DIETARY PATTERNS IN ROMANIAN PATIENTS WITH TYPE 2 DIABETES MELLITUS

Andreea Gherasim[1], Lidia I. Arhire[1*], Otilia Nita[1], A. C. Oprescu[1], R. S. Gavril[1], O. Mitu[2], Mariana Graur[1], Laura Mihalache[1]
"Grigore T. Popa" University of Medicine and Pharmacy Iasi
Faculty of Medicine
1. Departament of Medical Specialties (II)
2. Departament of Medical Specialties (I)
[*]Corresponding author. E-mail: lidia.graur@umfiasi.ro

DIETARY PATTERNS IN ROMANIAN PATIENTS WITH TYPE 2 DIABETES MELLITUS (Abstract): Adherence to healthy dietary patterns leads to improvements in metabolic health and prevents the risk of diabetes and obesity. Current guidelines underscore the importance of focusing on individualized dietary patterns in nutritional therapy of diabetics. The objectives of this study were to identify the dietary patterns in Romanian patients with Type 2 Diabetes Mellitus and to investigate the impact of these dietary patterns on associated anthropometric and metabolic parameters. **Material and methods**: A total of 118 adults were included in this cross-sectional, observational study. Demographic and lifestyle data, information on current pathologies and associated co-morbidities, anthropometric measurements and biological markers were obtained. Dietary intake was assessed via the EPIC food frequency questionnaire. **Results:** We identified three dietary patterns by principal component analysis, defined as *Prudent*, *Western* and *Traditional*. We found that patients belonging to the Western pattern had higher waist-to-hip ratio, higher glycated hemoglobin A1c and were significantly younger compared to those in the Prudent pattern. Alcohol intake was significantly higher in the *Western* compared to the *Prudent* pattern. **Conclusions:** This study demonstrates that the *Western* pattern, characterized by high intake of meat and meat products, eggs and soft drinks, has negative metabolic consequences in Romanian adult patients with T2DM, compared to the *Prudent* pattern. The *Traditional* pattern was closer to the *Prudent* one. **Keywords:** TYPE 2 DIABETES MELLITUS, DIET, DIETARY PATTERN, FOOD FREQUENCY QUESTIONNAIRE, NUTRIENTS.

Type 2 Diabetes Mellitus (T2DM) is a major and complex chronic disease and a worldwide public health issue. The epidemic of T2DM parallels the epidemic of obesity and the adoption of an unhealthy sedentary lifestyle. Epidemiological evidence demonstrates an unprecedented increase in the prevalence of diabetes around the world, from 125 million individuals with diabetes in 1990, to 537 million in 2021 and to an estimated 643 million by 2030. Of particular concern is that the increase incidence of diabetes disproportionately affects populations with a low socio-economic status (1). In Romania, a recent, large epidemiological study has shown that

11.6% of the adult population has diabetes and 16.5% has prediabetes (2). The high prevalence of excess weight in the Romanian population may partly explain the high number of diabetic individuals since 31.1% of the Romanian adult population is overweight and 21.3% is obese (3).Thus, nutritional assessment (anthropometric, biochemical, clinical, dietary) is important to highlight the relationship with chronic diseases. Anthropometric parameters are predictive factors for cardio-metabolic diseases (4), obesity can be associated with certain infections (5) and malnutrition is frequent in surgical patients (6).

Numerous global changes in the modern lifestyle led to unhealthy eating behaviors (7). The most important changes are lack of physical activity and an increased preference for readily available calorie-rich foods with low nutritional value, leading to a shift toward a Western-like food pattern (1). Recent evidence showed that metabolic health is less influenced by each individual nutrient and is more driven by these global dietary patterns and the consumption of specific foods that have synergistic effects (8). For example, a typical Western diet is generally associated with insulin resistance, hyperlipidemia and pro-inflammatory status, thus increasing the risk of T2DM and cardiovascular diseases. On the other hand, a prudent or healthy diet is associated with a low risk of all-cause mortality (9), diabetes and obesity (10). In particular, there is compelling evidence demonstrating that, in individuals with type 2 diabetes, a healthy dietary pattern improves glycemic control and cardiovascular risk factors (11). Thus, current guidelines emphasize the need of medical nutrition therapy in diabetes to focus on dietary patterns and not on the individual components of the diet and should be individualized to the needs of the targeted population (12).

MATERIAL AND METHODS

Study design

A one-year (2017), cross-sectional observational study was conducted on a group of patients with T2DM who were admitted-for the annual medical evaluation at the Center for Diabetes, Nutrition and Metabolic Diseases at “Sf. Spiridon” County-Clinical Emergency Hospital from Iasi, Romania. The study was approved by the Ethics Committee of the “Grigore T. Popa” University of Medicine and Pharmacy Iasi (Registration no 2327/02.02.2017). All patients received information about the study and signed informed consent before any investigation commenced.

Study population

Adult patients (n=118) of which 55 males and 63 females, with an average age of 60.8±10.05 y, with diagnosed T2DM, and on diabetes nutrition therapy with or without oral anti glycemic medication, who provided informed consent were enrolled in this study. Therefore, children, patients with T2DM treated with insulin or GLP-1 receptor agonists, patients with type 1 diabetes mellitus, malnutrition, psychiatric diseases, inflammatory diseases, individuals who were institutionalized or intellectually unfit, or those unwilling to sign the informed consent were excluded from the study.

