Public Health Nutrition: 24(15), 4949–4964 doi:10.1017/S1368980020004942

Food consumption in Tunisian university students and its association with sociodemographic characteristics and lifestyle behaviours

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Submitted 24 May 2020: Final revision received 28 October 2020: Accepted 25 November 2020: First published online 15 December 2020

Abstract

Objective: This study aimed to characterise food consumption among students at the University of Carthage (Tunisia), assessing quality of diet and main dietary patterns, and their association with potential conditioning factors.

Design: Cross-sectional study. Participants self-reported food consumption in two 24-h recalls and information about sociodemographic, anthropometric and lifestyle characteristics such as BMI, birthplace, physical activity, eating places or kitchen appliances. Mediterranean Diet Score (MDS) and the Nutrient Rich Foods (NRF) index (NRF9.3) were used to assess diet quality. Exploratory factor analysis was conducted to identify eating patterns. Linear regression models were used to test the association of dietary patterns with the diet quality markers.

Setting: Students at the University of Carthage, Tunisia.

Participants: 132 students

Results: Almost 96 % of participants need shifts towards healthier food. Four main food patterns were identified 'Traditional food', 'Transitional food', 'European breakfast' and 'Western food'. 'Traditional food' was the first dietary model, positively associated with MDS and NRF9.3. Women showed higher adherence to 'European breakfast' and higher quality of diet by NRF9.3. Students eating out of home showed higher adherence to 'Western food', those who never kept a regular schedule of meals consumed lower amount of vegetables and tubers, and sedentary or low active students had a higher intake of ready-to-eat products.

Conclusions: Diet quality of the participating Tunisian students is inadequate, but traditional Mediterranean diet remains the main pattern in spite of the advanced transitional nutrition. Some lifestyle risk behaviours affecting quality of diet were identified in this work, which supports the youth's particular vulnerability.

Keywords
Dietary patterns
Quality of diet
University students
Lifestyle behaviours
Mediterranean diet
Transitional nutrition

Economic development involves significant differences in demographic structures, health and lifestyle behaviours, which have been linked to the spread of non-communicable diseases associated with globalisation[1]. Regardless of cultural and social features, this process mainly impacts on urban areas and is expanding rapidly, with the emergence of significant changes in eating habits, which are, generally, less healthy[2–5]. These changes, coupled with rapid economic growth, have long been identified as nutritional transition.

The identification of dietary patterns has been considered a suitable approach to characterise lifestyle risk behaviours in low-middle-income countries, where environmental factors are inherent to each country. Epidemiological studies have shown that economic and social inequalities and lifestyle risk behaviours in food patterns should be taken into account, in prevention and control to diseases linked to globalisation in developing countries, where people of high status or resident in urban areas typically follow healthier diets. However, there is a significant lack of research in developing

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or low-middle-income countries, even though they are home to the largest proportion of the world's population.

In addition, other features can have a substantial impact on food choices, which will ultimately affect nutritional transition. This is the case of young adults, who are highly sensitive to convenience and fashion food products[6,7]. The shift towards independence can influence food choice, especially if they have poor cooking skills[8] or eat outside home[9]. University students' ability to choose their own foods regardless of their parents' food choices is a significant issue. Furthermore, it is known that higher educational level and living in urban areas is associated with healthy food habits. A large body of research has been conducted on young people living in high-income countries, but the lack of studies conducted on young people living in low-middle-income countries has not been considered[10–12].

In the case of Tunisia, a Southern Mediterranean country classified as low-middle-income country, a nutritional transition has been identified over the years, which involves a shift away from the traditional healthy model[13]. This process impacts on the north of the country due to the accelerated urbanisation evolving from the capital[2,14]. This region is a social and economic hub attracting productive population, to which young people move in search of a better quality of life. In parallel, obesity and overweight are increasing and, consequently, the prevalence of chronic non-communicable diseases[15], but they paradoxically coexist with certain significant nutritional deficits, such as Fe and I[16].

A small number of previous studies carried out in Tunisia among adult populations highlighted the prevalence of obesity in women[17], cardiovascular risk in men[18], type 2 diabetes[19] and hypertension[20]. Little is known about nutritional transition in this country.

In all cases, as might be expected, the consequences of globalisation were associated with urban areas, economic level and household welfare. However, to the best of our knowledge, studies on risky lifestyle behaviours relating to food patterns among young people with a high educational level are practically non-existent in Tunisia, where only fibre pattern has been described[21]. Young people are the largest age group living in an environment such as Grand Tunis[22], playing a significant role in improving the future health status of the country. Moreover, young people with a high level of education could be considered a potential target group for training and promoting healthy food habits. Thereby is a need for further research about these food environments.

In this context, the present study aimed to characterise food consumption among students at the University of Carthage (Tunisia), assessing quality of diet and main dietary patterns and their association with sociodemographic characteristics and lifestyle risk behaviours.

Materials and methods

Design and study population

This research is part of a project designed to investigate food habits in university populations from different countries. The project includes students enrolled at the University of Castilla-La Mancha (campus of Albacete) Spain, the University of Carthage, Tunisia and Florida International University, Miami, USA. Previous research has been published[21,23–25]. All procedures were in accordance with the WMA Declaration of Helsinki. Informed consent was obtained from all participants.

In this work, we performed a cross-sectional study with data from a sample of 132 students enrolled at the Institut des Hautes Études Commerciales (IHEC), University of Carthage (UCA) in Tunisia, during 2013. Inclusion criteria were students enrolled at IHEC, aged between 17 and 30 years, enrolled across all degree courses, who voluntarily agreed to participate in the survey. Students were invited to participate personally in class and through their online spaces. We excluded subjects suffering from acute diseases affecting diet when the surveys were administered, and surveys with incomplete data. Following recommended limit criteria for intakes, we also excluded surveys from males whose daily energy intake was higher than 4000 kcal/d and lower than 800 kcal/d, and from females whose daily energy intake was higher than 3500 kcal/d and lower than 500 kcal/d[26].

General information was self-reported by each subject using a questionnaire devised for this purpose. Trained dietary nurses explained how to complete the questionnaire, administered them and checked the data recorded. The questionnaire included the following items: (1) demographic data: gender and age; (2) anthropometric measurements: weight and height; (3) smoking habits; (4) birthplace; (5) housing; (6) eating place; (7) regular meal times; (8) type of cuisine; (9) kitchen appliances: gas cooker, electric cooker, refrigerator, freezer, microwave and other kitchen devices; (10) weight-loss diet; (11) artificial sweetener consumption; (12) consumption of vitamin and mineral supplements, and (13) diseases. BMI and level of physical activity were also obtained. BMI (kg/m^2) was calculated from anthropometric data and individuals were classified into four categories: underweight (BMI < 18·5), normal range (18·5 ≤ BMI ≤ 24·9), overweight (25 ≤ BMI ≤ 29·9) and obese (BMI ≥ 30)[27]. Physical activity level (PAL) was calculated as the ratio of total to baseline daily energy expenditure and classified individuals as sedentary (1·0 ≤ PAL < 1·4), low active (1·4 ≤ PAL < 1·6), active (1·6 ≤ PAL < 1·9) and very active (1·9 ≤ PAL < 2·5)[28].

