was to assess the association between baseline EH and the risk of weight gain or becoming overweight/obese in a Spanish dynamic prospective cohort (the Seguimiento Universidad de Navarra Project) of 10 509 participants. The baseline questionnaire included ten short questions with two possible answers: yes or no. We calculated a baseline EH score, categorised in quartiles, positively weighting answers on more fruit, vegetables, fish and fibre and less meat, sweets and pastries, fat, butter, fatty meats and added sugar in drinks. Reducing the consumption of meat or fat and removing fat from meat were significantly associated with lower weight gain. The partial correlation coefficient between EH score and weight change was −0·033 (P=0·001). We observed 1063 cases of incident overweight/obesity among 7217 participants without overweight/obesity at baseline. Trying to eat more fruit, fish or fibre and less meat was inversely significantly associated with incident overweight/obesity. Those participants in the upper quartile of the score were at a 38 % (adjusted OR 0·62; 95 % CI 0·48, 0·81) lower risk of developing overweight/obesity during the follow-up compared with those in the lower quartile. However, the receiver-operating characteristic curves for the model with and without the EH score were materially identical. Despite the apparent significant inverse association, this score had a low predictive value for future weight gain and for incident overweight/obesity in a Mediterranean population, although some EH were independently and positively associated with weight gain.

Key words: **Obesity: Cohort studies: Prospective studies: FFQ**

Obesity constitutes the most common metabolic disease in developed countries, and it is associated with numerous adverse health problems, including, but not limited to, CVD, hypertension, diabetes and cancer[1,2].

The rising prevalence of obesity in both developed and developing countries in the last two decades suggests that the present efforts to control weight have been inadequate[2,3]. In this regard, excess body fat has reached epidemic proportions and should be recognised as an important health crisis, and not simply a matter of cosmetics or lifestyle choice[4].

Determinants of weight gain are clearly multifactorial and involve genetic components, but the most important modifiable factors are the diet and a sedentary lifestyle[1]. Thus, although previous studies have shown that weight changes depend on energy balance and on the composition of the diet[5,6], others have suggested that several characteristics of diet-related habits or attitudes (for example, fewer healthy food choices, a lower fibre density and a higher percentage of energy from fat) may also be responsible for the considerable increase in the prevalence of obesity[6–9]. Besides, a better understanding of these

Abbreviations: EH, eating habits; EPIC, European Prospective Investigation into Cancer and Nutrition; MET, metabolic equivalent; SUN, Seguimiento Universidad de Navarra.

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factors is essential to design more appropriate health policies.

In the past 20 years, most of the epidemiologists who have investigated the relationships between diet and chronic disease have used long FFQ to evaluate dietary patterns in large studies[10]. However, the validity of dietary information obtained from this and other methods has been questioned, being also sometimes too complicated and time consuming for use in the field of intervention studies, routine clinical or community health education[11–13]. One of the main challenges of nutritional epidemiology has always been to assess correctly the diet of individuals, taking into account the possible inherent presence of information bias. One of the alternatives proposed is the possible assessment of dietary habits through closed questions, in addition to the assessment of nutrient intake. Also, this procedure allows giving simple and clear messages as fast feedback to participants in intervention studies[14].

Furthermore, a better understanding of eating behaviours could be essential to innovate more appropriate health policies to combat the growing obesity epidemic[15,16]. Although previous studies based on FFQ have consistently shown an association between some food patterns or specific dietary habits and the risk of obesity[17–19], to the best of our knowledge, no previous studies have focused on the effect of dietary habits on weight gain among a large cohort in a Mediterranean region. Thus, the purpose of the present study was to examine the association between several baseline eating behaviours and the risk of weight gain (or becoming overweight/obese) in a large prospective cohort of university graduates in Spain.

Subjects and methods

Study population

The 'Seguimiento Universidad de Navarra' (SUN) Project is a multipurpose, dynamic cohort study designed to establish the association between diet and several chronic diseases and health conditions such as overweight, obesity and weight change along time[20]. The SUN cohort was designed in collaboration with the Harvard School of Public Health and it uses a similar methodology to large American cohorts such as the Nurses' Health Study and the Health Professionals Follow-up Study.

Briefly, the recruitment of participants started in December 1999 and it is permanently open. Information is collected using self-administered questionnaires sent by postal mail every 2 years. The details on the cohort design, recruitment strategy and follow-up methods are available elsewhere[21].