Data collection

For each patient, socio-demographic and lifestyle data (age, sex, area of residence, smoking status, alcohol intake) and personal medical history including associated co-morbidities were recorded. In addition, anthropometric parameters such as weight, height and waist circumference were taken, using standard methods with a calibrated scale and stadiometer. Waist circumference (WC) was measured with a tape measure midway between the rib case and the upper edge of the iliac crest, around the abdomen, in a horizontal plane, parallel to the floor, at the end of a normal breath. Normal values were considered <80 cm in women and <94 cm in men, according to the International Diabetes Federation criteria for abdominal obesity (13). Body mass index (BMI) was calculated [Weight (kg) / Height^2 (m^2)] and patients were classified according to the World Health Organization criteria. We also calculated the waist-to-hip ratio (WHR), as the ratio between waist circumference and hip circumference, where normal values are less than 0.85 in women and less than 0.95 in men (14). Blood pressure was measured twice in all patients, using a mercury sphygmomanometer. Fasting blood samples were collected in all patients and the following laboratory tests were performed: plasma glucose, (measured by spectrophotometric method - colorimetric enzyme), glycated hemoglobin (HbA1c) (measured by HPLC assay), total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides (all measured by spectrophotometry, enzymatic method), C-reactive protein (measured by latex immunoturbidimetric assay).

Dietary assessment

Food intake (frequency and quantity) was estimated using the translated, adapted and validated version of the EPIC-Norfolk -FFQ (15). Participants were asked to specify the appropriate frequency of intake for each of the listed foods (133 items), choosing from the nine proposed frequency categories, from never before or less than once a month to more than 6 times a day. We used FETA program (16) for food analysis, which generated the daily average energy and nutrients intake and the daily average intake (in grams/day) of the 13 food groups generated in FETA: cereals and derivatives (which includes bread, pasta, polenta), potatoes, meat and derivatives, fish and derivatives, eggs, fruits, vegetables, milk and derivatives, nuts/seeds, sugar/snacks, fats/oil, soups/sauces, soft drinks (which includes all non-alcoholic beverages, sweetened coffee and tea) and, in addition, alcoholic beverages.

Statistical analysis

The applicability of the principal component analysis for the variables used was verified using the Keyser-Meyer Olkin test (KMO) and the Bartlett test. A KMO value of >0.5 was acceptable and a *p* value of <0.05 in the Bartlett test was considered significant. Only factors extracted based on the Kaiser criteria (Eigenvalue above 1.2) were considered. These factors were referred to as dietary patterns. To obtain an easy-to-interpret model, the correlation matrix was rotated (orthogonal, varimax). The factor loading over 0.3 was considered significant. If a food group had a loading factor of more than 0.3 in several components, then the food pattern was identified based on the highest value. After rotation, those food groups responsible for the highest load of factors for each factor were identified. Scores that defined each pattern were generated. These scores were the extent to which each individual differed from the average for each score (in standard deviations), therefore higher scores indicated a higher “adherence” to that pattern (17). Dietary patterns were named according to those food groups responsible for the highest load of factors corresponding to each factor. Chi-square test was used for categorical variables and ANOVA for continuous variables to compare the differences between subjects identified with different food patterns. For non-homogeneous variables t-test was used. Bivariate correlation (Pearson r) was used to identify associations between continuous variables. All data were analyzed using *SPSS Statistics version 20.0, for Windows.*

RESULTS

Subjects general characteristics

We analyzed a group of 118 patients. The general characteristics of the study population are presented in first table.

TABLE I

General characteristics of the study population

Characteristics	Total (n=118)	Men (n=55, 46.6%)	Women (n=63, 53.4%)	*p*
Age (years); mean±SD	60.85±10.05	59.09±10.78	62.38±9.18	NS
Residence (urban); n, %	83, 70.3	41, 49.4	42, 50.6	NS
Duration of DM (years); mean, 95% CI	5.49 (4.5, 6.4)	5.45 (3.8, 7.01)	5.53 (4.3, 6.6)	NS #
Smoking; n, %	11, 11.1	9, 9.1	2, 2	**0.021**
Education; n, %	Higher education 24, 23.8%	Highschool 9, 8.9%	Primary education 8, 7.9%	NS
Occupation; n, %	Retired 30, 25.4%	Active workers 10, 8.5%	Others (unemployed, household) 12,10.2%	**0.022**
Alcoholic beverages intake (g/day); mean, 95% CI	86.67 (62.91, 110.43)	125.8 (86.2, 165.39)	52.51 (26.31, 78.72)	**0.003#**
BMI (kg/m^2); mean±SD	31.96±5.76	31.18±5.94	32.65±5.55	NS
WC (cm); mean±SD	105.72±13.05	106.36±13.18	105.16±13.02	NS
WHR; mean±SD	0.97±0.07	0.99±0.05	0.95±0.08	**0.004#**
Normal weight; n, %	6, 5.1	3, 5.5	3, 4.8	NS
Overweight; n, %	42, 35.6	24, 43.6	18, 28.6	
Obesity; n, %	70, 59.3	28, 50.9	42, 66.7	
Systolic BP (mmHg); mean±SD	141.07±19.96	143.45±19.79	138.98±20.03	NS
Diastolic BP (mmHg); mean±SD	84.24±9.9	85.04±10.45	83.54±9.43	NS
Diagnostic of hypertension; n, %	86, 74.1	37, 43	49, 57	NS
Fasting plasma glucose (mg/dl); mean±SD	143.69±36.23	139.84±33.91	147.06±38.09	NS
HbA1c (%); mean±SD	6.94±1.22	6.97±1.35	6.92±1.1	NS
Total cholesterol (mg/dl); mean±SD	200.69±49.37	196.53±45.66	204.39±52.54	NS
HDL-cholesterol (mg/dl); mean±SD	47.75±13	43.49±9.68	51.58±14.43	**0.001#**
LDL-cholesterol (mg/dl); mean±SD	128.27±44.73	125.24±42.85	130.95±46.52	NS
Triglycerides (mg/dl); mean±SD	170.87±115.98	189.33±151.19	154.5±69.03	NS #
CRP (mg/dl); mean, 95% CI	0.43 (0.34, 0.52)	0.4 (0.26, 0.55)	0.45 (0.33, 0.58)	NS