Food consumption assessment

Food consumption data were obtained by means of two non-consecutive 24-h recalls including one weekend

day. Recruited subjects recorded all food and beverages consumed during those days. As with the general information collection, the dietary nurses explained how to complete the questionnaires, administered them and checked the recording of information. To help estimate portion sizes, participants were shown images of household measures and were provided with a visual guide[29] according to local food and portions. The 24-h recalls also specifically asked about all the ingredients and meal preparation. Dial program 3.10.3 (Alceingenieria, Madrid, Spain) was used to determine energy and nutrients. Daily intake was obtained for each participant and Tunisian Food Composition Tables[30] were used to carry out the assessment.

Dietary pattern quality was evaluated using the following nutritional markers: (1) percentage of energies from macronutrients (proteins, carbohydrates, simple sugars, lipids, SFA, MUFA, PUFA and *trans*-fatty acids); (2) fibre, vitamin A, vitamin C, vitamin D, vitamin E, I, Ca, Fe, Na, K and Mg densities (expressed in g, mg or μg per 1000 kcal); (3) adherence to the traditional Mediterranean diet (MD) assessed by the Mediterranean Diet Score (MDS), mainly based on food groups[31]; (4) the nutrient density of the total diet assessed by the Nutrient Rich Foods (NRF) index (the NRF9.3 variant was used in this study)[32,33] and (5) consumption of highly processed food, which has also been considered for describing the quality of patterns[34,35].

Total food items from the 24-h recalls were grouped according to the nutritional value, intake habits of the Tunisian population, food processing, literature data and previous experience of the research team[21,24].

Statistical analysis

Exploratory factor analysis was conducted to identify eating patterns, using the correlation matrix applied to the food groups. These groups were expressed in grams per capita (average of the 2-day recorded consumptions). The Kaiser–Meyer–Olkin and Barlett's sphericity tests were used to assess data adequacy for factor analysis, considering values over 0·50 and $P < 0·05$ as acceptable, respectively[36,37]. In order to simplify the data structure and improve interpretability, orthogonal rotation (varimax) was applied. The latent root criterion with eigenvalues $> 1·0$ and the screen plot test were used to select the number of factors retained. Food groups with factor loadings greater than 0·40 or less than –0·40 were considered as being representative of each pattern[38].

Scores were obtained for each individual factor. These values are composite variables providing information about an individual's placement on the factor(s) and representing each individual's adherence to each pattern. These scores were used in the subsequent analyses. Linear regression models adjusted for energy intake and sociodemographic characteristics were conducted to test the association of each dietary pattern with the diet quality markers. The dietary markers were the dependent variables and the dietary patterns were the independent variables.

Means (95 % CI) and standard deviations were used as descriptive statistics for quantitative variables. Proportions were used to describe qualitative variables. Kolmogorov–Smirnov and Shapiro–Wilk tests were used to study the normality of the distributions. Student's t test (with previous Levene's test for equality of variances) and Mann–Whitney U test were used to compare two independent samples. ANOVA test and Kruskal–Wallis test were performed to compare more than two independent samples. χ^2 and likelihood ratio tests were used to compare proportions.

The level of significance was established at a P value $< 0·05$ for all analyses. Statistical analysis was performed with IBM SPSS 24 (SPSS Inc.).

Results

Sample characteristics

A total of 188 students filled out the surveys. None of the students suffered from acute diseases affecting diet when the surveys were administered, but 53 surveys did not provide all the required information. Furthermore, three individuals did not meet daily energy intake limits. Therefore, the final sample consisted of 132 students.

Mean age was 19·8 years, and gender distribution was 86 females and 46 males. The population was non-obese and mean BMI was 21·4 kg/m^2. Mean age and mean BMI were significantly higher in males. Of the population, 84·1 % had no disease. More than three-quarters of the students reported being non-smokers and only 6·8 % of the sample consumed alcohol. One-fifth of the students consumed vitamin and mineral supplements, being statistically significant higher in women. Regarding the level of physical activity, 72·0 % of the sample was found to be active or very active, which was significantly higher in men.

Our population, mainly born in the north (62·9 %) and centre (25·8 %) of the country and mainly living at family home (72·7 %), mostly reported keeping a regular schedule of meals. A large majority of our students (83·3 %) ate at the university and a quarter of them did not have a regular place to eat on weekdays. However, most of the students ate at their own home or the family home on weekends (81·8 %). Just over half of the sample ate food cooked at their parents' home and this percentage was significantly higher in males. The study of household equipment revealed that the most common kitchen appliances were gas cooker (78·0 %) and refrigerator (82·6 %) and the least common were electric cooker (33·3 %) and other kitchen devices such as toaster or electric mixer (57·6 %). Detailed information about anthropometric, sociodemographic and lifestyle characteristics of the sample are reported in Table 1.

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Table 1 Anthropometric, sociodemographic and lifestyle characteristics of the sample

	Total sample (*n* 132)	Men (*n* 46)	Women (*n* 86)	*P*
Anthropometric and sociodemographic characteristics				
Population, %	100	34·8	65·2	
Age (years)				0·001†,*
Mean	19·8	20·2	19·6	
SD	1·4	1·4	1·4	
95% CI	29·6, 20·1	19·8, 20·6	19·3, 19·9	
Age (years) (%)				0·448‡
≤ 21	91·7	89·1	93·0	
> 21	8·3	10·9	7·0	
BMI (kg/m^2)				0·001†,*
Mean	21·4	22·3	20·8	
SD	2·8	2·8	2·7	
95 % CI	20·9, 21·8	21·5, 23·2	20·2, 21·4	
Birthplace (%)				0·245§
North	62·9	69·6	59·3	
Centre-south	37·1	30·4	40·7	
Housing (%)				0·188‡
Family home	72·7	78·3	69·8	
University residence	12·1	8·7	14·0	
Shared flat	11·4	6·5	14·0	
Rented flat	3·0	6·5	1·2	
Other	0·8	0·0	1·2	
Kitchen appliances: gas cooker (%)				0·171§
No	22·0	15·2	25·6	
Yes	78·0	84·8	74·4	
Kitchen appliances: electric cooker (%)				0·014§
No	66·7	80·4	59·3	
Yes	33·3	19·6	40·7	
Kitchen appliances: refrigerator (%)				0·635§
No	17·4	19·6	16·3	
Yes	82·6	80·4	83·7	
Kitchen appliances: freezer (%)				0·402§
No	31·8	26·1	34·9	
Yes	68·2	73·9	65·1	
Kitchen appliances: microwave (%)				0·441§
No	28·0	23·9	30·2	
Yes	72·0	76·1	69·8	
Other kitchen devices (%)				0·575§
No	42·4	39·1	44·2	
Yes	57·6	60·9	55·8	
Lifestyle characteristics				
Smoking habits (%)				0·473§
0–5 cigarettes/d	85·6	82·6	87·2	
> 5 cigarettes/d	14·4	17·4	12·8	
Level of physical activity (%)				0·047§,*
Sedentary or low active	28·0	17·4	33·7	
Active or very active	72·0	82·6	66·3	
Weight-loss diets (%)				0·812§
No	87·9	87·0	88·4	
Yes	12·1	13·0	11·6	
Alcohol consumption (%)				0·538‡
No	93·2	91·3	94·2	
Yes	6·8	8·7	5·8	
Artificial sweetener consumption (%)				1·000‡
No	96·2	95·7	96·5	
Yes	3·8	4·3	3·5	
Consumption of vitamin and mineral supplements (%)				0·046§
No	79·5	89·1	74·4	
Yes	20·5	10·9	25·6	
Place to eat on weekdays (%)				0·870§
Own or family home	16·7	17·4	16·3	
Out of home	83·3	82·6	83·7	
Place to eat on weekends (%)				0·263§
Own or family home	81·8	87·0	79·1	
Outside home	18·2	13·0	20·9	
Regular meal times (%)				0·652§
No	5·3	6·5	4·7	
Yes	94·7	93·5	95·3	