For this analysis, we included participants who had already been followed up for at least 2 years. Participants who completed a baseline assessment (Q_0) before February 2006 were eligible for longitudinal analyses (*n* 15 982). Among them, 1885 had not answered any of the follow-up questionnaires, and after five more mailings with a gap of 2 months each, they were considered lost to follow-up. We therefore retained 14 097 participants (88 %). The data from 10 509 participants remained available for the analysis, because we excluded those participants who were following a special diet at baseline (*n* 922), subjects who reported extremely low or high values for total energy intake (< 3347·2 kJ/d (< 800 kcal/d) or > 17 572·8 kJ/d (> 4200 kcal/d) for men and < 2092 kJ/d (< 500 kcal/d) or > 14 644 kJ/d (> 3500 kcal/d) for women) (*n* 1380), pregnant women at baseline and during the follow-up (*n* 1272) and participants with missing values in the variables of interest (*n* 14), but not in dietary habits. Finally, those participants with missing data in dietary behaviours were considered as negative respondents for healthy dietary habits.

The project protocol was approved by the Institutional Review Board at the University of Navarra, Pamplona, Spain. Voluntary completion of the first self-administered questionnaire was considered to imply informed consent.

Assessment of dietary exposure

Dietary exposures were assessed through a baseline semi-quantitative FFQ (136 items), previously validated in Spain[22], inquiring about food consumption during the previous year.

This questionnaire was based on typical portion sizes and had nine categories for frequency of consumption that ranged from 'never or almost never' to '≥ 6 times/d'. Energy and nutrient intake were derived by trained dietitians using a computer program based on latest available information in Spanish food composition tables[23,24].

Food and nutrient intakes were adjusted for total energy intake using the residuals method[25].

Additionally, the baseline FFQ included information about changes in the general dietary habits through the following questions: 'do you try to eat more fibre?', 'do you try to eat more fruit?', 'do you try to eat more vegetables?', 'do you try to eat more fish?', 'do you try to eat less fat?', 'do you try to eat less meat?', 'do you try to eat less sweets and pastries?', 'do you avoid the consumption of butter?', 'do you try to eat less fat from meat?' and 'do you add sugar to drinks?', all of them with two possible answers: yes or no. We calculated a baseline score of dietary behaviours assigning one point each if the behaviour was healthy: that is, defined as healthy, if the participant tried to eat more fibre, more fruit, more vegetables, more fish, less meat, less sweets and pastries, if he/she tried to avoid the intake of fat, the consumption of butter, removed fat from meat and if he/she did not add sugar to drinks. We summed up the ten values for each participant obtaining a score ranging from 0 to 10. A negative answer was considered when a participant had a missing value in those questions (range for missing values 1·1–6·8 %). Finally, this score was categorised roughly into quartiles.

Assessment of other variables

The baseline questionnaire included questions about a wide array of characteristics: socio-demographic (sex, age, marital status, college degree or employment), anthropometric (weight, height, body image or weight change), lifestyle and health-related habits (smoking status, physical activity or consumption of alcoholic beverages, time spent sitting and television viewing), family history of several diseases, obstetric history for women (pregnancy) and medical history variables (prevalence of chronic diseases, medication use and lipids or blood pressure levels).

Physical activity was collected at baseline through a questionnaire which included information about seventeen activities. To quantify the volume of activity during leisure time, an activity metabolic equivalent (MET) index was computed by assigning a multiple of RMR (MET score) to each activity[26]. The time spent in each of the activities was multiplied by the MET score specific to each activity and then summed for the overall activities, obtaining a value of overall weekly MET hours. The validity of data on self-reported leisure-time physical activity in the SUN cohort has been previously reported[27].

Assessment of the outcome

Information on weight was collected at baseline and at each follow-up questionnaire. BMI was calculated as weight (kg) divided by height (m^2). The validity of self-reported weight was assessed in a subsample of the cohort. The mean relative error in the self-reported weight was 1·45 %. The correlation coefficient between the measured and self-reported weight was 0·99 (95 % CI 0·98, 0·99)[28].

The outcomes after the follow-up were: (1) change per year in body weight during the follow-up as a continuous variable, calculated as the difference between the last answered questionnaire and the baseline questionnaire divided by the years of the follow-up; (2) incident overweight/obesity (participants with a BMI $<24{\cdot}9\,kg/m^2$ at baseline and with a BMI $\geq 25\,kg/m^2$ at follow-up). We repeated the analyses after excluding those participants who had missing values in dietary habits and also after excluding those who had prevalent CVD, diabetes or cancer at baseline.

Statistical analysis

Linear regression models were used to assess the association between each dietary habit and change per year in body weight during the follow-up period and also between the baseline eating behaviours score and weight change.

Unconditional logistic regression models were fit to assess the relationship between each eating behaviour or the overall baseline score (categorised in quartiles) and the risk of becoming overweight/obese (BMI $\geq 25\,kg/m^2$).

The area under the receiver-operating characteristic curve was used to assess the ability of the eating habit (EH) score to predict future weight changes.

For each exposure, we fitted four types of models: (1) a crude (univariate) model; (2) an age- and sex-adjusted model; (3) a multivariate-adjusted model controlling for age, sex and lifestyle; (4) a multivariate-adjusted model, adjusting also for total energy intake (kJ/d), in addition to all the variables presented earlier.

