



Section 4. Regional Economy

DOI:10.29013/EJEMS-24-3-16-28



FOOD HABITS AND DIETARY PATTERNS OF THE TUNISIAN POPULATION

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Cite: Gharbi A., Boudiche S., Ameur M. (2024). *Food Habits and Dietary Patterns of the Tunisian Population*. *European Journal of Economics and Management Sciences* 2024, No 3. <https://doi.org/10.29013/EJEMS-24-3-16-28>

Abstract

Objective: This article is a reflection on the food transition in Tunisia. This study aimed to characterize food consumption among Tunisian population assessing quality of diet and main dietary patterns, and their association with socioeconomic and anthropometric factors.

Methods: This analysis was based on data collected from 400 adult participants in Tunisia. The data included socioeconomic factors, eating habits, and food frequency consumption. Descriptive statistics, PCA, and logistic regression were performed using SPSS version 21.

Results: Modern products are now an integral part of consumers' daily routines, with over half of the respondents frequently snacking. Although the home remains the favored setting for shared meals, fast food is gaining importance.

The results of PCA show a trend of modernization / westernization of the diet. Using principal component analysis (PCA), we identified three dietary patterns among 400 adult participants from Tunisia: the Mediterranean diet (11.906%), the Western diet (10.668%), and the high protein diet (9.159%). Additionally, socioeconomic factors accounted for 28.505% of the variance. These findings highlight the evolving dietary habits in Tunisia, shaped by both traditional and modern dietary trends, and underscore the significant role of socioeconomic status in influencing these patterns. The analysis of the association between obesity and the identified dietary patterns, as well as socioeconomic factors, revealed that both socioeconomic status and adherence to a Western diet were significantly linked to a higher likelihood of obesity (OR 1.935 [95% CI: 1.436–2.608] and OR 1.439 [95% CI: 1.078–1.921], respectively). In contrast, no significant association was found between obesity and either the Mediterranean diet or the high-protein diet.

Conclusion: This study indicates that socioeconomic factors and adherence to a Western diet are significantly associated with an increased risk of obesity among participants in Tunisia. These findings suggest that tackling socioeconomic disparities and encouraging healthier dietary patterns may be essential in combating obesity in the region.

Keywords: *dietary patterns – food habits – diet – principal component analysis – logistic regression – Tunisian population*

Introduction:

Food involves the body's process of absorbing nutrients to maintain its functions. It forms the basis of good health. Our eating habits directly impact our well-being, either positively or negatively. A balanced diet is crucial for the normal growth and proper functioning of our body (Seignalet, 2012).

Supplying food with the required quality has become a priority, especially considering the changes in food habits due to economic development, urbanization and lifestyle improvements. These changes have led to a departure from the traditional Mediterranean diet, contributing to the rise of chronic diseases (FAO, 2014). These changes, along with rapid economic growth, have long been recognized as part of the nutritional transition.

Identifying dietary patterns is considered an effective approach to characterize lifestyle risk behaviors in low- and middle-income countries, where environmental factors are unique to each nation. Epidemiological studies have highlighted that economic and social inequalities, along with lifestyle risk behaviors in dietary patterns, must be considered in the prevention and control of diseases linked to globalization in developing countries. Typically, individuals of higher socioeconomic status or those living in urban areas tend to follow healthier diets. However, there is a significant lack of research in developing or low- and middle-income countries, despite these regions being home to the largest proportion of the world's population.

In Tunisia, a Southern Mediterranean country classified as a low-middle-income country, a nutritional transition has been observed over the years, involving a shift away from the traditional healthy dietary model (The World Bank (2016). This process is particularly evident in the northern region of the country due to the accelerated urbanization radiating from the capital (FAO, 2016, FAO, 2005). This region serves as a social and eco-

nomic hub, attracting a productive population, including young people seeking a better quality of life. Concurrently, rates of obesity and overweight are rising, leading to an increased prevalence of chronic non-communicable diseases.

Scientific studies have shown that changes in eating habits characterize the epidemiological transition marked by an increase in diseases of excess (60% of causes of death): type II diabetes, obesity, and cardiovascular diseases (Ciheam/Sahar, 2002). There is limited research on the nutritional transition in Tunisia.

In this context, the present study aimed to characterize food consumption among the adult Tunisian population in different regions in Tunisia. It assessed diet quality, identified main dietary patterns, and examined their associations with sociodemographic characteristics and lifestyle risk behaviors. Additionally, it determined the prevalent food habits.

Materials and Methods:

1. Selection of participants and questionnaire design

The study was carried out by the research team of the Laboratory of Research in Technological Innovation and Food Safety, LR22-AGR01-ESIAT. A Google Forms questionnaire was distributed to the Tunisian population aged 18 to 67 through social networks (Facebook) as well as institutional and private mailing lists. Participation in the study was entirely free, voluntary, and anonymous, with participants' informed consent to data sharing and privacy policy. No personal data was requested, in compliance with laws on the protection of personal data and the guarantee of digital rights. Consequently, this online survey did not require the intervention of an ethics committee.