Table 1 *Continued*

Type of cuisine (%)				0·029§,*
Cooked at parents' home	52·3	65·2	45·3	
Not cooked at parents' home	47·7	34·7	54·7	
Diseases				
Diseases (%)				0·874§
No	84·1	84·8	83·7	
Yes	15·9	15·3	16·4	
Diabetes mellitus (%)				0·458‡
No	96·2	97·8	95·3	
Yes	3·8	2·2	4·7	
Overweight/obesity (%)				0·073§
No	90·9	84·8	94·1	
Yes	9·1	15·2	5·9	

*Significant differences.
†Mann–Whitney U test.
‡Likelihood ratio test.
§χ^2 test.

Table 2 Daily macronutrient, micronutrient and energy intake

	Mean	SD	95 % CI	Mean	SD	95 % CI	Mean	SD	95 % CI
Energy (kcal/d)									
Mean				1843·4					
SD				563·1					
95 % CI				1746·4, 1940·3					
Macronutrients		g/d			g/1000 kcal/d			% kcal/d	
Proteins	63·7	25·3	59·4, 68·1	34·8	8·9	33·3, 36·3	13·9	3·5	13·3, 14·5
Carbohydrates	201·5	61·2	191·0, 212·1	110·7	17·6	107·7, 113·8	44·3	7·1	43·1, 45·5
Simple sugars	93·5	42·1	86·2, 100·7	50·5	16·3	47·7, 53·3	20·2	6·5	19·1, 21·3
Lipids	84·1	34·5	78·2, 90·0	44·9	7·3	43·6, 46·1	40·4	6·6	39·2, 41·5
SFA	29·3	12·4	27·1, 31·4	15·6	3·3	15·1, 16·2	14·1	2·9	13·6, 14·6
MUFA	34·5	15·6	31·8, 37·2	18·4	4·7	17·6, 19·2	16·6	4·2	15·9, 17·3
PUFA	13·0	9·9	11·3, 14·7	6·8	3·2	6·3, 7·4	6·1	2·9	5·7, 6·6
Trans-fatty acids	0·04	0·10	0·03, 0·06	0·02	0·05	0·01, 0·03	0·02	0·05	0·01, 0·03
Cholesterol†	332·1	182·6	300·7, 363·6	176·1	69·6	164·1, 188·1	–	–	–
Fibre	15·0	4·8	14·1, 15·8	8·4	2·2	8·0, 8·7	–	–	–
Alcohol	0·1	0·7	0·1, 0·2	0·07	0·41	0·00, 0·14	0·05	0·29	0·00, 0·10
Micronutrients		mg/d			mg/1000kcal/d				
Vitamin A‡	844·2	484·3	760·8, 927·6	462·6	236·2	422·0, 503·3	–	–	–
Vitamin C	91·0	60·4	80·6, 101·4	49·4	29·6	44·3, 54·5	–	–	–
Vitamin D‡	2·2	1·8	1·9, 2·5	1·1	0·8	1·0, 1·3	–	–	–
Vitamin E	8·0	5·0	7·2, 8·9	4·2	1·7	3·9, 4·5	–	–	–
Ca	674·8	265·9	629·0, 720·6	373·9	117·4	353·6, 394·1	–	–	–
Fe	10·1	4·8	9·3, 10·9	5·5	2·1	5·1, 5·9	–	–	–
Na	1988·0	737·0	1861·1, 2114·9	1090·0	289·9	1040·1, 1139·9	–	–	–
K	2048·4	758·2	1917·8, 2178·9	1124·6	278·1	1076·8, 1172·5	–	–	–
Mg	201·4	67·9	189·7, 213·0	110·2	19·2	106·9, 113·5	–	–	–
I‡	61·7	25·4	57·4, 66·1	33·7	9·1	32·1, 35·3	–	–	–

†mg/d.
‡μg/d.

Quality of diet

The study of diet quality was carried out at levels of nutrients, food groups and dietary patterns.

Nutrients and food groups

Each item of food consumed by the participants was recorded into 16 groups. Detailed information is shown in a supplementary file (see online supplementary material, Supplemental Table S1). Tables 2 and 3 report the contribution of nutrients and food groups, respectively, to total daily intake.

The sugars, pastries and chocolate group (22 %) together with the bread, pasta and flour group (15·6 %) accounted for the major energy supply in our population, followed by dairy products (10 %) and olive oil (9·3 %).

Regarding the main sources of free sugars in diet, the group of sugars, pastries and chocolate achieved the first position (38·6 g/person/d), followed by soft drinks-packaged juice (18·7 g/person/d), which surpassed in three grams of fruit and natural orange juice intake. Dairy products ranked fourth (10·3 g/person/d). On the other hand, the biggest sources of SFA were dairy products

Table 3 Contribution of food groups to daily total energy

	g/d			% kcal/d		
	Mean	SD	95 % CI	Mean	SD	95 % CI
Legumes	4·4	11·4	2·5, 6·4	0·8	2·1	0·5, 1·2
Nuts	2·1	9·8	0·4, 3·8	0·6	2·4	0·2, 1·0
Fish and shellfish	39·2	75·4	26·2, 52·2	2·2	3·9	1·5, 2·8
Spices	2·8	1·7	2·5, 3·1	0·2	0·2	0·2, 0·3
Beef meat	3·5	10·2	1·7, 5·2	0·4	1·3	0·2, 0·7
Soft drinks and packaged juice	182·7	179·5	151·8, 213·6	4·1	3·8	3·4, 4·7
Fruit and natural orange juice	157·7	159·2	130·3, 185·1	4·2	4·3	3·4, 4·9
Vegetables and tubers	106·5	77·8	93·1, 119·9	2·4	2·1	2·0, 2·7
Olives and olive oil	20·4	16·9	17·4, 23·3	9·3	6·7	8·2, 10·5
Sugars, pastries and chocolate	93·4	62·4	82·6, 104·1	22·0	13·6	19·7, 24·4
Dairy products	221·8	143·0	197·2, 246·5	10·0	5·8	9·0, 11·1
Eggs	23·9	28·9	18·9, 28·9	2·1	2·5	1·7, 2·6
Poultry	44·8	53·8	35·5, 54·1	2·9	4·0	2·2, 3·5
Lamb	16·9	48·64	8·5, 25·3	1·8	4·5	1·1, 2·6
Bread, pasta and flour	85·3	45·6	77·5, 93·1	15·6	8·8	14·0, 17·1
Ready-to-eat products	38·8	50·8	30·0, 47·5	7·8	7·2	6·5, 9·0