The lifestyle variables that we adjusted for were: baseline BMI (kg/m^2, continuous), smoking status (never smoker, ex-smoker and present smoker), physical activity during leisure time (MET-h/week, continuous), time spent sitting (h/week, continuous), television viewing (h/week, continuous) and weight gain ≥ 3 kg in the past 5 years (yes/no).

We considered the lowest quartile of the overall baseline score or the negative answers to each dietary habit change as the reference category.

The association between the baseline EH score and weight gain was analysed using a partial correlation coefficient, and controlling for age, sex and television viewing. Finally, we used the Hosmer–Lemeshow test cross-classification in deciles to assess the proportion of participants correctly classified by the logistic model as future cases of overweight/obesity or not. In one model, we introduced only the baseline BMI as the predictor, and in the other, we added the baseline EH score.

Analyses were performed with SPSS version 15.0 (SPSS, Inc., Chicago, IL, USA). All the *P* values are two tailed and $P<0{\cdot}05$ was considered statistically significant.

Results

The median follow-up of participants was 4·5 years. Baseline characteristics of the study population according to the categories of the quartiles of the overall score of eating behaviours are shown in Table 1. Women were more likely than men to be in the upper quartile. Participants with better dietary habits were also older, more active during leisure time and less likely to be present smokers or ex-smokers. Energy, total fat, PUFA and alcohol intakes were inversely associated with the baseline score. However, carbohydrate, protein and fibre intakes increased in parallel with the ten-unit dietary habit score. Moreover, participants belonging to the highest quartile were more likely to exhibit healthier dietary habits in almost every evaluated aspect.

Table 2 shows the results of the linear regression models fitted to evaluate the association between baseline eating behaviours and weight gain during the follow-up. We found that although, on average, participants increased

Table 1. Main characteristics of the 10 509 participants of the Seguimiento Universidad de Navarra cohort based on scores evaluating baseline eating habits

(Mean values and standard deviations or percentages)

	Quartiles (Q) of baseline eating habits (score)							
	Q1 (≤4 points)		Q2 (5–6 points)		Q3 (7–8 points)		Q4 (≥9 points)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Sample size (*n*)	2113		2661		3402		2333	
Age (years)	35·3	10·4	37·4	11·6	40·0	12·2	42·5	12·7
Baseline BMI (kg/m^2)	23·7	3·5	23·6	3·5	23·8	3·4	23·6	3·3
Baseline BMI >24·9 (%)	33·5		31·9		33·2		31·6	
Baseline wt (kg)	70·5	14·1	68·2	13·6	67·8	13·3	66·3	12·6
Physical activity during leisure time (MET-h/week)	22·7	20·7	23·4	20·5	24·0	21·3	27·2	24·4
Sex (%)								
Men	62·3		48·0		42·9		35·9	
Smoking status (%)								
Ex-smoker	22·1		26·2		32·4		35·5	
Present smoker	30·0		23·7		21·4		16·8	
Non-smokers	44·5		46·9		43·6		45·0	
Fruit consumption (g/d)	208·1	179·6	276·8	224·1	355·9	291·5	470·3	342·9
Vegetable consumption (g/d)	374·2	281·0	455·0	278·9	528·4	309·2	615·5	362·0
Fish consumption (g/d)	75·6	47·6	87·4	50·1	100·8	61·6	120·8	68·8
Meat consumption (g/d)	199·5	81·4	187·2	74·4	170·3	74·0	150·1	70·9
Nuts (g/d)	5·8	8·3	6·6	9·6	6·9	11·2	8·8	14·9
Legumes (g/d)	22·3	20·0	22·4	15·2	23·0	17·0	23·6	17·3
Dairy products (g/d)	281·0	228·0	241·2	213·3	196·6	194·8	157·0	174·0
Cereals (g/d)	109·8	79·8	105·2	75·3	104·4	75·9	100·3	71·2
Mediterranean diet score*	3·2	1·6	3·9	1·7	4·5	1·7	5·2	1·7
Energy intake (kJ/d)	10 413·976	2727·968	10 213·144	2556·424	9769·64	2539·688	9602·28	2514·584
CHO intake (% energy)	44·5	17·5	45·1	15·8	48·5	17·4	50·6	17·3
Protein intake (% energy)	17·1	3·1	17·5	2·9	18·2	3·2	18·7	3·5
Fat intake (% energy)	40·3	15·2	39·5	13·8	39·8	14·9	36·7	15·3
PUFA intake (% energy)	5·9	2·6	5·7	2·4	5·7	2·5	5·7	2·6
MUFA:SFA ratio	1·2	0·3	1·2	0·3	1·5	8·0	1·4	1·3
Fibre intake (g/d)	20·6	7·9	24·1	8·5	28·3	9·3	33·1	11·2
Alcohol intake (g/d)	7·9	11·7	7·4	11·1	7·1	10·8	6·6	9·7
Do you try to eat more fruit? (% yes)	26·7		57·9		77·1		95·9	
Do you try to eat more vegetable? (% yes)	38·2		73·2		91·6		99·2	
Do you try to eat more fish? (% yes)	20·5		44·9		68·0		92·9	
Do you avoid the consumption of butter? (% yes)	28·0		61·0		82·9		96·2	
Do you try to eat less meat? (% yes)	4·9		15·7		35·6		76·9	
Do you try to remove fat from meat? (% yes)	56·9		75·7		87·1		97·4	
Do you try to eat less sweets and pastries? (% yes)	21·2		49·6		71·0		93·4	
Do you try to eat more fibre? (% yes)	13·9		39·6		68·7		93·7	
Do you try to eat less fat? (% yes)	28·7		72·2		93·3		99·7	
Do you add sugar to some beverages? (% yes)	44·4		34·4		25·1		10·5	