The first section of the questionnaire focused on socioeconomic characteristics and

anthropometric parameters. The second section included questions about food consumption, while the third section covered dietary habits. Participants declared their weight and height, which were used to calculate body mass index (BMI), expressed in kg/m². Participants completed the forms directly on the Google platform. Once completed, each response was transmitted to this platform, and the final database was downloaded as a Microsoft Excel spreadsheet.

2. Principal Component Analysis:

Dietary patterns were assessed using principal component analysis. Before performing PCA, the suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) test, which measures sampling adequacy, to ensure the variables were suitable for correlation analysis. Bartlett's test of sphericity was also conducted to verify that relationships between variables existed. Factors were retained using the Kaiser criterion, which includes all eigenvalues greater than 1.0. PCA with

Varimax rotation was employed to achieve a clearer interpretation of factor loadings, thus facilitating the identification of dietary patterns.

3. Statistical Analyses:

Statistical analysis was performed using IBM SPSS Statistics for Windows®, Version 22.0 (Armonk, NY: IBM Corp). Percentage and frequencies were used to describe the quantitative and qualitative variables.

Survey results and discussion:

1. Characteristics of the population study

In total of 400 participants from different regions in Tunisia, age 18 to 67, were selected in the survey, including (142) 35.5% men and 64.5% (258) women with mean age of 28.8 years. Table 1 summarizes the demographic and anthropometrics characteristics of the subjects who answered the questionnaire. A normal BMI was found for 55.3% of the study population, 5.5% were classified as underweight, 27% as overweight, and 12.3% as obese.

Table 1. *Characteristics of the population study*

Sociodemographic Variable		Percentage (n)
Gender		
Men %		35.5 (142)
Women %		64.5 (258)
Age Group Percentage	18 – 24	34.5 (138)
	25 – 30	36 (144)
	31 – 44	22 (88)
	45 – 67	7.5 (30)
Mean Age (years)		28.8
Region		
Greater Tunis %		24.5 (98)
Bizerte + North %		44.5 (178)
Sehel: Central East %		12.3 (49)
Central West %		10.3 (41)
South %»		8.5 (34)
Educational Level		
Secondary		11.5 (46)
Higher»		88.5 (354)
Categories		
Student		28.2 (113)

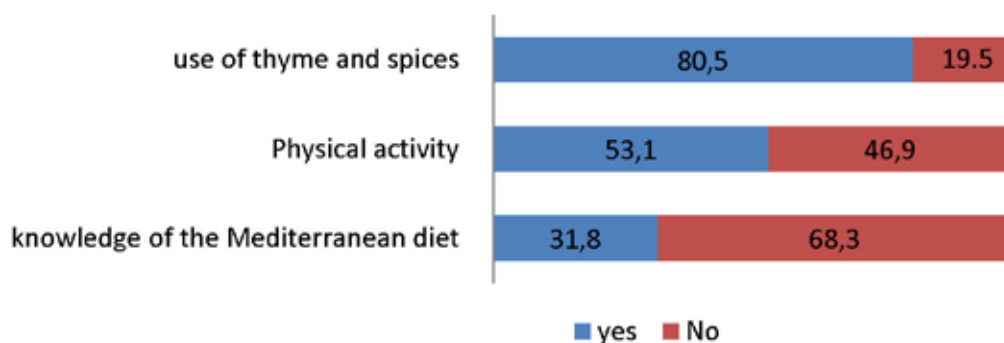
Sociodemographic Variable	Percentage (n)
Employee	19 (76)
Senior Executive	18.5 (75)
Other (Retired...)	34 (136)
Income	
Less than 500 dinars	49.8 (199)
Between 500 and 1000 dinars	18.5 (74)
Between 1000 and 1500 dinars	21.8 (87)
More than 1500 dinars	10 (40)
BMI	
BMI < 18.5	5.5 (22)
18,5 < BMI < 24,9	55.3 (221)
25 < BMI < 29.9	27 (108)
30 < BMI < 34.9	10.8 (43)
BMI ≥ 35	1.5 (6)

2. Eating habits:

The study reveals notable insights into dietary and lifestyle habits among the surveyed population. A significant 68.3% of respondents are unfamiliar with the Mediterranean diet, highlighting a potential gap in awareness of this health-promoting eating pattern. In terms of physical activity, 53.1% of the population participates in sports, reflecting a moderate level of engagement in exercise. However, when it comes to water consumption, the findings are concerning:

51.5% of individuals drink less than two liters of water daily, which falls well short of the recommended 1,500 liters per day. This substantial deviation underscores a widespread insufficiency in hydration practices. Additionally, the study shows that 80.5% of the population incorporates thyme and spices into their meals, indicating a strong preference for enhancing flavors with these ingredients. In contrast, 19.5% of individuals do not use thyme or spices, suggesting varied culinary practices within the community.

