ENERGY, MACRONUTRIENTS AND DIETARY FIBRE INTAKE AMONG ADULTS IN NORTH MACEDONIA

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SUMMARY

Objective: The present research aimed to estimate macronutrients intake among adults in North Macedonia and to identify their predominant food sources.

Methods: Within this cross-sectional study dietary data were collected using repeated 24h recall interviews. Nationwide, adults aged 18+ were recruited. Dietary data, anthropometric measures and socio-demographic characteristics were available for 496 participants. Nutrient intake was analyzed using the Balkan Food Composition Database and Diet Assess and Plan platform. Macedonian dietary guidelines were used for estimation of inadequacy.

Results: Significant differences in macronutrients intake are noticed between age groups within certain socio-demographic factors. Total sugar intake was significantly higher among young adult females comparing with those older than 25 years (p = 0.049). Young urban females have significantly higher fats intake than older participants (p = 0.038). Higher total daily energy, proteins, fats and carbohydrates intake (p = 0.033, p = 0.043, p = 0.032, p = 0.042, respectively) was noticed among young urban males when compared to older ones. Only dietary fibre intake was higher among older urban males (p = 0.030). Univariate linear regression models showed that obese participants had significantly higher relative proteins intake comparing with those having BMI within recommended range (p = 0.024, β = 1.21). Relative carbohydrates intake was significantly lower among males (p = 0.018, β = −2.077) and among highly educated participants (p = 0.018, β = −4.304). Participants with tertiary education had higher relative fats intake (p = 0.012, β = 4.213).

Conclusion: Macronutrients intake of adults should be improved. There is higher intake of dietary fats and need for an increase of complex carbohydrates intake, particularly dietary fibre. Findings of this survey should be used in shaping, fine-tuning and implementing food and nutrition policies that will stimulate healthier diets for prevention of diet related non-communicable diseases.

INTRODUCTION

Dietary risk factors are proven to be the leading global contributors both in deaths and in Disability Adjusted Life Years (DALYs). High body mass index (BMI) is the leading risk factor in many countries along with the high blood pressure, another health risk closely related with nutrition and dietary habits of the population (1). Robust research data show correlation between diet and most of the leading non-communicable diseases (NCDs) and also beneficial health effects when dietary patterns are improved (2). The Republic of North Macedonia (MKD) is no exception when both leading risk factors and NCDs are compared to other developed or developing countries. NCDs are leading cause for premature dying in Macedonian population, attributing for most of the Years of Life Lost (YLL). In terms of DALYs in MKD, dietary risks and high systolic blood pressure are the leading risk factors (3). Cardiovascular diseases (CVD) and cancers account for around 80% of all deaths. Additionally, there

is high rate of fatal outcomes related to type 2 diabetes mellitus in MKD, accounting for 4% of all deaths. Dietary guidelines for the population of MKD were developed by the Institute of Public Health (IPH) and were formally endorsed by the Government, in 2014 (4). The Guidelines include the Dietary Intakes (DRIs) for nutrients and qualitative guidelines for healthy eating patterns.

Nutritional epidemiology, as relatively new area of research, is growing and expanding, and the need for data to implement science into policy is inevitable (5). Comprehensive population data about the food consumption of adults in MKD has not been collected and analyzed until our survey was initiated. Availability of comprehensive food consumption data in Southern Europe is also very limited. Available data suggest that the countries in the region share similar dietary patterns (6). Consequently, there was a need for population based national food consumption survey, both for research and policy purposes. The data collection for the first Food Consumption Survey (FCS) in MKD took place during the period April–June 2015 with the objective to assess the food

and drink consumption among the Macedonian adults. The study was initiated to assess the baseline situation having in mind that no nationally representative data on food consumption of adults existed in MKD. The aim of this paper is to analyze the energy, macronutrients and fibre intake, and to identify the predominant food sources for it in the diet of the adult population in MKD. Additionally, the study investigates the adherence of the population to the existing national dietary recommendations.

MATERIALS AND METHODS

Sampling

Sampling frame was based on the data of telephone (book) database, census of population from 2002, vital statistics and the migrations data, as well as estimates of population and households, annually provided by the State Statistical Office (7). It was a 2-staged stratified combined probability sample through sampling households by simple random sampling without replacement (SRSWOR) in the first stage and household's member according to quota criteria in the second one. Stratification was done according to type of settlement (urban or rural), four geo-economical regions, age groups and gender. Allocation of the sample by stratum was proportional to the size of the stratum. 95% confidence interval for incidence of 50% on sample size of 1,000 was $\pm 3.2\%$. Automatic control of procedure, interactive control of consistency and logical control of collected data was performed in 100% of cases.