MET-h, metabolic equivalent-hours; CHO, carbohydrate.
* Trichopoulou *et al.* [51].

their weight at follow-up, subjects with the worst dietary habits (quartile 1 of the score) showed a weight gain $= +0{\cdot}33$ kg/year, whereas subjects with the better eating behaviours (quartile 4) experienced a significantly lower weight gain $= +0{\cdot}16$ kg/year. These results remained also statistically significant in all multivariable models. Moreover, an increase of two points in the baseline eating score was significantly associated with less weight gain ($\beta = -0{\cdot}03$, 95 % CI $-0{\cdot}05$, $-0{\cdot}01$) in the multivariate model (Table 2). The partial correlation coefficient after controlling for age, sex and television viewing showed a significant inverse association between the EH score and weight change (P=0·001); however, the absolute magnitude of the coefficient was small (partial r $-0{\cdot}033$).

When we specifically assessed the association with weight change for each of the ten components of the eating behaviour score (Table 3), we found an inverse association with a positive answer to the questions ‘do you try to eat less meat?’ ($\beta = -0{\cdot}07$, 95 % CI $-0{\cdot}11$, $-0{\cdot}02$), ‘do you try to remove fat from meat?’ ($\beta = -0{\cdot}06$, 95 % CI $-0{\cdot}11$, $-0{\cdot}01$) and ‘do you try to eat less fat?’ ($\beta = -0{\cdot}06$, 95 % CI $-0{\cdot}11$, $-0{\cdot}02$) after adjusting for age, sex, lifestyle and total energy intake (Table 3).

Moreover, positive answers to 'do you try to eat more fruit?', 'do you try to eat more vegetables?', 'do you try to eat more fish?', 'do you try to avoid the consumption of butter?' and 'do you try to eat less sweets and pastries?' were not statistically significant after multivariate adjustment, although the point estimates suggested a beneficial effect.

We did not observe any significant interaction between eating behaviour score and sex, age and physical activity.

We included 7217 subjects without prevalent overweight or obesity at baseline to assess the association between baseline dietary habits and the risk of incidence overweight/obesity (Table 4). During the follow-up, we observed 1063 incident cases of overweight/obesity.

When we assessed the association between quartiles of the overall score and the risk of becoming overweight/obese, we observed that participants in the two upper quartiles of the dietary habit score exhibited a significantly lower risk during the follow-up than did participants in the quartile with the worst practices (OR 0·77; 95 % CI 0·62, 0·97 and OR 0·62; 95 % CI 0·48, 0·81 for quartiles 3 and 4, respectively) (Table 4). In addition, an increase of two points in the score reduced the risk of becoming overweight/obese by 12 % (OR 0·88; 95 % CI 0·81, 0·94) after adjusting for age, sex and other potential confounding variables.

Moreover, the most consistent predictors of a lower risk for the development of overweight/obesity were more fruit, more fish, less meat and more fibre intake. No significant association was observed for any of the other six eating behaviours (Table 5).

However, the proportions of correctly classified cases by the models with or without the EH score were very similar (99·29 and 99·37 %, respectively).

When we repeated the analyses after excluding the subjects with missing values in variables of eating behaviours in the baseline questionnaire (n 1244) as a sensitivity analysis, the results were almost the same (data not shown). Finally, when we excluded from the analysis those with a diagnosis of diabetes, hypertension, cancer or CVD during the follow-up period (n 1835) from the analysis, the results in the multivariate models were very similar and they were in the same direction with respect to the following items: 'try to eat less fat' ($\beta = -0·09$, 95 % CI $-0·14$, $-0·04$); 'try to eat less butter' ($\beta = -0·06$, 95 % CI $-0·10$, $-0·01$); 'try to eat less meat' ($\beta = -0·09$, 95 % CI $-0·13$, $-0·04$), in the multivariate models.