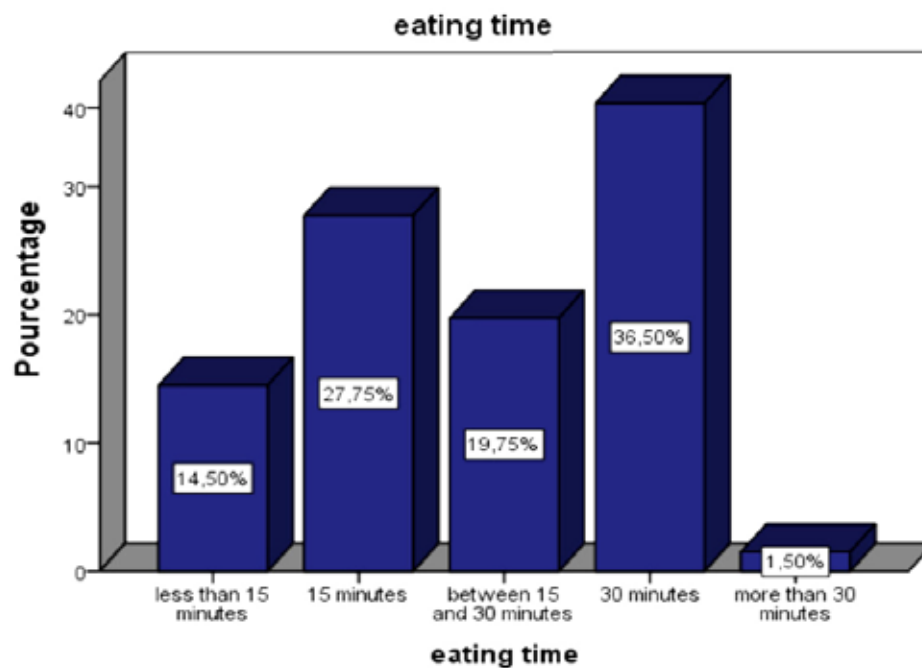
Figure 1. *Healthy habits*



3. Time Reserved for Eating

The Figure no. 2 represents the time allocated for eating meals. According to the data, 27.75% of the surveyed population reserves 15 minutes to eat their meals. Meanwhile,

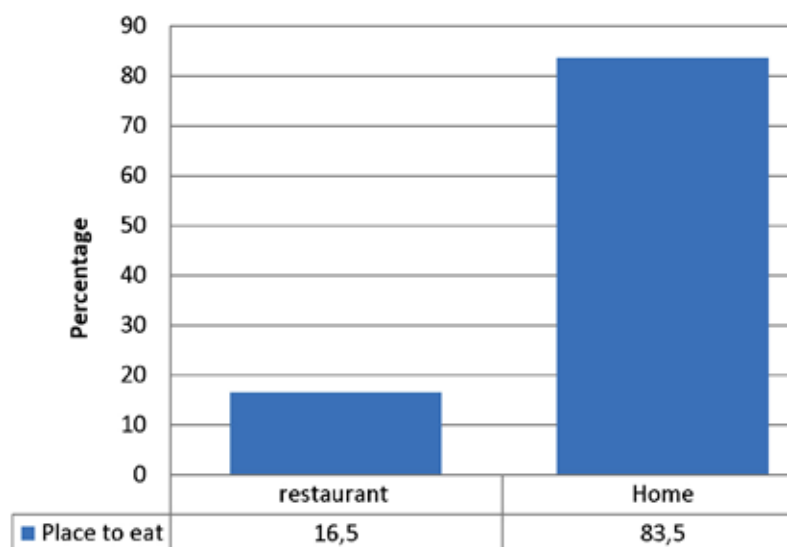
14.5% of the population spends less than 15 minutes eating, and 57.5% spend more than 15 minutes on their meals, with 36.5% needing 30 minutes to finish their meals.

Figure 2. Eating Time

4. Where Do You Eat?

Consumers predominantly prefer dining at home. According to the data, 83.5% of the surveyed individuals choose to eat at home, reflecting a strong preference for the comfort and familiarity of home-cooked meals. In contrast, only 16.5% of respondents opt to dine at restaurants. This significant dispari-

ty highlights the importance of home dining in daily life, which may be influenced by factors such as cost, convenience, and personal taste. The preference for home meals suggests a value placed on the quality and control over food preparation, as well as a desire for a more relaxed and private eating environment.