Table 4 Main sources of free sugar and SFA

Food groups	Sugar (g/person/d)	SFA (g/person/d)
Legumes	0·04	0·01
Nuts	0·05	0·11
Fish and shellfish	0·05	0·26
Spices	0·25	0·03
Beef meat	0·00	0·24
Soft drinks and packaged juice	18·77	0·00
Fruit and natural orange juice	15·71	0·05
Vegetables and tubers	2·71	2·18
Olives and olive oil	0·03	2·74
Sugars, pastries and chocolate	38·60	8·22
Dairy products	10·35	8·41
Eggs	0·16	0·80
Poultry	0·00	0·09
Lamb	0·00	1·17
Bread, pasta and flour	1·46	0·32
Ready-to-eat products	1·02	3·40

(8·4 g/person/d) and sugars, pastries and chocolate (8·2 g/person/d), which provided over half of total SFA (59·3 %). These results are shown in Table 4.

Dietary patterns

Both the Kaiser–Meyer–Olkin value (0·515) and Bartlett's test ($P < 0·001$) showed that the correlations between the variables were sufficiently strong to perform a factor analysis. Based on exploratory factor analysis, four dietary patterns were suggested (Table 5): 'Traditional food', 'Transitional food', 'European breakfast' and 'Western food'. These factors explained 43·2 % of the total variance. The first dietary model, which explained 14·3 % of the variance, was mainly associated with food groups that characterise MD, a widely recognised healthy eating pattern. This pattern showed significant contributions of legumes, spices, vegetables and tubers, olives and olive oil, and lamb meat, all of which are typical foods associated with the Mediterranean culture. Specifically, lamb meat intake is rooted in the traditional culture of North African Mediterranean countries on autumn–winter weekend days.

The second eating pattern, 'Transitional food', explained 10·3 % of the total variance. This omitted the major MD food groups included in the 'Traditional food' pattern and was characterised by substantial amounts of beef meat, fish and shellfish, and nuts. The third pattern, identified as 'European breakfast', was characterised by a substantial contribution of fruit and natural orange juice, dairy products, and sugars, pastries, and chocolate, and explained 9·6 % of the total variance. The last model, called 'Western food', showed positive factor loadings for the highly processed food groups included in the ready-to-eat products group together with the soft drinks and packaged juice group, and the poultry group. This model explained 9·0 % of the total variance.

Associations between markers of diet quality and dietary patterns adjusted for energy intake and personal and sociodemographic characteristics are shown in detail in Table 6.

Note that the 'Traditional food' pattern was negatively associated with the percentage of energies from carbohydrates, SFA and PUFA, and was positively associated with the percentage of energies from MUFA and proteins (legumes is the only protein food group considered representative of this pattern) and density of fibre. Besides, it was also positively associated with MDS and the NRF9.3 index. In contrast, we found a positive association between the 'Western food' pattern and the percentage of energies from PUFA as well as a negative association with fibre density and the NRF9.3 index. 'European breakfast' was positively associated with both the percentage of energy from simple sugars and the percentage of energy from SFA.

Indicators

Assessment of the overall diet quality by MDS and the NRF9.3 index revealed deficient diet quality, as MDS scored 3·8 and NRF9.3 scored 204. According to MDS cut-off points, 62·9 % of individuals showed low adherence to MD, 33·3 % showed intermediate adherence and 3·8 %

Table 5 Factor-loading matrix for the food groups of the dietary patterns among Tunisian students from University of Carthage

	Dietary patterns*			
Food groups	Traditional food†	Transitional food‡	European breakfast§	Western food‖
Legumes	0·473	0·255	−0·184	−0·319
Nuts	0·026	0·618	0·165	0·078
Fish and shellfish	0·375	0·516	−0·210	−0·141
Spices	0·667	0·307	0·093	0·062
Beef meat	−0·101	0·686	0·009	−0·049
Soft drinks and packaged juice	0·117	0·341	−0·140	0·529
Fruit and natural orange juice	0·012	0·072	0·728	0·003
Vegetables and tubers	0·734	−0·284	0·144	0·077
Olives and olive oil	0·719	−0·241	0·026	0·133
Sugars, pastries and chocolate	−0·047	0·239	0·596	0·299
Dairy products	0·229	0·001	0·558	−0·274
Eggs	0·179	0·229	−0·359	0·101
Poultry	0·116	−0·064	0·197	0·588
Lamb	0·437	0·153	0·012	−0·011
Bread, pasta and flour	0·060	0·149	−0·173	−0·020
Ready-to-eat products	−0·074	−0·101	−0·163	0·699
Eigenvalues	*2·291*	*1·655*	*1·534*	*1·439*
% of explained variance	*14·320*	*10·341*	*9·586*	*8·995*
% of accumulated explained variance	*14·320*	*24·661*	*34·246*	*43·241*

*Only the food groups with a factor loading greater than 0.40 or less than −0.40 were considered as being representative of the pattern.
†Composition: legumes, spices, vegetables and tubers, olives and olive oil and lamb.
‡Composition: nuts, fish and shellfish, and beef meet.
§Composition: fruit and natural orange juice, sugars, pastries and chocolate, and dairy products.
‖Composition: soft drinks and packaged juice, poultry, and ready-to-eat products.