The areas under the receiver-operating characteristic curves were also estimated for the models with and without the EH score. They were very similar, showing areas under the curve of 0·8810 and 0·8798, respectively.

Discussion

To our knowledge, this is the first prospective cohort study that has investigated the association between several EH and weight change in a Mediterranean population.

Table 2. Mean weight change (kg) based on quartiles of scores evaluating baseline eating habits and based on an increase of two points in the score

(Mean values, linear regression coefficients (β) and 95 % confidence intervals)

Quartiles (Q) of ten-unit eating habit score	Wt change (kg/year) Mean	Crude β	Crude 95 % CI	Adjusted for age and sex β	Adjusted for age and sex 95 % CI	Adjusted for age, sex and lifestyle† β	Adjusted for age, sex and lifestyle† 95 % CI	Adjusted for age, sex, lifestyle† and total energy intake β	Adjusted for age, sex, lifestyle† and total energy intake 95 % CI
Q1 (≤4 points)	+0·33	0 (ref)		0 (ref)		0 (ref)		0 (ref)	
Q2 (5–6 points)	+0·23	−0·10*	−0·16, −0·04	−0·08*	−0·14, −0·02	−0·07**	−0·13, −0·10	−0·07**	−0·13, −0·01
Q3 (7–8 points)	+0·18	−0·15*	−0·21, −0·10	−0·11*	−0·17, −0·05	−0·10*	−0·15, −0·04	−0·10*	−0·16, −0·04
Q4 (≥9 points)	+0·16	−0·16*	−0·23, −0·10	−0·11*	−0·17, −0·04	−0·09*	−0·15, −0·03	−0·10*	−0·16, −0·03
Eating habit score (for an increase of two points in the score)	+0·22	−0·05*	−0·07, −0·03	−0·03*	−0·05, −0·01	−0·03*	−0·04, −0·01	−0·03*	−0·05, −0·01

ref, Reference.
* $P<0·001$, ** $P<0·05$.
† Lifestyle variables: baseline BMI, smoking status (never smoker, ex-smoker or present smoker), leisure-time physical activity (metabolic equivalent-h/week), sitting (h/week), television viewing (h/week) and weight gain ≥3 kg in the past 5 years (yes or no).

Table 3. Factors associated with weight change (kg/year) in the Seguimiento Universidad de Navarra cohort (*n* 10 509)†

(Mean values, linear regression coefficients (β) and 95 % confidence intervals)

	Wt change (kg/year)	Crude		Adjusted for age and sex		Adjusted for age, sex and lifestyle‡		Adjusted for age, sex, lifestyle‡ and total energy intake	
	Mean	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI
Do you try to eat more fruit?									
Yes (*n* 6964)	+0·19	−0·06*	−0·11, −0·02	−0·03	−0·07, 0·01	−0·03	−0·07, 0·02	−0·03	−0·07, 0·02
Do you try to eat more vegetables?									
Yes (*n* 8187)	+0·21	−0·05**	−0·10, −0·001	−0·02	−0·07, 0·03	−0·03	−0·08, 0·02	−0·03	−0·08, 0·02
Do you try to eat more fish?									
Yes (*n* 6107)	+0·20	−0·05**	−0·09, −0·01	−0·03	−0·07, 0·01	−0·02	−0·06, 0·02	−0·02	−0·06, 0·02
Do you avoid the consumption of butter?									
Yes (*n* 7279)	+0·19	−0·10*	−0·14, −0·06	−0·06*	−0·12, −0·02	−0·04	−0·08, 0·01	−0·04	−0·08, 0·01
Do you try to eat less meat?									
Yes (*n* 3528)	+0·15	−0·09*	−0·13, −0·05	−0·06*	−0·10, −0·01	−0·06*	−0·11, −0·02	−0·07*	−0·11, −0·02
Do you try to remove fat from meat?									
Yes (*n* 8455)	+0·21	−0·05**	−0·01, −0·10	−0·04	−0·10, 0·01	−0·06**	−0·11, −0·01	−0·06**	−0·11, −0·01
Do you try to eat less sweets and pastries?									
Yes (*n* 6364)	+0·19	−0·06*	−0·10, −0·02	−0·04**	−0·08, −0·001	−0·02	−0·06, 0·02	−0·02	−0·06, 0·02
Do you try to eat more fibre?									
Yes (*n* 5870)	+0·20	−0·03	−0·07, 0·01	−0·01	−0·05, 0·03	−0·01	−0·05, −0·04	−0·01	−0·05, 0·04
Do you try to eat less fat?									
Yes (*n* 8027)	+0·20	−0·10*	−0·15, −0·06	−0·07*	−0·12, −0·02	−0·06**	−0·11, −0·01	−0·06**	−0·11, − 0·02
Do you add sugar to some beverages?									
Yes (*n* 2955)	+0·24	0·03	−0·02, 0·07	0·01	−0·03, 0·06	0·002	−0·04, 0·04	0·001	−0·04, 0·05

* $P<0·001$, ** $P<0·05$.