Figure 3. Percentage of eating locations

5. Snacking:

Snacking is a dietary behavior that contributes to the emergence of chronic diseases. Therefore, combating this risky behavior

is crucial and should involve targeted public health programs (A. Temessek et al., 2018).

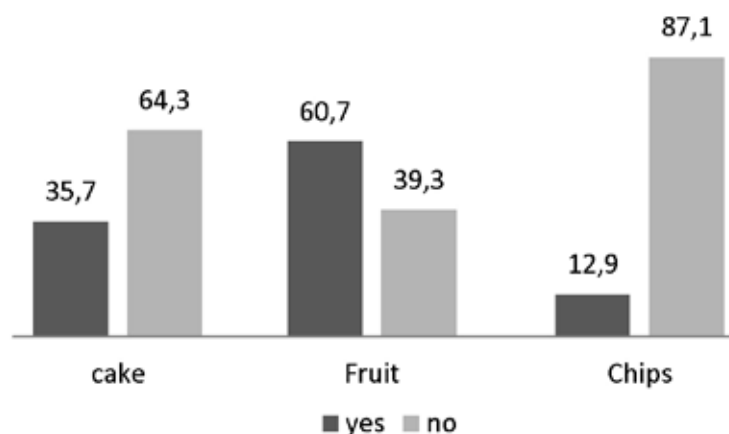
Snacking is prevalent among young people. According to the data, 63.2% of the pop-

ulation reports that they snack, while 36.8% do not. Fruits are the most commonly consumed snacks (60.7%), followed by cakes (35.7%) and chips (12.9%).

This pattern suggests a mixed approach to snacking, where healthier choices coexist with less nutritious options. The significant consumption of fruits indicates a posi-

tive trend toward healthier snacking habits, yet the presence of cakes and chips points to areas where dietary improvements can be made. Addressing snacking behaviors through public health strategies could help shift preferences toward more nutritious options and reduce the risk of chronic diseases associated with poor dietary habits.

Figure 4. *Percentage of Snacks*



6. Prepared meals

Regarding the question, “Do you eat prepared meals, whether fresh, frozen, or

canned?” 58% of the respondents indicated that they consume ready-to-eat meals.

Figure 5. *Percentage of Prepared dishes*

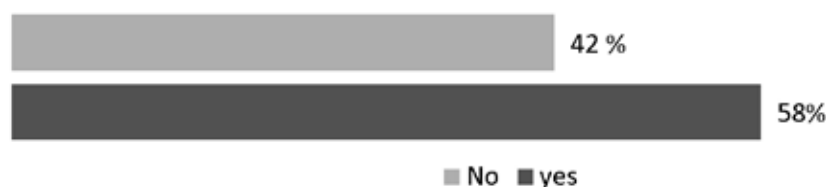
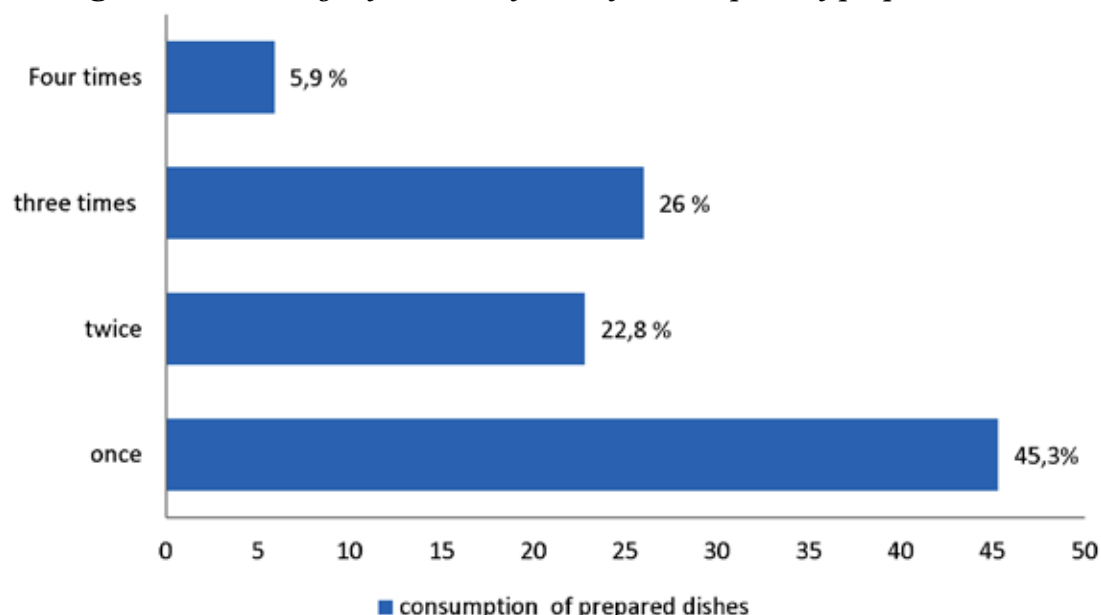