Table 6 Association between dietary markers and pattern scores for each eating pattern adjusted for energy intake and personal and sociodemographic characteristics

	Traditional food		Transitional food		European breakfast		Western food	
	β	*P*	*β*	*P*	*β*	*P*	*β*	*P*
% of energy from proteins	0·377	< 0·001	0·340	< 0·001	−0·334	0·001	−0·128	0·227
% of energy from carbohydrates	−0·276	0·004	−0·006	0·948	0·161	0·099	−0·071	0·486
% of energy from simple sugars	−0·200	0·050	0·083	0·385	0·457	< 0·001	−0·017	0·876
% of energy from fats	0·087	0·363	−0·182	0·037	−0·013	0·898	0·159	0·112
% of energy from SFA	−0·320	0·001	0·040	0·655	0·222	0·024	−0·054	0·601
% of energy from MUFA	0·570	< 0·001	−0·314	0·001	−0·038	0·711	0·003	0·976
% of energy from PUFA	−0·283	0·005	−0·062	0·511	−0·143	0·164	0·435	< 0·001
% of energy from *trans*-fatty acids	−0·161	0·107	0·542	< 0·001	0·007	0·942	−0·216	0·040
Fibre (g/1000 kcal)	0·289	0·003	0·059	0·526	0·108	0·292	−0·273	0·009
Vitamin A (μg/1000 kcal)	0·235	0·023	−0·048	0·620	0·080	0·450	−0·108	0·328
Vitamin C (mg/1000 kcal)	0·046	0·652	−0·129	0·169	0·531	< 0·001	−0·159	0·138
Vitamin D (μg/1000 kcal)	0·008	0·928	−0·091	0·268	−0·092	0·308	0·015	0·872
Vitamin E (mg/1000 kcal)	−0·059	0·557	0·034	0·716	−0·159	0·117	0·252	0·015
Ca (mg/1000 kcal)	0·090	0·391	0·091	0·348	0·293	0·005	−0·354	< 0·001
Fe (mg/1000 kcal)	0·262	0·014	0·236	0·016	−0·116	0·292	−0·204	0·071
Na (mg/1000 kcal)	0·175	0·092	0·065	0·499	−0·195	0·065	0·108	0·326
K (mg/1000 kcal)	0·617	< 0·001	0·146	0·123	0·260	0·012	−0·497	< 0·001
Mg (mg/1000 kcal)	0·333	0·001	0·355	< 0·001	0·170	0·102	−0·460	< 0·001
I (μg/1000 kcal)	−0·543	0·588	−0·034	0·726	0·080	0·463	−0·159	0·155
MDS	0·379	< 0·001	0·019	0·845	−0·160	0·125	−0·199	0·065
NRF9.3	0·391	< 0·001	−0·018	0·848	0·081	0·426	−0·291	0·005

were classified as individuals with high adherence. On the other hand, none of the participants surpassed 2/3 of the maximum score on the NRF9.3 index.

Potential factors conditioning food consumption

The relationship of food consumption with anthropometric, sociodemographic and lifestyle characteristics of the sample was studied. Tables 7 and 8 and Supplemental Table S2 show in detail daily consumption for each nutrient, daily consumption for each food group and the average of each food pattern factor scores, respectively, according to anthropometric, sociodemographic and lifestyle characteristics across the different categories for the variables presenting significant comparisons. Only some significant differences were found when the analysis of

food pattern scores was carried out. However, many significant differences were observed when food groups and nutrients were studied. The main results about potential factors conditioning food consumption have been shown below in two categories, namely (1) sociodemographic and anthropometric characteristics and (2) lifestyle behaviours.

Sociodemographic and anthropometric characteristics

(a) Gender differences were found in vitamin C and fish and shellfish intakes, which were higher in females. Mean factor score was also higher in females for the 'European breakfast' pattern. Moreover, mean NRF9.3 score was higher in women than in men (222·5 *v.* 173·1 points, $P = 0{\cdot}033$). (b) Students aged over 21 years consumed higher quantities of soft drinks and packaged juice than those aged 21 years or below. (c) Regarding the birthplace variable, we found that olive and olive oil intake was higher in individuals born in the centre-south of the country, whereas lamb intake was higher in individuals born in the north. (d) Concerning appliances, students living in households equipped with a gas cooker presented higher consumption of ready-to-eat products and lower consumption of fish and shellfish. However, opposite results showed students living in households equipped with an electric cooker. On the other hand, individuals with a refrigerator at home consumed lower quantities of olives and olive oil, and those having a microwave consumed less lamb. Participants with other kitchen devices at home had more adhesion to the 'European breakfast' pattern than those not having this kind of devices. (e) Finally, obese and overweight students consumed more nuts but less fish and shellfish. These BMI categories were also associated with lower *trans*-fatty acid consumption.

Lifestyle behaviours

(a) Smoking more than five cigarettes per day was associated with higher consumption of dairy products and lower intake of total carbohydrates and simple sugars. Mean factor score for the 'European breakfast' was also lower in these individuals. (b) Regarding physical activity, the consumption of nuts was higher in active or very active subjects, while the consumption of ready-to-eat products was higher in sedentary or low active people. (c) Besides, students who usually ate food cooked at their parents' home consumed less sugars, pastries and chocolate and less ready-to-eat products. The intake of *trans*-fatty acids was also lower in these subjects. (d) On the other hand, eating outside home on weekdays was associated with higher intake of total carbohydrates, fat and Na. Besides, these subjects showed more adhesion to the 'Western food' pattern than those who ate at their own or family home. (e) Finally, students who never kept a regular schedule of meals showed lower vegetable and tuber intake.

Discussion

This research found that overall quality of diet of studied population was deficient by both MDS and the NRF9.3 index. Four dietary patterns were suggested, being the 'Traditional food' pattern the first dietary model. The analysis of food groups and nutrients showed that the sugars, pastries and chocolate group provided the bulk of the total free sugars of the diet, and soft drinks and packaged juice group ranked second. Dairy products were the main source of SFA. Regarding to potential conditioning factors, women showed higher quality of overall diet, according to the NRF9.3 index, and higher adherence to the 'European breakfast' pattern. Some food habits such as eating out of home revealed high adherence to the 'Western food' pattern, which showed negative association with fibre intake. Besides, eating out of home was linked to high consumption of Na, total carbohydrates and total lipids, but it was not associated with high consumption of SFA. Students who usually ate food cooked at their parents' home consumed less sugars, pastries and chocolate and ready-to-eat products and those who never kept a regular schedule of meals consumed less vegetables and tubers. Finally, some unhealthy well-known lifestyles such as being sedentary promoted high consumption of ready-to-eat products, among the studied population. Our findings revealed that quality of diet of Tunisian university students is inadequate, despite the traditional MD continuing to be the most common pattern. Studies focused on these topics in low-middle-income countries are almost non-existent. The present work is, to the best of our knowledge, the first to characterise food consumption among university students living in Grand Tunis (Tunisia) with the identification of potential conditioning factors. Tunisia has undergone a nutritional transition over the last two decades, developing substantial changes in lifestyles linked to the increase in chronic non-communicable diseases[24,39]. Young people with high educational level living in urban areas are associated with healthy food habits[10–12]; therefore, they could be a target group to promote lifelong healthy behaviours.

These results were similar to those found among young people with a high educational level living in other Mediterranean high- and middle-income countries[7,25,40]. Counter to expectations, a high level of education among young adults living in urban area in a low-middle-income country might not play a protecting role against lifestyle risk behaviours, such as high consumption of free sugars and saturate fat or eating outside home. In this way, the food habits of the study population were worse than those found among young people in Tunisia regardless of educational level[41] and among adults with a university degree[41].