† The answer 'no' is given as the reference (zero values).

‡ Lifestyle variables: baseline BMI, smoking status (never smoker, ex-smoker or present smoker), leisure-time physical activity (metabolic equivalent-h/week), sitting (h/week), television viewing (h/week) and weight gain ≥3 kg in the past 5 years (yes or no)

Table 4. Incident overweight/obesity in participants without overweight/obese at baseline based on quartiles of scores evaluating baseline eating habits and based on an increase of two points in the score

(Odds ratios and 95 % confidence intervals)

	Subjects (*n*)	Incident cases of overweight/obesity (*n*)	Crude		Adjusted for age and sex		Adjusted for age, sex and lifestyle†		Adjusted for age, sex, lifestyle† and total energy intake	
			OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Quartiles (Q) of the ten-unit eating habit score										
Q1 (≤4 points)	1430	250	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Q2 (5–6 points)	1841	285	0·87	0·72, 1·04	1·02	0·84, 1·23	0·89	0·71, 1·11	0·89	0·71, 1·12
Q3 (7–8 points)	2330	336	0·80*	0·67, 0·96	0·99	0·81, 1·19	0·77*	0·62, 0·96	0·77*	0·62, 0·97
Q4 (≥9 points)	1626	192	0·63**	0·52, 0·77	0·81	0·65, 1·00	0·62**	0·48, 0·81	0·62**	0·48, 0·81
Eating habit score (for an increase of two points in the score)	7217	1063	0·89**	0·84, 0·94	0·96	0·90, 1·02	0·87**	0·81, 0·94	0·88**	0·81, 0·94

ref, Reference.
*$P<0.05$, **$P<0.001$.
† Lifestyle variables: baseline BMI, smoking status (never smoker, ex-smoker or present smoker), leisure-time physical activity (metabolic equivalent-h/week), sitting (h/week), television viewing (h/week) and weight gain ≥3 kg in the past 5 years (yes or no).

The use of a few simple, short, closed-ended questions has a low value to predict future weight gain or the risk of overweight/obesity in a cohort of Spanish university graduates.

In the present population, overall nutrient intake profile was more favourable among participants with better baseline dietary habits (quartile 4 of the score) compared with those who had the worst dietary practices (quartile 1).

As expected, although the participants increased their average weight during the follow-up (0·22 kg/year), crude increments were lower among those with the best dietary practices according to the score.

Although the scientific literature about this topic is not abundant, previous studies have suggested that EH may be associated with body weight and weight changes. However, an important concern to compare our findings with other studies is that the majority of the available evidence comes from studies using a long FFQ, instead of a short questionnaire of food habits and practices.

The results from the present study suggest that specific dietary habits such as ‘trying to eat less meat’, ‘removing fat from meat’ and ‘eating less fat’ are associated with less weight gain after controlling for age, sex, lifestyle and total energy intake. The role of dietary intake, particularly dietary fat and some dietary patterns (low-carbohydrate, Mediterranean or low-fat diet), in weight gain remains highly controversial[18,29]. Thus, a recent randomised trial suggests that low-fat diets may contribute to weight maintenance, while high-fat diets may promote weight gain due to the fact that dietary fat is more energy-dense per g than protein or carbohydrate[30]. On the other hand, saturated fat and *trans*-fat are the two subtypes of dietary fat that have the strongest association with the risk of weight gain[31]. Besides, foods that are high in fat are usually more palatable. Therefore, people may consume them in larger quantities and thus increase their energy intake[32]. However, evidence from long-term randomised trials and epidemiological studies linking dietary fat intake to weight gain or obesity is weak and not consistent[30–32].

It is important to note that the Mediterranean dietary pattern is characterised by a high intake of monounsaturated fat obtained from olive oil. However, in some Mediterranean countries, traditional food choices are changing and the adherence rate to the Mediterranean diet has decreased[33]. Thus, in Spain, unfortunately, the consumption of fast food, rich in saturated fat, has increased in the last few years. A previous study of our cohort reported this change, but especially in younger men after 28 months of follow-up[17].