Figure 6. *Percentage of number of time of consumption of prepared dishes*



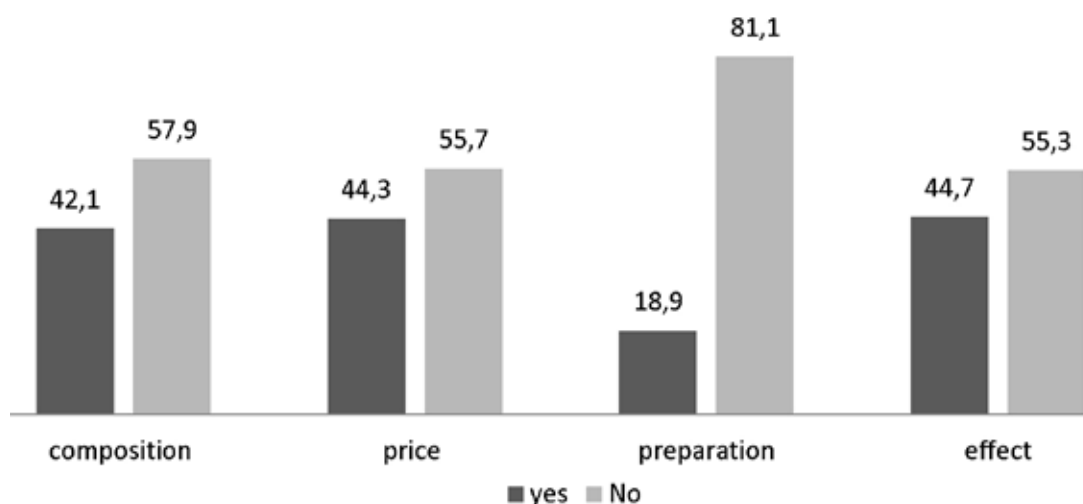
This significant percentage reflects a reliance on convenience foods, which can be attributed to busy lifestyles, ease of preparation, and time-saving benefits. However, it also raises concerns about the nutritional quality of these meals, which often contain higher levels of sodium, preservatives, and unhealthy fats.

Additionally, 31.9% of the respondents consume these prepared meals more than three times a week. This frequent consumption pattern suggests a need for increased awareness and education about the importance of balanced, home-cooked meals and the potential health risks associated with regular intake of processed foods.

7. Purchase Criteria

The question regarding the purchase of food products is: "When I buy food, what do I take into account?" The various criteria mentioned are provided in the table. The responses are either yes or no for each criterion. The most important purchase criterion is the effect on health, with 44.7% of respondents considering this factor. In second place is the price criterion, with 44.3% of the population taking the cost of the food into account when making a purchase. Consumers of food products appear to have a willingness to pay a higher price for these products. Nutritional composition ranks third. The least important criterion for this population is the simplicity of preparation.

Figure 7. *Percentage of purchase criteria*

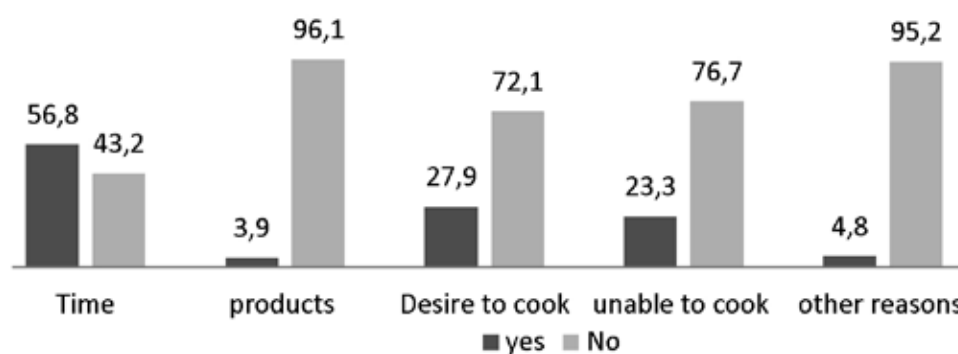


7. Cooking Habits

The results indicate that 35.1% of respondents do not cook at all, 39.6% cook once a day, 13.5% cook more than twice a week,