Taking into account WHO and FAO nutritional objectives (NO)[42] and the Guidelines for Tunisian population based on the MD pyramid[43], the studied diet surpassed total fat intake (15–30 %). Total carbohydrates intake did

Table 7 Macronutrient (g) and micronutrient (mg) daily intake according to anthropometric and sociodemographic characteristics and lifestyle habits of the sample (only data comparisons presenting significant differences are shown). Data are presented as mean [standard deviation] (95% confidence interval)

	Macronutrients: proteins, carbohydrates, simple sugars, lipids, SFA, MUFA, PUFA, *trans*-fatty acids, cholesterol§, fibre and alcohol		Micronutrients: vitamin A§§, vitamin C, vitamin D§§, vitamin E, Ca, Fe, Na, K, Mg and I§§	
Anthropometric and sociodemographic characteristics				
Gender			Vitamin C, $P=0{\cdot}011$†	
Male			72·9 [49·1] (58·3–87·4)	
Female			100·7 [63·8] (87·0–114·4)	
Kitchen appliances: gas cooker	PUFA, $P=0{\cdot}004$†			
No	12·5 [5·0] (10·6–14·4)			
Yes	13·2 [10·9] (11·0–15·3)			
Kitchen appliances: electric cooker	PUFA, $P=0{\cdot}010$†			
No	13·5 [11·6] (11·1–16·0)			
Yes	12·0 [4·8] (10·6–13·5)			
Kitchen appliances: freezer			Vitamin A, $P=0{\cdot}012$†	
No			708·2 [321·0] (608·1–808·2)	
Yes			907·7 [533·8] (795·9–1019·5)	
Kitchen appliances: other kitchen devices	Simple sugars, $P=0{\cdot}028$‡		Vitamin A,$P=0{\cdot}005$†	
No	84·5 [33·5] (75·6–93·5)		729·7 [372·7] (629·9–829·5)	
Yes	100·0 [46·6] (89·4–110·7)		928·6 [539·2] (805·3–1051·8)	
Lifestyle characteristics				
Smoking habits	Carbohydrates, $P=0{\cdot}010$‡	Simple sugars, $P=0{\cdot}020$‡	Ca, $P=0{\cdot}009$†	
0–5 cigarettes per day	207·1 [61·0] (195·8–218·5)	96·9 [42·0] (89·1–104·8)	691·1 [252·7] (644·0–738·2)	
>5 cigarettes per day	168·2 [52·1] (143·0–193·3)	72·8 [37·4] (54·7–90·8)	577·7 [324·7] (421·2–734·2)	
Artificial sweetener consumption	Lipids, $P=0{\cdot}031$†	SFA, $P=0{\cdot}025$†	Vitamin E, $P=0{\cdot}030$†	Ca, $P=0{\cdot}040$†
No	85·1 [34·7] (79·0–91·2)	29·6 [12·5] (27·5–31·8)	8·1 [5·0] (7·3–9·0)	628·6 [267·5] (635·6–729·6)
Yes	57·9 [8·2] (47·7–68·1)	19·4 [2·6] (16·2–22·5)	4·7 [1·3] (3·1–6·3)	476·0 [95·2] (357·8–594·2)
	PUFA, $P=0{\cdot}043$†		Na, $P=0{\cdot}004$†	I, $P=0{\cdot}027$†
No	13·2 [10·0] (11·5–15·0)		2019·0 [733·0] (1890·5–2148·0)	62·4 [25·6] (57·9–66·9)
Yes	7·8 [2·7] (4·4–11·2)		1193·0 [207·1] (936·2–1450·6)	43·6 [7·8] (33·9–53·3)
Consumption of vitamin and mineral supplements	*Trans*-fatty acids, $P=0{\cdot}034$†	Alcohol, $P=0{\cdot}009$†		
No	0·04 [0·09] (0·02–0·05)	0·1 [0·7] (0·0–0·3)		
Yes	0·07 [0·10] (0·03–0·11)	0·2 [0·4] (0·0–0·3)		
Place to eat on weekdays	Carbohydrates, $P=0{\cdot}008$‡	Lipids, $P=0{\cdot}007$†	Vitamin E, $p<0{\cdot}001$†	
Own or family home	170·4 [43·5] (151·1–189·6)	68·2 [25·6] (56·9–79·5)	5·3 [2·7] (4·1–6·5)	
Outside home	207·8 [62·5] (196·0–219·6)	87·3 [35·2] (80·6–93·9)	8·6 [5·2] (7·6–9·5)	
	Trans-fatty acids, $P=0{\cdot}041$†	Fibre, $P=0{\cdot}047$†	Na, $P=0{\cdot}023$†	
Own or family home	0·01 [0·05] (0·00–0·03)	13·5 [5·2] (11·2–15·8)	1708·3 [692·0] (1401·5–2015·1)	
Outside home	0·05 [0·10] (0·03–0·07)	15·2 [4·6] (14·4–16·1)	2043·9 [735·9] (1904·8–2183·0)	
	MUFA, $P=0{\cdot}014$†	PUFA, $p<0{\cdot}001$†		
Own or family home	27·8 [11·4] (22·8–32·9)	9·0 [5·0] (6·8–11·2)		
Outside home	35·8 [16·1] (32·8–38·9)	13·8 [10·4] (11·8–15·8)		

Table 7 *Continued*

	Macronutrients: proteins, carbohydrates, simple sugars, lipids, SFA, MUFA, PUFA, *trans*-fatty acids, cholesterol§, fibre and alcohol	Micronutrients: vitamin A§§, vitamin C, vitamin D§§, vitamin E, Ca, Fe, Na, K, Mg and I§§
Type of cuisine	*Trans*-fatty acids, *P* = 0·024†	
Cooked at parents' home	0·02 [0·06] (0·01–0·04)	
Not cooked at parents' home	0·06 [0·12] (0·03–0·09)	
Diseases		
Diseases	*Trans*-fatty acids, *P* = 0·026†	
No	0·05 [0·10] (0·03–0·07)	
Yes	0·00 [0·01] (0·00–0·01)	
Overweight/obesity	*Trans*-fatty acids , *P* = 0·026†	Ca, *P* = 0·049†
No	0·04 [0·09] (0·02–0·06)	688·4 [268·1] (639·9–736·8)
Yes	0·00 [0·00] (0·00–0·00)	538·8 [205·6] (408·2–669·4)

†Mann–Whitney U test.
‡Student's *t* test.
§mg/d.
§§μg/d.

not reach their recommended levels (55–75 %), while protein consumption was within range (10–15 %). Moreover, intake of SFA and free sugars widely exceeded their nutritional objectives (< 10 %), with free sugars intake being more than double that of the nutritional objectives. These results are linked to the main energy food sources that contribute to total daily energy intake.

Transitional nutrition implies an increased proportion of energy from fats, reduced total carbohydrate intake and a rise in protein intake[39]. Our results coincide with these variations in macronutrient profiles and although protein intake remains balanced, consumption is higher compared to older Tunisian studies[44–46].