We might speculate that the dietary pattern of participants belonging to the upper quartile of the practice score resembles a prudent diet, characterised by high intakes of fruit, vegetables, whole grains, fish, but less meat, sweets and fat[34]. Relatively few studies have examined the associations between overall dietary patterns and

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Table 5. Incident overweight/obesity according to eating habits in the Seguimiento Universidad de Navarra cohort (*n* 7217) after excluding 3292 overweight/obese participants at baseline
(Odds ratios and 95 % confidence intervals)

	Incident cases of overweight/obesity (*n*)	Crude		Adjusted for age and sex		Adjusted for age, sex and lifestyle†		Adjusted for age, sex, lifestyle† and total energy intake	
		OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Do you try to eat more fruit?									
No (*n* 2398)	388	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 4819)	675	0·84*	0·74, 0·97	0·84*	0·73, 0·97	0·74**	0·62, 0·87	0·73**	0·62, 0·87
Do you try to eat more vegetable?									
No (*n* 1509)	265	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 5708)	798	0·76**	0·66, 0·89	0·87	0·74, 1·02	0·84	0·70, 1·01	0·84	0·69, 1·01
Do you try to eat more fish?									
No (*n* 3083)	488	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 4134)	575	0·86*	0·75, 0·98	0·86*	0·75, 0·99	0·83*	0·71, 0·97	0·83*	0·71, 0·97
Do you avoid the consumption of butter?									
No (*n* 2384)	347	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 4833)	716	1·02	0·89, 1·17	1·11	0·96, 1·29	0·88	0·74, 1·04	0·88	0·74, 1·05
Do you try to eat less meat?									
No (*n* 4719)	741	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 2498)	322	0·79*	0·69, 0·92	0·84*	0·72, 0·97	0·76**	0·64, 0·90	0·76**	0·64, 0·90
Do you try to remove fat from meat?									
No (*n* 1217)	258	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 6000)	805	0·58**	0·49, 0·67	0·73**	0·62, 0·87	0·84	0·69, 1·01	0·84	0·69, 1·01
Do you try to eat less sweets and pastries?									
No (*n* 2959)	414	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 4258)	649	1·11	0·97, 1·26	1·34**	1·17, 1·54	1·02	0·87, 1·21	1·03	0·88, 1·22
Do you try to eat more fibre?									
No (*n* 3099)	516	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 4118)	547	0·77**	0·67, 0·87	0·85*	0·74, 0·98	0·81**	0·69, 0·95	0·81**	0·69, 0·95
Do you try to eat less fat?									
No (*n* 1692)	259	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 5525)	804	0·94	0·81, 1·10	1·16	0·99, 1·36	0·99	0·82, 1·19	0·99	0·82, 1·20
Do you add sugar to some beverages?									
No (*n* 5157)	747	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Yes (*n* 2060)	316	1·07	0·93, 1·23	0·96	0·83, 1·11	1·02	0·86, 1·20	1·01	0·85, 1·20

ref, Reference.
* $P<0·05$, ** $P<0·001$.
† Lifestyle variables: baseline BMI, smoking status (never smoker, ex-smoker or present smoker), leisure-time physical activity (metabolic equivalent-h/week), sitting (h/week), television viewing (h/week) and weight gain ≥3 kg in the past 5 years (yes or no).

prospective weight change. However, the results from the Nurses' Health Study II suggest that a prudent dietary pattern may facilitate weight maintenance, whereas a Western pattern characterised by high intakes of red and processed meats, refined grains, sweets, desserts and potatoes was associated with larger weight gain in women[18]. Moreover, in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam cohort, Schulz *et al.*[35] identified a food pattern characterised by high-fibre and low-fat food choices. The main result was that subjects scoring high for this pattern maintained their weight or gained significantly less weight over time compared with subjects with an opposite pattern. In this context, in the present study, participants who had a higher score (≥ 9) in the eating behaviours were 38 % less likely to become overweight or obese in comparison with those who had a lower score (≤ 4). We considered the possibility that this inverse association may be simply a marker of an overall healthier lifestyle. However, when we simultaneously adjusted for age, sex, a wide array of lifestyle variables and total energy intake, the results were similar to the unadjusted estimates.

We also observed that 'to eat less meat' was associated with lower gains in body weight over time. This finding is consistent with previous studies[36–40] and with a previous assessment from the SUN cohort[17]. It should be highlighted that this healthy behaviour presented a consistent inverse association with weight gain and with the risk of presenting overweight/obesity. Higher intakes of meat were also predictive of weight gain over a 2-year follow-up period among men and women in the EPIC study[36]. In addition, in the EPIC-Spain cohort, meat consumption in women was significantly associated with the incidence of obesity[37]. Moreover, a larger weight gain was significantly predicted by meat consumption in the Cancer Prevention Study[38] of 79 000 men and women recruited in 1982. Another study suggested that consumption of more red meat may be a factor contributing to body weight gain in China[39]. Finally, recent research has suggested that meat consumption was especially associated with weight change and that a decrease in meat consumption was able to improve weight management[40].