Equal variances not assumed; *p*, significant difference between sexes; NS, non-significant;
BMI, body mass index; WC, abdominal circumference; WHR, waist-to-hip ratio; HbA1c, glycated hemoglobin;
CRP, C-reactive protein; SD, standard deviation; CI, confidence interval; SD, standard deviation

Daily intake of energy, macronutrients and food groups

Tab. II shows the average intake of energy and macronutrients in the study population, as derived from FETA analysis of the EPIC questionnaire, for the entire study population and with comparison between sexes. We found significant differences between sexes for consumption of total lipids (32.67% in women, *vs*. 30.59% in men, p=0.029) and polyunsaturated fatty acids (PUFA) (6.7% in women *vs*. 5.96% in men, p=0.006). The analysis also generated the daily average intake of the 13 food categories defined by FETA. Although there were some differences in the consumption of food groups between sexes, these were not statistically significant.

TABLE II

Average daily intake of calories, macronutrients and food groups

Energy, macronutrients, food group intake	**Total (n=118)**	**Men (n=55, 46.6%)**	**Women (n=63, 53.4%)**	***p***
Energy and macronutrients intake mean±SD				
Energy (kcal/day)	1672.60±572.4	1754.99±613.9	1600.67±527.9	NS
Carbohydrates (%)	48.21±5.9	47.76±5.8	48.60±5.9	NS
Lipids (%)	31.66±5.3	30.51±4.8	32.67±5.6	**0.029**
Proteins (%)	19.25±3.2	19.15±3.6	19.33±2.8	NS
SFA (%)	11.03±2.7	10.71±2.4	11.30±2.8	NS
MUFA (%)	11.17±2.5	10.73±2.0	11.56±2.8	NS
PUFA (%)	6.36±1.4	5.96±1.2	6.70±1.6	**0.006**
Fiber (g/day)	18.03±7.2	17.63±7.5	18.38±7.0	NS
Cholesterol (mg/day)	336.79±123.0	366.55±132.2	317.70±123.9	NS
Food group intake (g/day) mean±SD				
Cereals and derivatives	225.52±120.2	222.60±121.4	228.08±120.2	NS
Eggs	23.21±14.9	25.67±15.2	21.07±14.4	NS
Fats/oil	12.69±7.4	11.78±7.2	13.49±7.5	NS
Fish and derivatives	31.6±21.4	33.86±24.0	29.63±18.9	NS
Fruits	270.16±138.5	259.10±144.3	279.83±133.6	NS
Meat and derivatives	124.21±69.0	137.21±74.3	112.87±62.5	NS
Milk and derivatives	235.85±145.3	219.27±146.0	250.34±144.4	NS
Soft drinks	382.51±274.9	372.15±271.8	391.55±279.4	NS
Nuts, seeds	6.23±11.5	4.24±6.9	7.97±14.2	NS
Potatoes	64.77±36.6	62.33±36.6	66.90±36.8	NS
Soups and sauces	215.82±135.1	239.99±163.3	194.72±101.3	NS
Sugar/snacks	13.44±15.7	16.32±19.79	10.93±10.52	NS
Vegetables	288.14±149.32	295.87±162.92	281.39±137.34	NS

SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SD, standard deviation; *p*, difference between sexes; NS, non-significant

When correlation analyses were conducted between daily intake of food groups and clinical and metabolic parameters, there was a small, but statistically significant inverse correlations between total cholesterol and consumption of nuts and seeds (r=-.199, *p*=.032). WHR was negatively correlated with consumption of nuts and seeds (r=-.26, *p*=.007) and positively correlated with intake of soups and sauces (r=.262, *p*=0.006). Fasting plasma glucose correlated negatively with meat and derivatives intake (r=-.208, *p*=.024). CRP was positively correlated with the amount of sugar/snacks (r=.189, *p*=.041) and diastolic blood pressure was positively correlated with fish and derivatives intake (r=.198, *p*=.003) (tab. III).

TABLE III
Correlations between daily average intake of different food groups and clinical and metabolic parameters

Food groups	Pearson's correlation coefficient										
	BMI	WC	WHR	SBP	DBP	FBG	HbA 1c	Total chol	LDL chol	Tg	CRP
Cereals and derivatives	-.050	-.077	-.138	.094	.101	-.030	.062	- 0.018	.024	-.009	-.043
Eggs	-.044	-.067	.020	-.076	-.067	-.061	-.003	- 0.012	.053	-.043	-.089
Fats / oil	-.130	-.166	-.140	.049	.135	-.160	-.033	0.072	.119	-.019	-.066
Fish and derivatives	-.140	-.135	-.119	.110	**.198***	-.030	-.015	- 0.020	.025	-.034	-.128
Fruits	-.066	-.138	-.034	.003	.046	-.083	-.007	- 0.114	-.062	-.029	-.127
Meat and derivatives	-.074	-.084	.020	-.033	-.016	-.208*	-.036	- 0.072	-.008	-.002	-.104
Milk and derivatives	.041	.064	-.059	.060	.045	-.056	-.011	0.038	.079	-.027	-.175
Soft drinks	.177	.079	.049	-.034	-.062	.023	.000	- 0.020	.023	.030	.093
Nuts, seeds	-.078	-.120	**-.260****	.167	.024	-.009	-.138	**- 0.199***	**-.193***	-.078	-.059
Potatoes	-.029	-.074	-.113	.040	-.044	-.148	-.045	- 0.045	.018	.012	-.147
Soups and sauces	.002	.014	**.262****	-.105	-.123	-.036	-.008	- 0.143	-.057	-.048	-.052
Sugar / snacks	-.150	-.055	.006	.024	.062	-.180	-.074	0.061	.140	-.141	**.189***
Vegetables	-.050	-.030	.179	.102	.049	.022	.077	- 0.147	-.080	-.015	.020

*p<0.05; **p<0.01; BMI, body mass index; WC, waist circumference; WHR, waist-to-hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; Tg, triglycerides; CRP, C-reactive protein.