Only one member of the household aged 18+ was interviewed. The interviews with the selected members of the households lasted for approximately 30 minutes on average. Anthropometric data were also collected based on self-reported information on height and weight. Socio-demographic characteristics of the study sample are presented in Table 1. Total of 219 men and 277 women were involved in the survey. Average age of respondents was 46.0 (47.8 for men and 45.2 for women). Age groups breakdown is as follows: 80 respondents were 18–24 years old; 319 were at the age group of 25–64 years; and 87 were older than 65. Regarding their place of living, 322 are living in urban and 174 in rural areas.

Dietary Assessment

Dietary data were collected using repeated 24h recall phone interviews conducted by trained interviewers. Data was collected for a representative sample of 496 respondents older than 18 years for two non-consecutive days. Time difference between the two interviews was approximately four weeks. The respondents were asked to report the complete consumption of food and beverages from the previous day (a day starting at midnight before the day of the interview). According to the methodology, interviewers were trained and instructed to obtain the quantification of food and drinks consumed in grams, using household measures. Interviewers also collected the data about recipes and their preparation and cooking methods. Using multiple pass technique, interviewers were able to capture food items that participants usually forget to report such as snacks, sweets, spices and liquids.

Nutrient Analysis

Macronutrients intake was estimated using the Balkan Food Composition Database (8). Total daily intake of macronutrients and contribution of particular food groups to total energy from carbohydrates, proteins and fats was calculated using the Diet Assess and Plan, the dietary assessment software tool validated in national and regional consumption studies and evaluated in a European Food Safety Authority (EFSA) project (9). The average daily macronutrients intake was calculated on individual level. Contribution of 13 food groups to average relative macronutrients intake was calculated.

Comparison According to Population Goals

Inadequacy of macronutrients intake was analyzed using existing population goals for MKD (4). For residents of MKD total carbohydrates intake should account for 45–65% of total energy, total protein intake for 10–35%, and the adequate intake of fats for 20–35% of total energy intake. We have also analyzed inadequacy for total daily fats intake for upper limit of 30% of total energy intake according to the WHO/FAO population goals in order to see the difference among participants who had inadequate intake according to these two versions of recommendations. Inadequacy for fatty acids was calculated according to the recommendations of the European Heart Network (10). Percentage of individuals in the population who met the dietary recommended target for macronutrients was calculated for four socio-demographic categories that have been analyzed: age, gender, education, and type of settlement. Nutritional adequacy was also analyzed according to the BMI status.

Statistical Analysis

Mean and standard deviation were calculated for BMI, macronutrients and their components by age, gender and type of urbanization. Chi-square test was performed to check for the association between socio-demographic factors and BMI status as well as macronutrients inadequacy. T-test was used to assess the gender differences and type of urbanization while one-way analysis of variance (ANOVA) was used to assess difference within factors that have more than two categories. When statistically significant effects were identified, comparisons of means were further examined using Bonferroni correction to ascertain which specific means differed. For variables that were not normally distributed the Mann-Whitney and Kruskal-Wallis non-parametric test were used for comparison between two or more groups. Univariate linear regression models were used to explore the association between relative macronutrients contribution to energy intake and prediction factors. Value of $p < 0.05$ was considered statistically significant. All statistical analyses were performed using SPSS software package for Windows (version 20). Tables and figures were created using Microsoft Excel spreadsheets (version 1997 SR-2, Microsoft Corporation, Redmond, WA).

RESULTS

Table 2 presents results on anthropometric data. BMI was calculated based on self-reported height and weight and analyzed

by socio-demographic factors. We have found that females had significantly lower BMI than males and adults younger than 25 significantly lower than older ones. Participants were classified as underweight (BMI < 18.5 kg/m^2), weight within recommended range (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), and obese (> 30 kg/m^2). Significantly more females were underweight and had weight within recommended range, comparing to males who were more overweight and obese. Distribution of participants in BMI categories is also affected by age groups. There were significantly more underweight participants among young adults comparing to those older than 25 while more than 40% of adults older than 25 were overweight. The highest prevalence of overweight and obese participants was observed in the elderly group. Also, 40% of primarily educated participants were obese. Table 3 presents average daily intake of energy, macronutrients and fibre, as well as contribution of macronutrients to the total daily energy intake by age, gender and urbanization groups. We have examined effect of age factor within the gender and urbanization type and found that among rural females there was significant difference in relative sugar intake between age groups (p = 0.049). On the other side, among urban females, age factor affected total fats intake (p = 0.038). Age factor has shown a huge impact on urban males. Significant difference was found between age groups for total daily energy, proteins, fats and carbohydrates intake (p = 0.033, p = 0.043, p = 0.032, p = 0.042, respectively). Relative intake of fats was also affected by age factor within this group (p = 0.010). It is noteworthy to mention that adults younger than 25 years have higher intake of macronutrients than older participants except for the relative fats intake where the highest average relative intake was noticed among adults aged 25 to 65. It is interesting that age factor affects fibre intake too, but the trend was opposite (p = 0.030). Analyzing differences in macronutrients intake with respect to urbanization (within gender, excluding age factor) we have found that rural females had lower total sugar intake comparing with those living in urban areas. There were no such differences among men living in different urbanization settings. When analyzing macronutrients intake among rural