Similarly to the situation in other emerging countries[47–50], four major dietary patterns were identified in this study, namely 'Traditional food', 'Transitional food', 'European breakfast' and 'Western food'. Gender differences in diet quality are consistent with other studies. They could be partially attributed to women's dissatisfaction or concern about their body image influenced by fashion[51] and their better cooking skills[8], which are in line with studies set in both low-middle and high-income countries among different age populations[25,49,52,53]. However, quality of diet among young and adolescent people and among university adults was higher in men in other Tunisian studies[41,45].

According to other research, certain environmental factors, such as eating out of home and not consuming traditional made foods, which occur mostly on weekdays among our students, lead to worse food habits[8,9]. Participants showed lifestyle risk behaviours, such as following high sugar-free and high SFA patterns. The marked excess of free sugar intake even exceeds free sugar intakes among young people in high-income countries[54]. These results are inconsistent with other studies among Tunisian adult and adolescent populations living in the same location[41,46], which showed a moderate growth. Neither do they coincide with those obtained in low-income countries, where people with high socioeconomic status resident in urban areas usually show healthier dietary patterns[9,10,55].

Furthermore, according to FAO (2010), the stage of nutritional transition in Tunisia is evidenced by trends in food supplies, which greatly exceed the energy needs of the population, with cereal, olive oil and sweeteners accounting for three-quarters of total energy provision. These sources nearly match the major energy food sources among our students, but the energy contribution from other food groups, such as dairy products and groups of ready-to-eat, soft drink-packaged juice and fruit and natural orange juice, must be added in order to approach three-quarters of total energy intake. This evidences an advanced transitional nutrition. Note the surprising third position achieved by the ready-to-eat group as a SFA source, and the second position of the soft drink-packaged juice group as a free sugar source.

It is interesting to note that behaviours linked to Western diets are related to a good economic position in

Table 8 Daily intake (g) for each food group of the dietary patterns according to anthropometric and sociodemographic characteristics and lifestyle habits of the sample (only data comparisons presenting significant differences are shown). Data are presented as mean [standard deviation] (95% confidence interval)

	Traditional food: legumes, spices, vegetables and tubers, olives and olive oil and lamb		Transitional food: nuts, fish and shellfish and beef meat	European breakfast: fruit and natural orange juice, sugars, pastries and chocolate and dairy products	Western food: soft drinks and packaged juice, poultry and ready-to-eat products
Anthropometric and sociodemographic characteristics					
Gender			Fish and shellfish, $P < 0{\cdot}001$*		
Male			18·6 [60·8] (0·5–36·6)		
Female			50·3 [80·3] (33·1–67·5)		
Age (years): two categories					Soft drinks and p. j., $P = 0{\cdot}017$*
≤21					171·2 [174·5] (139·8–202·6)
>21					309·1 [193·4] (179·2–439·0)
Birthplace	Olives and olive oil, $P = 0{\cdot}024$*	Lamb, $P = 0{\cdot}017$*			
North	18·7 [18·3] (14·7–22·7)	19·7 [41·8] (10·6–28·9)			
Centre-south	23·2 [14·0] (19·1–27·2)	12·2 [58·5] (0·0–29·0)			
Kitchen appliances: gas cooker			Fish and shellfish, $P = 0{\cdot}039$*		Ready-to-eat products, $P = 0{\cdot}012$*
No			50·9 [75·7] (22·1–79·7)		22·7 [18·3] (15·8–29·7)
Yes			35·9 [75·3] (21·2–50·7)		43·3 [56·0] (32·4–54·2)
Kitchen appliances: electric cooker			Fish and shellfish, $P = 0{\cdot}028$*		Ready-to-eat products, $P = 0{\cdot}011$*
No			34·8 [76·2] (18·7–51·0)		44·4 [58·7] (32·0–56·8)
Yes			48·0 [73·8] (25·6–70·5)		27·5 [26·8] (19·4–35·7)
Kitchen appliances: refrigerator	Olives and olive oil, $P = 0{\cdot}011$*				
No	29·5 [25·7] (18·4–40·6)				
Yes	18·4 [13·8] (15·8–21·0)				
Kitchen appliances: microwave	Lamb, $P = 0{\cdot}025$*				
No	31·9 [78·4] (5·8–58·1)				
Yes	11·1 [28·5] (5·3–16·9)				
Lifestyle characteristics					
Smoking habits				Dairy products, $P = 0{\cdot}015$†	
0–5 cigarettes per day				209·6 [137·7] (183·9–235·2)	
>5 cigarettes per day				294·9 [155·8] (219·9–370·0)	
Level of physical activity			Nuts, $P = 0{\cdot}044$*		Ready-to-eat products, $P = 0{\cdot}017$*
Sedentary or low active			0·6 [3·9] (0·0–1·9)		52·6 [76·4] (27·1–78·0)
Active or very active			2·7 [11·3] (0·4–5·0)		33·4 [35·6] (26·2–40·7)
Weight-loss diets	Olives and olive oil, $P = 0{\cdot}045$*				Poultry, $P = 0{\cdot}005$*
No	21·3 [17·4] (18·1–24·5)				49·0 [55·8] (38·7–59·2)
Yes	13·3 [11·0] (7·4–19·2)				14·6 [16·6] (5·8–23·5)

Table 8 *Continued*

	Traditional food: legumes, spices, vegetables and tubers, olives and olive oil and lamb	Transitional food: nuts, fish and shellfish and beef meat	European breakfast: fruit and natural orange juice, sugars, pastries and chocolate and dairy products	Western food: soft drinks and packaged juice, poultry and ready-to-eat products
Alcohol consumption			Sugars, pastries and chocolate, $P = 0{\cdot}016$*	Dairy products, $P = 0{\cdot}011$†
No			90·2 [62·0] (79·1–101·3)	213·3 [137·3] (188·8–237·8)
Yes			136·9 [54·4] (95·2–178·7)	338·0 [176·8] (202·2–473·9)
Artificial sweetener consumption				Poultry, $P = 0{\cdot}020$*
No				46·4 [54·2] (36·9–55·9)
Yes				4·9 [10·9] (0·0–18·4)
Consumption of vitamin and mineral supplements			Sugars, pastries and chocolate, $P = 0{\cdot}001$*	
No			84·7 [60·8] (73·0–96·5)	
Yes			127·0 [58·0] (104·1–150·0)	
Place to eat on weekends			Sugars, pastries and chocolate, $P = 0{\cdot}024$*	
Own or family home			88·7 [62·8] (76·7–100·6)	
Outside home			114·7 [57·3] (90·5–138·9)	
Regular meal times	Vegetables and tubers, $P = 0{\cdot}021$*			
No	46·9 [49·7] (1·0–92·8)			
Yes	109·8 [77·8] (96·0–123·6)			
Type of cuisine		Nuts, $P = 0{\cdot}023$*	Sugars, pastries and chocolate, $P = 0{\cdot}043$*	Ready-to-eat products, $P = 0{\cdot}025$*
Cooked at parents' home		0·9 [4·3] (0·0–1·9)	90·2 [62·0] (79·1–101·3)	34·9 [59·0] (20·7–49·0)
Not cooked at parents' home		3·5 [13·4] (0·1–6·8)	136·9 [54·4] (95·2–178·7)	43·1 [40·1] (33·0–53·2)
Diseases				
Diseases	Spices, $P = 0{\cdot}046$*	Olives and olive oil, $P < 0{\cdot}001$*		Dairy products, $P = 0{\cdot}017$†
No	2·9 [1·7] (2·6–3·2)	22·1 [16·9] (18·9–25·3)	209·0 [132·4] (184·1–233·9)	
Yes	2·2 [1·6] (1·4–2·9)	11·2 [14·2] (4·7–17·7)	289·6 [178·5] (208·3–370·8)	
Diabetes mellitus	Spices, $P = 0{\cdot}046$*			
No	2·8 [1·7] (2·5–3·1)			
Yes	1·3 [0·6] (0·5–2·1)			
Overweight/obesity		Nuts, $P = 0{\cdot}012$*	Fish and shellfish, $P = 0{\cdot}045$*	
No		1·1 [4·3] (0·3–1·9)	41·1 [75·8] (27·4–54·8)	
Yes		12·3 [28·8] (0·0–30·6)	20·6 [71·4] (0·0–66·0)	