Dietary patterns characterization

There was a high correlation between food groups (KMO = 0.72). Using the principal component analysis, and selecting the varimax rotation, based on the Kaiser criteria and the scree plot (Fig. 1), three food patterns were generated. In the initial solution, these patterns had an Eigenvalue value > 1.2 and accounted for 53.6% of the variance.

The first factor identified that accounted for 29.24% of the variance, was characterized by an increased intake of fat, oil, cereals, potatoes, vegetables, fish, nuts, seeds and fruits. This was named the *Prudent* pattern. The second factor that represented 13.85% of variance and was characterized by increased intake of meat and meat products, eggs and soft drinks, was named the *Western* pattern. Although the sugar/snacks load did not exceed 0.3, we elected to include it in this pattern since it had the highest loading value, among all three patterns. The third factor that accounted for 10.5% of the variance and was characterized by high intake of milk and derivatives, soups/sauces and vegetables, was named the *Traditional* pattern (tab. IV, fig. 2).

There was a significant difference between patterns, with 21.8% men and 42.9% women included in the *Prudent* pattern, whereas 40% men and 15.9% women belonged to the *Western* pattern (p=0.002). Also, there were significantly more women than men in the *Traditional* compared to the *Western* pattern (p=0.004). Likewise, patients included in the *Prudent* pattern were significantly older than those included in the *Western* pattern (p=0.02). Alcoholic beverages intake was significantly higher in the *Western* compared to the *Prudent* pattern (p=0.005) and patients included in the *Western* pattern had a significantly higher WHR compared to those included in the *Prudent* pattern (p=0.013). HbA1c value was higher in the *Western* pattern (p=0.031) (tab. V).

When correlations analyses between pattern scores and characteristics of the study population were run, there was a significant direct relationship between the *Prudent* pattern and age. WHR was negatively associated with *Prudent* pattern and positively with *Western* pattern (tab. VI).

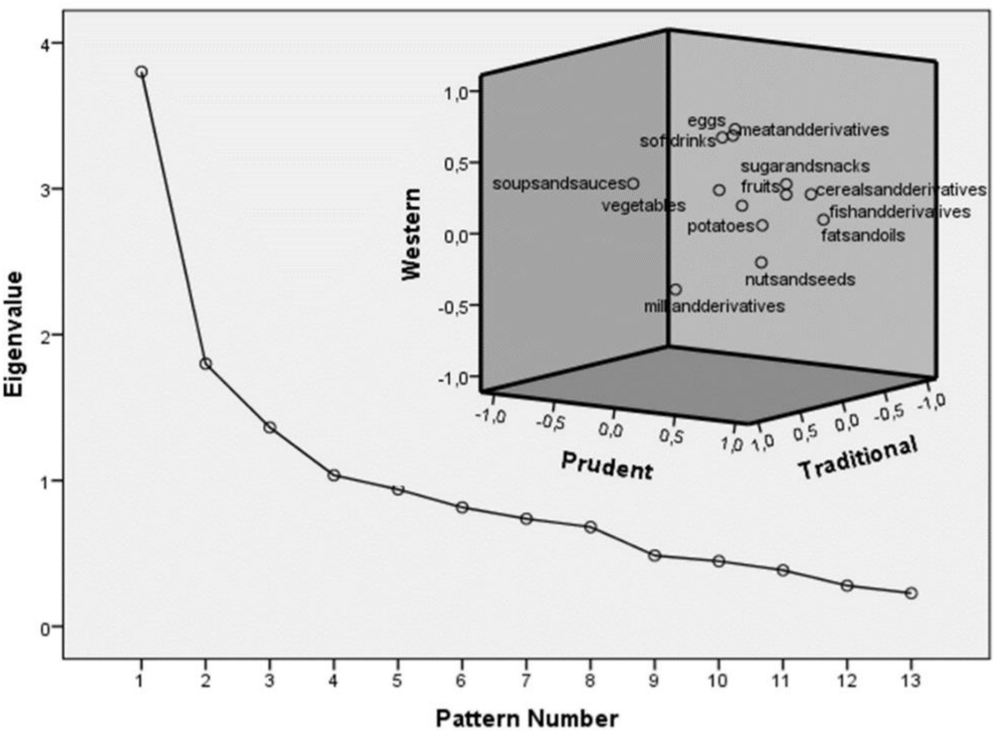

Fig. 1. Number of dietary patterns identified based on Eigenvalue criteria and analyzed by rotated space matrix

TABLE IV

Factor loadings and dietary patterns derived by PCA

	Factor 1 *Prudent* pattern	Factor 2 *Western* pattern	Factor 3 *Traditional* pattern
Fats/oil	**.870**	.121	-.120
Cereals/derivatives	**.761**	.286	-.128
Fish/derivatives	**.639**	.289	-.009
Potatoes	**.607**	.104	.230
Fruits	**.566**	.265	.411
Nuts/seeds	**.376**	-.225	-.090
Meet/derivatives	.278	**.726**	.084
Soft drinks	.133	**.644**	.027
Eggs	.091	**.626**	-.160
Sugar/snacks	.238	**.240**	-.581
Soups/sauces	-.122	.394	**.718**
Milk/derivatives	.192	-.324	**.664**
Vegetables	.457	.380	**.526**