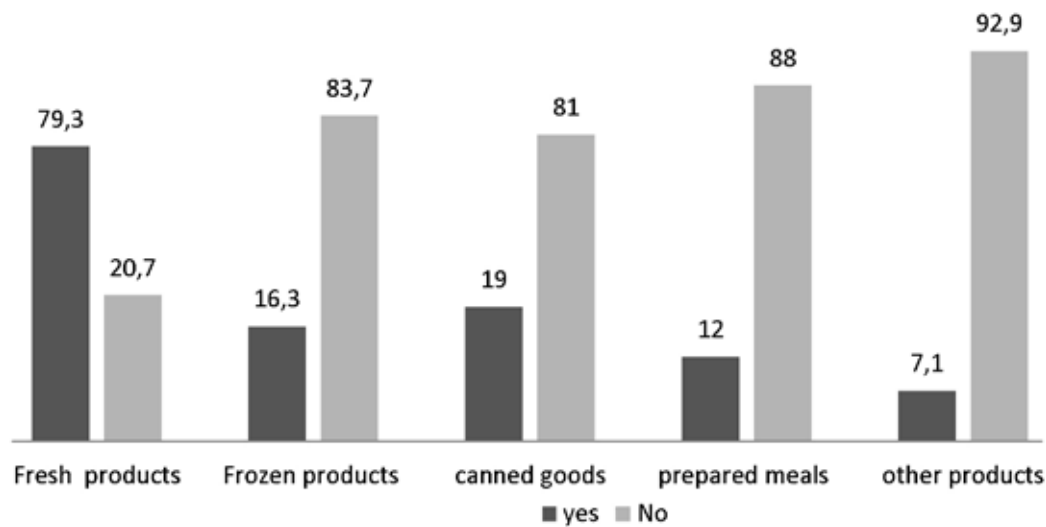
and 11.8% cook twice a day. The survey responses suggest that nearly 56.8% of consumers do not have time to cook (Fig. 8).

Figure 8. *Causes for not cooking*



Regarding consumer eating behaviors, 79.3% of the respondents use fresh products for preparing their dishes, while 19% use canned products. This indicates a

strong preference for fresh ingredients in meal preparation among the majority of the population (Fig. 9).

Figure 9. *Percentage of used products***8. Food Choice:**

The responses indicate that most consumers, with a percentage of 40.5%, consider a balanced meal to consist of a chicken and butter sandwich, accompanied by a portion of cheese and one seasonal fruit. his choice reflects a preference for a combination of protein, dairy, and fruit in their diet,

suggesting an inclination towards meals that provide a mix of macronutrients and vitamins. The inclusion of a seasonal fruit highlights a preference for fresh, potentially locally sourced ingredients, which could be associated with perceptions of health and quality (Table 2).

Table 2. *Percentage of food choice*

Food choice	Percentage %
Spaghetti + dessert cream	13
Chicken sandwich + 1 portion of cheese + 1 seasonal fruit	40.5
Salad + 1yogurt	18.8
Hamburger + salad + 1 fruit yogurt	27.8

9: Dietary patterns derived by PCA approach:**Table 3.** *Variables used in analysis*

Variables:	Description	Codes
Education Level	Education Level	1: secondary / 2: university
Category	Category	1: other/2: student/3: employee/4: senior executive
Income	Income	1: less than 500 dinars /2: between 500 and 1000 dinars /3: between 1000 and 1500 dinars /4: more than 1500 dinars
Cons _olive oil:	Quantity of olive oil consumed per day	1: Less than one tablespoon /2: 1 to 2 tablespoons / 3:2 to 4 tablespoons/4: 4 tablespoons or more

Variables:	Description	Codes
Cons _Meat:	Portions of red meat, hamburgers, or meat products (such as ham, sausages, etc.) consumed per day (1 portion = 100–150 g)	1: less 1 / 2: 1 or more
Cons _Fat:	Portions of butter, margarine, or cream consumed per day (1 portion = 12 g)»	1: less 1 / 2: 1 or more
Cons_ Sweets:	candies, sweets, or commercial pastries (not homemade) such as cakes or cookies consumed per week	1: less 3 /2: more 3
Age:	Age	Continuous
Cons_vegetables:	portions of vegetables consumed per day	1: 0 / 2: 1 / 3: 2 or more
Age _ class	Class of Age	1: 18 to 24 /2: 25 to 30 /3: 31 to 44 /4: 45 to 67
Legumes	portions of legumes (dried beans, lentils, etc.) consumed per week (1 portion = 150 g)	1: less 2 / 2: 3 or more

We retained 4 principal components (factors) from the principal component analysis (PCA), which represent the key dietary patterns identified in the dataset: (Fig. 10, Table 6 and Table 7).

The Kaiser-Meyer-Olkin (KMO) index was 0.714 (Table 4), indicating that the sam-

pling was adequate for this analysis. Based on Bartlett's test of sphericity ($p < 0.001$), we rejected the null hypothesis that the correlation matrix is an identity matrix. The factor loadings of the food groups for each dietary pattern are shown in Table 8.