*Mann–Whitney U test.
†Student's *t* test.

low-middle-income countries. Note that being obese or overweight in this population is associated with scarce consumption of *trans*-fatty acids. It could be deduced, at least in part, that this weight excess is not due to high intake of energy food sources from highly processed foods.

Although the 'Traditional food' pattern based on the MD is still present as the first food pattern among participants, taking into account that less than 4 % of participants were assessed as following an 'adequate diet' when MDS was used, these results are a cause for concern. However, consumption of culinary spices and herbs with high antioxidant capacity is also associated with this model[56,57], though they are not specifically included in common indicators of diet quality. The shift from the 'Traditional food' pattern to the 'Transitional food' pattern entails the disappearance of the spices and herbs group. These results contrast with those of Aounallah-Skhiri et al. (2011)[45], who found that the consumption of different herbs and spices increased or decreased depending on transitional patterns. This may be due to the 'Traditional food' pattern had not been identified in their study. Moreover, it is worth highlighting the contribution of the decline in olive oil consumption.

Furthermore, when the food groups of the 'Traditional food' model were analysed, being born in the centre-south of the country was found to be associated with lower lamb meat consumption and higher olive oil consumption, which contribute to improve the quality of diet and maintain food tradition. Some authors have suggested that greater intake of animal products can be regarded as representing typical behaviour of people with a high social position in local Mediterranean culture, where their availability was traditionally limited[58,59]. Patterns of protein consumption were consistent with those found among Tunisian adolescents when their transitional models were studied[45]. Moreover, fresh fish and shellfish consumption is associated with the female gender, contributing to improve the quality of diet. This food group is also associated with features of a higher economic level, such as the possession of electric cooker rather than a gas cooker[22].

A wide variety of daily dairy products are available to young people in urban areas of developing countries and in all parts of developed countries[60], which defined the 'European breakfast' model. This is in line with patterns of SFA, where fat from dairy products was ranked first, taking into account that dairy products are a common ingredient in cakes or pastries.

Consumption of highly processed foods such as soft drinks-packaged juice and ready-to-eat products, generally high in SFA, salt and sugar, together with increased sources of animal protein, coinciding with a low quality diet, are unquestionable consequences of the westernisation of food[39,47]. Our 'Western food' model accounted for the highest contributions from these groups, in line with literature[47,52].

The largest presence of supermarkets[58,60] involves positive health changes, such as achieving recommended intakes of proteins or micronutrients. However, this environment occurs alongside other changes that worsen diet quality. Market globalisation is modifying the food behaviours of inhabitants, which could be due to extensive and easy access to ultra-processed food and products rich in protein from animals raised on intensive farms, in contrast to sustainable food systems such as traditional MD.

On the other hand, we found no significant association between the Western pattern and overweight or obesity. These results are consistent with other studies conducted in developing countries[47]. Several studies conducted on this group found onset of symptoms of diseases of globalisation emerging earlier than expected by biological age alone[61]. The implementation of educational policies promoting local raw materials and traditional cooking could increase adherence to this pattern before it is irrecoverably lost. This situation is consistent with current recommendations for an optimal diet, taking into account environmental sustainability and healthy eating[62].

Our work has some limitations. The first are those inherent to cross-sectional studies. The omission of the intake and the inaccurate estimation of portion sizes are also potential sources of error when 24-h recalls are used. We attempted to minimise this bias by means of significant homogeneity in the data collection process developed by a small and qualified team and in coordination with experts from the Tunisian university. High educational level of our population also helped ensure the self-reported information. The lack of standardised measurement instruments for a proper assessment of highly processed food consumption in the context of the nutritional transition[63] was attenuated by the design '*ad hoc*' highly processed food groups. Other factors such as seasonality may contribute to daily variation in nutrient intakes, which are mainly associated with the availability[26] in low-middle-income countries. Nonetheless, although our data were recorded in winter, a wide variety of local seasonal vegetables and fruit were consumed, according to MD. Finally, this study was conducted in a specific context and population, so extrapolation of conclusions must be done with caution. However, theses ecological models have been accepted as a suitable framework to study behaviours under different environments, in the context of reducing serious and prevalent health problems[64].

Conclusions

Diet quality of the participating Tunisian university students is inadequate, but traditional MD remains the main pattern in spite of the advanced transitional nutrition. In this population, living in an urban area in Tunisia, a low-middle-income country with heathy traditional food pattern, might not play a protective role against risky lifestyle behaviours. Some of these lifestyles affecting quality of diet were identified in this work, which supports the

youth's particular vulnerability. Further studies should be needed to deepen and broaden knowledge on food habits and lifestyle risk behaviours among young people in different environments.

Acknowledgements

Acknowledgements: We are very grateful to UCA for the facilities for developing the research and University of Castilla-La Mancha which supported this research. *Financial support:* This research was supported by the University of Castilla-La Mancha, Spain (Support for I + D + I Research Groups: GI20153153, GI20163500, and GI20174031). *Conflict of interest:* None. *Authorship:* The authors' responsibilities were as follows: M-JG-M and RS-U conceptualised and designed the study and conducted and supervised the research; AD-S, TD and FC-B developed the databases; M-JG-M, RS-U, AD-S and FC-B performed the statistical analysis and analysed and interpreted the data; M-JG-M and TD designed data collection protocol; AD-S, TD and FC-B contributed to data collection; RS-U, AD-S and FC-B curate data, M-JG-M, RS-U and AD-S wrote, reviewed and edited the manuscript; M-JG-M and RS-U managed funding acquisition and project administration and had the primary responsibility for the final content. All authors participated in the discussion and read and approved the final version of the manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the Ethics Committee at University Hospital Complex of Albacete (CEIC) Acta nº 11/13). Informed consent was obtained from all subjects.

Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980020004942

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