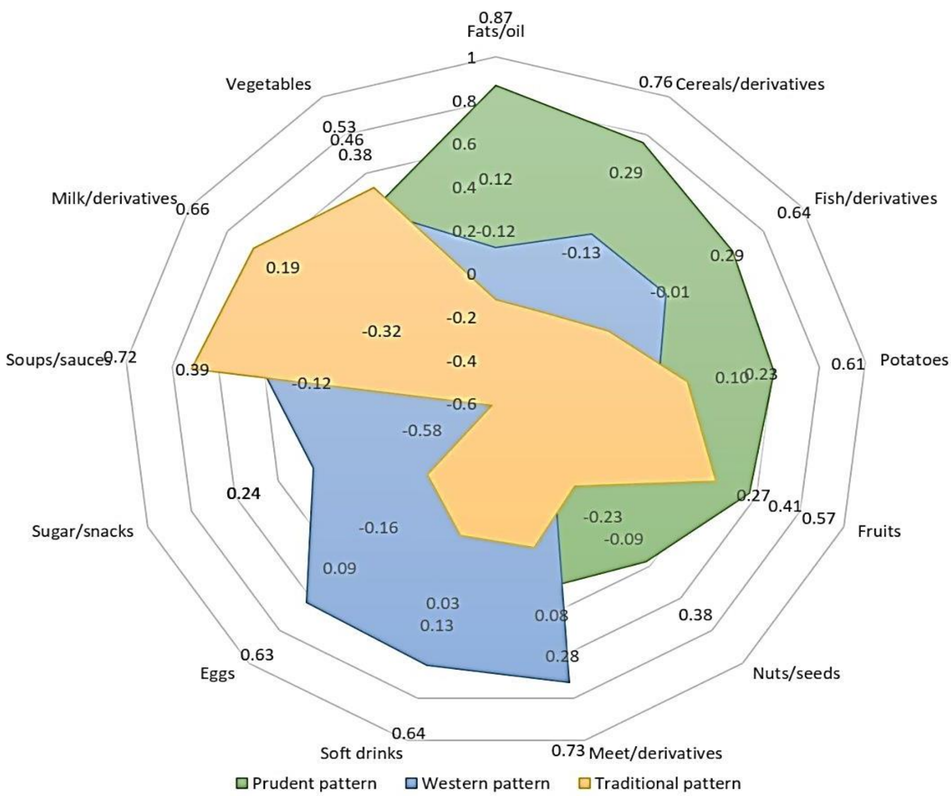

Fig. 2. The three dietary patterns identified

TABLE V

Comparison of the characteristics of the study population included in dietary patterns

Characteristics	***Prudent* pattern (n=39, 33.1%)**	***Western* pattern (n=32, 27.1%)**	***Traditional* pattern (n=47, 39.8%)**	***p***
Men; n, %	12, 21.8	22, 40	21, 38.2	**0.002#**
Women; n, %	27, 42.9	10, 15.9	26, 41.3	**0.004***
Age (years); mean±SD	63.9±9.23	57.44±9.64	60.64±10.38	**0.02#**
Residence (urban); n, %	28, 33.7	23, 27.7	32, 38.6	NS
Duration of DM (years); mean, 95% CI	5.38 (3.82, 6.94)	4.51 (2.79, 6.23)	6.25 (4.61, 7.89)	NS
Smoking; n, %	4, 36.4	5, 45.5	2, 18.2	NS
Alcoholic beverages intake (g/day);mean, 95% CI	44.46 (23.16, 65.76)	140.96 (86.42, 195.49)	84.73 (42.55, 126.92)	**0.005#**
Education; n, %	Higher education 24, 23.8%	Highschool 9, 8.9%	Primary education 8, 7.9%	NS
Occupation; n, %	Retired 30, 25.4%	Active workers 10, 8.5%	Others 12, 10.2%	**0.022**
BMI (kg/m^2); mean±SD	31.04±5.87	32.65±5.23	32.26±6.02	NS
WC (cm); mean±SD	103.18±13.46	107.91±11.38	106.34±13.68	NS
WHR; mean±SD	0.95±0.07	0.99±0.05	0.98±0.07	**0.013#**
Normal weight; n, %	3, 50	0, 0	3, 50	NS
Overweight; n, %	16, 38.1	11, 26.2	15, 35.7	
Obesity; n, %	20, 28.6	21, 30	29, 41.4	
Systolic BP (mmHg); mean±SD	145.13±24.38	136.78±16.29	140.62±17.79	NS
Diastolic BP (mmHg); mean±SD	86.97±10.2	82.53±9.4	83.13±9.72	NS
Diagnostic of hypertension;n, %	33, 38.4	20, 23.3	33, 38.4	NS
Fasting plasma glucose (mg/dl); mean±SD	139.9±33.4	147.38±33.4	144.34±40.53	NS
HbA1c (%); mean±SD	6.65±0.92	7.28±1.37	6.96±1.28	**0.031#**
Total cholesterol (mg/dl); mean±SD	210.64±55.09	198.81±48.27	193.68±44.53	NS
HDL-cholesterol (mg/dl); mean±SD	49.26±13.64	45.76±13.1	47.73±12.48	NS
LDL-cholesterol (mg/dl); mean±SD	135.8±51.9	126.38±44.35	123.38±38.29	NS
Triglycerides (mg/dl); mean, 95% CI	170.95 (145.13, 196.77)	188.06 (119.51, 256.62)	159.47(137.56, 181.38)	NS
CRP (mg/dl); mean, 95% CI	0.38 (0.21, 0.55)	0.48 (0.32, 0.64)	0.43 (0.27, 0.59)	NS