Table 4. KMO index and Bartlett's test

Indice de Kaiser-Meyer-Olkin pour la mesure de la qualité d'échantillonnage		.714
Test de sphéricité de Bartlett	Khi-deux approx	1257.682
	ddl	55
	Signification	.000

The results of the PCA conducted are shown in the table n°5, 6,7 et 8. The main goal is to reduce the data by grouping them into axes or factors (Kaufman et al. 2000).

The correlation matrix indicated in Table 5 proves the existence of a correlation between socioeconomic variables. There is a correlation between category and level of education and between age and income.

The table n° 7 indicates that the first axis alone explains 28.505% of the total variance of the 11 variables in the analysis, the sec-

ond axis explains 11.906%, the third axis explains 10.668%, and the fourth axis explains 9.159% of the variability within the sample.

Starting from the fifth axis, the explanatory power becomes increasingly weaker, and for this reason, only 4 axes are retained. By cumulatively considering these 4 components or factors, we can explain 60.238% of the total variability.

Table 5. Matrice of correlation between variables

	Education Level	Category	Income	Cons_ol- ive oil	Cons Meat	Cons Fat	Cons Sweets	Age	Cons veg- etables	Age class	Legumes
Education Level	1.000	0.292	0.196	0.118	0.028	-0.084	-0.194	0.230	0.180	0.246	0.072
Category	0.292	-	0.591	0.102	0.052	0.019	-0.091	0.402	0.082	0.438	0.103
Income	0.196	0.591	-	0.105	0.049	-0.046	-0.106	0.578	0.110	0.592	0.102
Cons_olive oil	0.118	0.102	0.105	-	0.083	0.022	-0.118	0.268	0.208	0.252	0.051
Cons - meat	0.028	0.052	0.049	0.083	-	0.151	0.049	0.015	0.060	0.011	0.126
Cons_Fat	-0.084	0.019	-0.046	0.022	0.151	-	0.164	-0.025	-0.057	0.003	0.027
Cons - sweets	-0.194	-0.091	-0.106	-0.118	0.049	0.164	-	-0.158	0.012	-0.137	0.015
Age	0.230	0.402	0.578	0.268	0.015	-0.025	-0.158	-	0.241	0.913	0.106
Cons - veg- etables	0.180	0.082	0.110	0.208	0.060	-0.057	0.012	0.241	-	0.225	0.137
Age class	0.246	0.438	0.592	0.252	0.011	0.003	-0.137	0.913	0.225	-	0.122
Legumes	0.072	0.103	0.102	0.051	0.126	0.027	0.015	0.106	0.137	0.122	-

Table 6. *Total explained variance*

Components	Initial Eigen values		
	Total	% variance	% cumulative
1	3.136	28.505	28.505
2	1.310	11.906	40.411
3	1.173	10.668	51.079
4	1.007	9.159	60.238
5	0.968	8.796	69.034
6	0.855	7.771	76.805
7	0.798	7.257	84.062
8	0.699	6.355	90.417
9	0.619	5.624	96.042
10	0.351	3.187	99.228
11	0.085	.772	100.000

Table 7. *Total explained variance*

Com- po- nents	Initial Eigen values			Sums extracted from the square of loadings		
	Total	% variance	%cumulative	Total	% variance	%cumulative
1	3.136	28.505	28.505	3.136	28.505	28.505
2	1.310	11.906	40.411	1.310	11.906	40.411
3	1.173	10.668	51.079	1.173	10.668	51.079
4	1.007	9.159	60.238	1.007	9.159	60.238
5	.968	8.796	69.034			
6	.855	7.771	76.805			
7	.798	7.257	84.062			
8	.699	6.355	90.417			
9	.619	5.624	96.042			
10	.351	3.187	99.228			
11	.085	.772	100.000			

After selecting the number of factors and based on the rotated component matrix, we were able to assign each of them a name according to the food products that determine them.

FACTOR1: The first factor identified by socioeconomic factors, is strongly and positively correlated with the variables category (0.738), income (0.841), age (0.826), and age class (0.850).

FACTOR2: The dietary pattern identified by Factor 2, labeled “Mediterranean diet,” explained 11.906% of the dietary variation and was characterized by a high intake of olive oil and vegetables. It was strongly correlated with the consumption

of olive oil (0.747) and vegetables (0.697), which are central to the Mediterranean dietary model.