However, in our cohort, participants who 'tried to eat more fibre' had an 18 % lower risk of developing overweight/obesity than those who did not try to consume more fibre. This finding was broadly in agreement with those observed in other studies[6,41–43] and in a previous cross-sectional assessment in the SUN project[44]. Thus, whole-grain consumption has been associated with reduced risk of both weight gain and the development of obesity in large cohorts of both middle-aged women[41] and men[42]. Our group also found that food items with low fibre content[45], which are not typical of the Mediterranean diet[17], were associated with larger weight gains. Moreover, intervention studies have also reported smaller weight change with an increase in fibre intake in the context of *ad libitum* diets[46,47]. Dietary fibre has been shown to increase insulin sensitivity, decrease hunger and subsequently decrease total energy intake and increase the sensation of satiety[17,45].

Another dietary behaviour that was inversely associated with the development of overweight/obesity was 'try to eat more fish'. Unfortunately, there is a scarcity of research on the relationship between fish consumption and the risk of obesity. This finding can be partially confirmed by the results from the Nurses' Health Study[48], but not by the data from the EPIC-Potsdam cohort or the EPIC-Spain cohort, although some estimates were also below the null value[36,37], and there were methodological differences between the present study and the other cohorts.

On the contrary, 'trying to eat less fat' was not associated with a lower risk of overweight/obesity. Perhaps the lack of association might be due to the fact that this question does not specify what type of fat the participants try to reduce. For example, in our context of a Mediterranean dietary pattern, it is possible that the participants try to decrease dietary fat intake from meats, pastries or dairy food, but not of healthy fat, such as olive oil.

Finally, the present results indicate that adding sugar to beverages was not associated either with a higher risk of developing overweight/obesity or with higher weight gain. A possible explanation is that our question was likely to be interpreted by the participants as referring to the practice of adding sugar (for example, one or two teaspoons) to beverages with low energy density (i.e. coffee or tea), but it was not perceived as the consumption of sugar-sweetened beverages *per se*. In addition, a prospective study of more than 58 000 women and men demonstrated that increases in caffeine intake may lead to a small reduction in long-term weight gain[49].

The strengths of the present study include the prospective design, which avoids the possible effect of reverse causality in the reported associations, the relatively large sample size, the long follow-up period, the control for an important number of potential confounders and the previous validation of the methods used for the assessment of our outcomes. This may clarify the complex and dynamic relationship between eating behaviours and weight change.

The present study has several methodological limitations. First, the questions on eating behaviours have not been specifically validated. However, the questions used are simple enough to expect not many problems with classification, because people should easily remember their food habits. Besides, the high level of education in our cohort (all participants were university graduates, with 48 % health professionals) increased the internal validity of the study and probably the quality of these self-reported data. When we supported the validity of our instrument with more data on food and nutrient intake from the validated FFQ, we observed that although the short tool captures only specific foods or nutrients of interest, it could also capture a larger pattern of dietary behaviour or nutrient intake. However, we have shown that each question assesses more specifically the participants' food consumption or nutrient intake directly related to it (data not shown). Nevertheless, we have to take into account the inherent methodological flaws of self-reported FFQ.

Second, a potential limitation of the present study is related to the use of self-reported weight gain. Thus, weight change might have been under-reported in our participants. However, the validity of a self-reported medical diagnosis of overweight/obesity among highly educated participants in our cohort and in other similar cohorts has been sufficiently demonstrated elsewhere[28,50].

Third, residual confounding may have affected the observed associations. However, we attempted to adjust for the known weight-gain risk factors in our multivariate analyses. We did not control for confounding due to socio-economic status or educational level because the relatively homogeneous study population (all of them were university graduates) with respect to these characteristics reduced the possibility that the present findings were seriously biased because of confounding by socio-economic status.

It could be speculated that both the answers to the ten short questions on habits/practices towards a healthy diet and the self-reporting of weight might be affected by the social desirability bias. Thus, the subjects more prone to this bias, wanting to be perceived as healthier from their responses to the questionnaire, might be classified both with a higher score and less likely to gain weight. Had this bias occurred, it would provide an alternative, non-causal explanation of the present findings. We were concerned about this potential bias and analysed in the weight validation study whether those with a higher score were more or less likely to under-report their weight. We found that those with a higher score were significantly less likely to under-report their actual weight (mean average error = 2·4 % among those scoring ≤5 *v.* mean average error = 0·6 % among those scoring ≥6, P=0·005). Therefore, this alternative non-causal explanation does not seem very likely for the present results.

In conclusion, the present study is important because it is the first in suggesting that a score built after a brief assessment of key EH is independently associated with weight gain and with the incidence of overweight/obesity in a free-living Mediterranean adult population. But, as all our participants were university graduates, and many of them (48 %) were health professionals, the present results may lack external validity for less-educated subjects. However, in a highly educated population, this abbreviated-form tool has the advantage of providing short, easily understandable messages to the population to avoid overweight and obesity. This simplified method could be useful as an additional tool to evaluate dietary habits. Nevertheless, the present results suggest that its value to predict, discriminate or classify future weight change is low.

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