#, sig. between *Prudent* and *Western* pattern; *, sig. between *Western* and *Traditional* pattern BMI, body mass index; WC, abdominal circumference; WHR, waist-to-hip ratio, HbA1c, glycated hemoglobin; CRP, C-reactive protein; SD, standard deviation; CI, confidence interval; *p*, difference between sexes; NS, non- significant

TABLE VI

Correlations between dietary pattern scores and clinical/biological variables

Variables		Pearson's coefficient		
		***Prudent* pattern**	***Western* pattern**	***Traditional* pattern**
Clinical parameters	Age (years)	**.199***	-.163	-.022
	BMI (kg/m2)	-.138	.014	.069
	WC (cm)	-.166	-.008	.049
	WHR	**-.232***	**.190***	.142
	SBP (mm Hg)	.154	-.116	-.017
	DBP (mm Hg)	.162	-.087	-.061
Biological parameters	FPG (mg/dl)	-.116	-.073	.027
	HbA1c (%)	-.035	.023	.037
	Total cholesterol (mg/dl)	-.029	-.057	-.118
	LDL cholesterol (mg/dl)	.021	.023	-.081
	HDL cholesterol (mg/dl)	-.068	-.063	-.098
	Triglycerides (mg/dl)	-.039	-.011	.024
	CRP (mg/dl)	-.118	.041	-.152

*p<0.05; BMI, body mass index; WC, waist circumference; WHR, waist-to-hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; CRP, C-reactive protein.

DISCUSSION

Eating habits are difficult to change even when patients diagnosed with T2DM are motivated to pursue such changes (18). Our study population presents typical characteristics of individuals with T2DM: mature adults (60.85±10.05 years old), with excess body weight (94.9%), hypertension (74.1%) and borderline glycemic control (HbA1c=6.9±1.2). The average duration of the disease in our patients was 5.5 years and they were provided with nutritional therapeutic education, according to current guidelines for the management of diabetes. Indeed, when we assessed the energy and macronutrient intake of our study population, we observed a balance between macronutrients as percentage of total caloric intake, consistent with the recommendations from food guidelines (12). They reported on average daily intake of 48.2% carbohydrates, 31.6% total lipids and 19.2% protein. However average daily energy intake seen in our study was lower than the recommendations for the general population.,explained either by the typical underestimation seen with self-reported methods of investigation (19) or by the fact that patients with excess weight were reducing caloric intake. A close inspection of the data from the analysis of EPIC questionnaire in FETA revealed several nutritional issues in our patients: low intake of fiber (18 g/day), high consumption of SFA

(11% of total caloric intake) and increased dietary cholesterol (336.8 mg/day), although these observations were consistent with FAO reports (20).

Usually, the terms used in the literature to describe dietary patterns are: "healthy or prudent" that are represented by foods or food groups such as fruits, fish, poultry, whole grains and vegetables) (21); "Western", represented by foods or food groups such as red meat, processed meat, sweets, sugar, snacks, high-fat dairy products and French fries) (22), and "traditional" that is represented by foods or food groups that are country specific, such as white rice, beans, beer, processed and fresh meats, for a common Brazilian meal (23), or such as vegetables, seaweeds, soybean products, fish, fruits, miso soup and green tea, for traditional Japanese pattern (24). Out of the three commonly used dietary patterns, *Western* is the one of concern given that its representative food groups have been associated with high prevalence of chronic diseases (25).

The first pattern we identified is the *Prudent* pattern, characterized by an increased intake of fats, oil, cereals, potatoes, vegetables, fish, nuts, seeds, and fruits. The second is the *Western* pattern, characterized by high intake of meat and meat products, eggs and soft drinks. The third is the *Traditional* pattern, characterized by a high intake of milk and derivatives, soups/ sauces and vegetables. A characteristic of our *Western* pattern was high intake of soft drinks. Fructose-sweetened beverages have many adverse effects such as deposition of visceral fat, increased lipid parameters and increased blood pressure and decreased insulin sensitivity in overweight and obese people (26). We found that patients included in the Western pattern had higher WHR and HbA1c values compared to those in the *Prudent* pattern. These improved health outcomes in patients included in the Prudent pattern could be explained by fish consumption, known for its high contents in omega 3 PUFA, nuts consumption which are high in PUFA and MUFA. Despite the high fat and energy content, regular nut consumption was not associated with increased obesity, but instead it offered benefits in weight control (27). These data confirm our results showing a negative correlation between nut intake and WHR. Furthermore, the *Prudent* pattern is characterized by high intake of fruit, vegetables, cereals that may exert hypoglycemic effects and decrease insulin response via increase in fiber, specific vitamins and minerals, flavonoids, carotenoids (28).

Our results did not show significant associations between dietary patterns and blood pressure, which is consistent with other studies (29).