FACTOR3: This factor, labeled “western diet” is characterized by high consumption of fats and sweets, showing a strong positive correlation with these dietary components, evidenced by values of 0.680 and 0.669, respectively. Additionally, it is negatively correlated with the variable educational level (−0.558) indicating that higher educational attainment is associated with more health-conscious food choices. This negative correlation underscores the influence of education and food literacy on dietary habits,

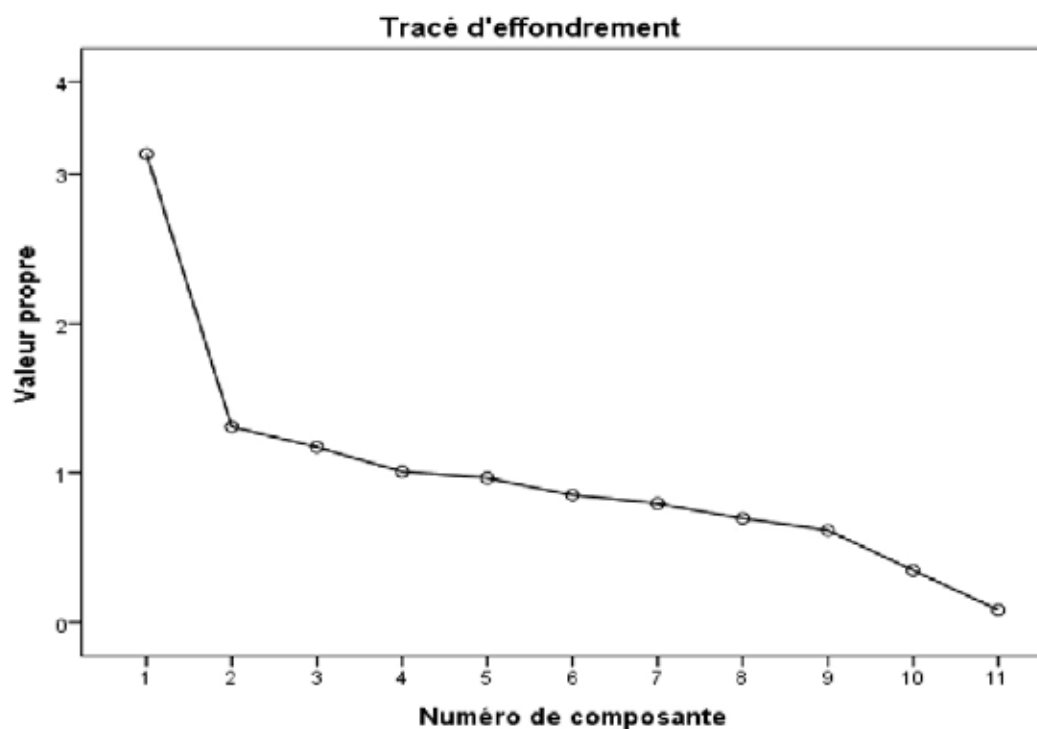
suggesting that individuals with university-level education tend to be more mindful of their health and are likely to avoid sugary and fatty products. This pattern highlights the role of educational background in shaping dietary preferences and emphasizes the importance of food education in promoting healthier eating behaviors.

Factor 4: The dietary pattern identified by Factor 4, labeled high protein diet is characterized by a significant consumption of legumes (0.671) and meat (0.685), indicating that the diet followed by these consumers is rich in protein.

Table 8. *Components matrix after rotation*

	1	2	3	4
Level	.259	.096	-.558	.342
Category	.738	-.157	-.129	.227
Income	.841	-.043	-.071	.075
Cons olive oil	.110	.747	-.012	-.001
Cons meat	-.005	.069	.225	.685
Cons Fat	.074	-.016	.680	.210
Cons sweets	-.103	-.050	.669	.052
Age	.826	.384	-.039	-.079
Cons vegetables	.052	.697	-.106	.206
Age class	.850	.349	-.021	-.056
Legumes	.072	.087	-.057	.671

Figure10. *Scree plot for identification of dietary patterns by principal component analysis*



When testing the association of obesity with identified dietary patterns and socioeconomic factor.

Socioeconomic factor and Western diet were associated with a higher probability for the presence of obesity successively (OR 1.935

[95%CI:] 1.436–2.608). (OR 1.439 No association of Mediterranean diet and high protein diet with obesity was observed (Table 9).

Table 9. Multiple logistic regression analysis between obesity and factor scores for dietary patterns and socioeconomic factor

	Sig	Or	95% CI
Socioeconomic factor	0.000	1.935	1.436–2.608
Mediterranean diet	0.538	1.099	0.813–1.486
Western Diet	0.013	1.439	1.078–1.921
High protein diet	0.992	1.002	0.738–1.360

OR, odds ratio; CI, confidence interval

Conclusion:

This study provides additional information on the dietary patterns of adults in Tunisia, including participants from various categories, genders, and educational levels across different regions of the country. Using principal component analysis with an a posteriori approach, we identified three dietary

patterns and the population characteristics associated with each. This investigation of dietary patterns may serve as a starting point for developing public health strategies targeting specific groups to improve nutrition and prevent the future development of obesity and its complications.

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submitted 06.08.2024;

accepted for publication 21.08.2024;

published 31.10.2024

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