Dietary analyses and metabolic parameters indicate that *Traditional* pattern is much closer to the *Prudent* rather than *Western* pattern in terms of health outcomes. Moreover, soups and sauces that are included in this pattern are part of the traditional Romanian cooking with "borș", a liquid resulting from wheat bran fermentation, and significant amounts of vegetables and greens. Patients included in the Western pattern, were significantly younger than those who adhered to the *Prudent* pattern. It might be that younger individuals are more exposed to the Western influence in their dietary choices or prefer fast foods. This is important and worrisome since adherence to *Western* pattern from an early age may result in increased risk for T2DM. On average, prudent diets were more prevalent in older adults compared to younger adults (30). In general, food pattern studies have found that older people, and women in particular, consume less red meat, whole milk and other fatty foods and consume more fruits and vegetables than younger people (31). Higher standard of living, higher education, nutritional knowledge has been associated with a healthy/"prudent" dietary pattern (32). It has been shown that people with lower education have more financial restraints and limited access to healthy food (33). In our study, individuals with higher education degrees and those currently retired, have adhered to the Prudent pattern, whereas those with lower education and employed tended to adopt the Western pattern.

The Romanian Dietary Guidelines promotes a healthy nutrition based on consumption of cereals, fruits, vegetables, foods with low fat content and reduction of processed and high sugar foods (34). Dietary patterns recently studied in the general Romanian population showed a Prudent pattern characterized by large intake of fish, vegetables, legumes, fruits and soymilk, adopted by elderly women and those with a higher education level (35).

Although we have included a large number of T2DM patients, our study has several limitations such as the observational design and lack of a control group consisting of individuals without diabetes. Also, since most subjects were from the urban areas, we cannot make a clear distinction between urban and rural dietary patterns. These patterns are from the Iasi County, situated in the north-eastern region of the country thus data from other regions of the country will be useful in order to get a broader picture of dietary patterns in this population.In addition, our study cannot identify the effects of different oral hypoglycemic treatments or other pathologies that may have influenced patients' food selections.

Also, our subjects did not complete a physical activity questionnaire, thus the extent to which physical exercise might have influenced food selection is difficult to ascertain. Notwithstanding these limitations, our findings demonstrate the value of dietary patterns in nutritional therapy in T2DM in Romanian population.

CONCLUSIONS

This is the first clinical observational study to identify dietary patterns in Romanian patients with type 2 diabetes. Using principal component analysis on 13 food groups derived from the EPIC questionnaire has allowed us to identify three food patterns: *Prudent*, *Western* and *Traditional*. The *Western* pattern was associated with detrimental consequences on abdominal adiposity and glycemic control compared to the *Prudent* pattern. The *Traditional* pattern seems closer to the *Prudent*, than the *Western* pattern. Studies on food patterns, food selections and dietary preferences in patients with metabolic disorders including diabetes in Romania are scarce. Given the differences in country specific food patterns and their impact in disease management, identifying food patterns in patients with Type 2 Diabetes Mellitus could help tailor educational programs in order to target diet and overall lifestyle optimization meant to slow down disease progression and its complications.

CONFLICT OF INTEREST AND FUNDING

The authors declare that there is no conflict of interest, and they received no specific funding regarding the scientific research.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas, 10th ed. 2021. https://diabetesatlas.org/ [Accesed May 24, 2022].
2. Mota M, Popa SG, Mota E, *et al.* Prevalence of diabetes mellitus and prediabetes in the adult Romanian population: PREDATORR study. *J Diabetes* 2016; 8(3): 336-344 / doi: 10.1111/ 1753-0407. 12297.
3. Roman G, Bala C, Creteanu G, *et al.* Obesity and Health-Related Lifestyle Factors in the General Population in Romania: a Cross Sectional Study. *Acta Endocrinologica (Bucharest)* 2015; 11(1): 64-72 / doi: 10.4183/ aeb.2015.64.
4. Mihalache L, Graur LI; Popescu DS, Nita O, Graur M. Anthropometric parameters predictive factors for cardio-metabolic diseases. *Rev Med Chir Soc Med Nat Iasi* 2012; 116(3): 794-798.
5. Mihalache L, Gavril R, Arhire LI, *et al.* Nutritional biomarkers in patients with obesity-the relation between helicobacter pylori infection and micronutrients. *Rev Chim* 2016; 67: 2413-2416.
6. Trufa DI, Arhire LI, Grigorescu C, *et al.* Assessment of preoperative and postoperative prealbumin in thoracic surgery - a two-month experience in a Romanian university hospital / Evaluarea preoperatorie şi postoperatorie a prealbuminei în chirurgia toracică - experienţa de 2 luni a unui spital universitar din România. *Rev Romana Med Lab.* 2015; 23(1): 75-86.
7. Gherasim A, Arhire LI, Niță O, Popa AD, Graur M, Mihalache L. The relationship between lifestyle components and dietary patterns. *Proc Nutr Soc* 2020; 79(3): 311-323.
8. Mozaffarian D, Appel LJ, Van Horn L. Components of a cardioprotective diet: new insights. *Circulation* 2011; 123(24): 2870-2891 / doi: 10.1161/CIRCULATIONAHA.110.968735.
9. Rodriguez-Monforte M, Flores-Mateo G, Sanchez E. Dietary patterns and CVD: a systematic review and meta-analysis of observational studies. *Br J Nutr* 2015; 114(9): 1341-1359 / doi: 10.1017/ S0007 114515003177.
10. Godos J, Zappala G, Bernardini S, Giambini I, Bes-Rastrollo M, Martinez-Gonzalez M. Adherence to the Mediterranean diet is inversely associated with metabolic syndrome occurrence: a meta-analysis of observational studies. *Int J Food Sci Nutr* 2017; 68(2): 138-148 / doi: 10.1080/09637486. 2016. 1221900.
11. Esposito K, Maiorino MI, Bellastella G, Panagiotakos DB, Giugliano D. Mediterranean diet for type 2 diabetes: cardiometabolic benefits.*Endocrine* 2017; 56(1): 27-32 / doi: 10.1007/s12020-016-1018-2.
12. American Diabetes Association. 5. Lifestyle Management: Standards of Medical Care in Diabetes-2019. *Diabetes Care* 2019; 42(Suppl 1): S46-S60 / doi: 10.2337/dc19-S005
13. Alberti KG, Eckel RH, Grundy SM, *et al.* Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation* 2009; 120(16): 1640-1645 / doi: 10.1161/ CIRCULATIO NAHA.109.192644.
14. World Health Organization Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008.
15. Gherasim A Arhire LI, Niță O, Străteanu R, Oprescu AC, Graur M, Mihalache L. Can the EPIC food frequency questionnaire be applied to the population in Romania? *Rev Med Chir Soc Med Nat Iasi* 2015; 119(3): 856-863.
16. Mulligan AA, Luben RN, Bhaniani A, *et al.* A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability. *BMJ Open* 2014; 4(3): e004503 / doi: 10.1136/bmjopen-2013-004503.

17. Gimeno SG, Andreoni S, Ferreira SR, Franco LJ, Cardoso MA. Assessing food dietary intakes in Japanese-Brazilians using factor analysis. *Cad Saude Publica* 2010; 26(11): 2157-2167 / doi: 10.1590/s0102-311x2010001100017.
18. Cheng L, Leung DY, Sit JW, *et al.* Factors associated with diet barriers in patients with poorly controlled type 2 diabetes. *Patient Prefer Adherence* 2016; 10: 37-44 / doi: 10.2147/ PPA.S94275.
19. Svensson A, Renstrom F, Bluck L, Lissner L, Franks PW, Larsson C. Dietary intake assessment in women with different weight and pregnancy status using a short questionnaire. *Public Health Nutr* 2014; 17(9): 1939-1948 / doi: 10.1017/S1368980013003042.
20. Fats and fatty acids in human nutrition. Report of an expert consultation 2010. *FAO Food Nutr Pap* 2010; 91: 1-166.
21. Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D, Willett WC. Prospective study of major dietary patterns and risk of coronary heart disease in men. *Am J Clin Nutr* 2000; 72(4): 912-921 / doi: 10.1093/ajcn/72.4.912.
22. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* 2002; 13(1): 3-9 / doi: 10.1097/00041433-200202000-00002.
23. Drehmer M, Odegaard AO, Schmidt MI, *et al.* Brazilian dietary patterns and the dietary approaches to stop hypertension (DASH) diet-relationship with metabolic syndrome and newly diagnosed diabetes in the ELSA-Brasil study. *Diabetol Metab Syndr* 2017; 9: 13 / doi: 10.1186/s13098-017-0211-7.
24. Niu K, Momma H, Kobayashi Y, *et al.* The traditional Japanese dietary pattern and longitudinal changes in cardiovascular disease risk factors in apparently healthy Japanese adults. *Eur J Nutr* 2016; 55(1): 267-279 / doi: 10.1007/s00394-015-0844-y.
25. Marchioni DM, Latorre Mdo R, Eluf-Neto J, Wunsch-Filho V, Fisberg RM. Identification of dietary patterns using factor analysis in an epidemiological study in Sao Paulo. *Sao Paulo Med J* 2005; 123(3): 124-127 / doi: 10.1590/s1516-31802005000300007.
26. Stanhope KL, Schwarz JM, Keim NL, *et al.* Consuming fructose-sweetened, not glucose-sweetened, beverages increases visceral adiposity and lipids and decreases insulin sensitivity in overweight/obese humans. *J Clin Invest* 2009; 119(5): 1322-1334 / doi: 10.1172/JCI37385.
27. Jiang R, Manson JE, Stampfer MJ, Liu S, Willett WC, Hu FB. Nut and peanut butter consumption and risk of type 2 diabetes in women. *JAMA* 2002; 288(20): 2554-2560 / doi: 10.1001/jama.288.20.2554.
28. Mizoue T, Yamaji T, Tabata S, *et al.* Dietary patterns and glucose tolerance abnormalities in Japanese men. *J Nutr* 2006; 136(5): 1352-1358 / doi: 10.1093/jn/136.5.1352
29. Dabbagh-Moghaddam A, Kamali M, Hojjati A, *et al.* The Relationship between Dietary Patterns with Blood Pressure in Iranian Army Staffs. *Adv Biomed Res* 2018; 7: 127 / doi: 10.4103/ abr.abr35_18.
30. Imamura F, Micha R, Khatibzadeh S, *et al.* Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. *Lancet Glob Health* 2015; 3(3): e132-e142 / doi: 10.1016/ s2214-109x(14)70381-x.
31. Wakimoto P, Block G. Dietary intake, dietary patterns, and changes with age: an epidemiological perspective. *J Gerontol A Biol Sci Med Sci* 2001; 56 (Spec No 2): 65-80 / doi: 10.1093/ gerona/56. Suppl 2.65.
32. Wall CL, Gearry RB, Pearson J, Parnell W, Skidmore PM. Dietary intake in midlife and associations with standard of living, education and nutrition literacy. *NZ Med J* 2014; 127(1397): 30-40.
33. Martikainen P, Brunner E, Marmot M. Socioeconomic differences in dietary patterns among middle-aged men and women. *Soc SciMed* 2003; 56(7): 1397-410 / doi: 10.1016/s0277-9536(02)00137-5.
34. Graur M. *Ghid pentru alimentația sănătoasă*. Iasi: Performantica, 2006.
35. Roman G, Rusu A, Graur M, *et al.* Dietary Patterns and Their Association with Obesity: A Cross-Sectional Study. *Acta Endocrinol (Buchar)* 2019; 5(1): 86-95 / doi: 10.4183/ aeb.2019.86.