Table 1. Demographic characteristics of the sample (N = 496)

	Males (n = 219) n (%)	Females (n = 277) n (%)	Total n (%)
Age			
18–24	32 (14.6)	48 (17.3)	80 (16.1)
25–64	141 (64.4)	178 (64.3)	319 (64.3)
≥ 65	46 (21.0)	51 (18.4)	97 (19.6)
Type of settlement			
Urban	138 (63.0)	184 (66.4)	322 (64.9)
Rural	81 (37.0)	93 (33.6)	174 (35.1)
Education			
Primary	12 (5.5)	23 (8.3)	35 (7.1)
Secondary	134 (61.2)	171 (61.7)	305 (61.5)
Tertiary	73 (33.3)	83 (30.0)	156 (31.5)
BMI			
Underweight	1 (0.5)	17 (6.1)	18 (3.6)
Weight within recommended range	80 (36.5)	127 (45.8)	207 (41.7)
Overweight	96 (43.8)	88 (31.8)	184 (37.1)
Obese	42 (19.2)	45 (16.2)	97 (19.6)

Table 2. Distribution of participants according to their BMI status and SES factors (N = 496)

	BMI (mean ± SD)	p-value*	Underweight n (%)	Weight within recommended range n (%)	Overweight n (%)	Obese n (%)	p-value**
	25.8 ± 4.8		18 (3.6)	207 (41.7)	184 (37.1)	87 (17.5)	
Gender							
Female	25.4 ± 5.3	< 0.001	17 (6.1)	127 (45.8)	88 (31.8)	45 (16.2)	< 0.001
Male	26.3 ± 3.9		1 (0.5)	80 (36.5)	96 (43.8)	42 (19.2)	
Age							
18–24	21.8 ± 3.6		11 (13.8)	53 (66.3)	13 (16.3)	3 (3.8)	
25–64	26.4 ± 4.6	< 0.001	7 (2.2)	123 (38.6)	130 (40.8)	59 (18.5)	< 0.001
≥65	27.2 ± 4.4		0 (0.0)	31 (32.0)	41 (42.3)	25 (25.8)	
Type of settlement							
Rural	26.2 ± 5.6	ns	7 (4)	70 (40.2)	59 (33.9)	38 (21.8)	ns
Urban	25.6 ± 4.3		11 (3.4)	137 (42.5)	125 (38.8)	49 (15.2)	
Education							
Primary	27.5 ± 5.9		1 (2.9)	13 (37.1)	7 (20.0)	14 (40.0)	
Secondary	25.6 ± 4.6	ns	12 (3.9)	130 (42.6)	117 (38.4)	46 (15.1)	0.024
Tertiary	25.7 ± 4.8		5 (3.2)	64 (41.0)	60 (38.5)	27 (17.3)	

ns – not significant; *Mann Whitney test was used for comparison between rural and urban as well as between females and males while Kruskal-Wallis test was used for comparison between different age groups; **Chi-square test was used for comparison between BMI status categories and SES factors.

Table 3. Daily energy, macronutrient and fibre intakes in Macedonian adults according to age, sex and type of urbanization (mean ± SD) (N=496)

Rural

	Females										Males									
	18–24 (n=19)		25–64 (n=57)		≥65 (n=17)		p†	Total (n=93)		p‡	18–24 (n=14)		25–64 (n=53)		≥65 (n=14)		p†	Total (n=81)		pᵀ
	Mean	SD	Mean	SD	Mean	SD		Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	
Energy (MJ)	7.3	3.2	8.6	3.3	9.2	2.7	ns	8.4	3.2	ns	11.6	4.4	11.8	4.3	10.3	3.3	ns	11.5	4.2	<0.001
Proteins (g)	76.6	38.5	88.5	44.7	94.7	33	ns	87.2	41.6	ns	128.7	49.7	122.8	58.9	103.4	37.3	ns	120.4	54.3	<0.001
Proteins (% TE)	17.6	4.5	17.1	4.5	17.4	3.5	ns	17.3	4.3	ns	19.5	5.3	17.3	4.3	17	3.8	ns	17.7	4.5	
Total fats (g)	55.4	30.2	70.8	37.1	73.2	27.8	ns	68.1	34.5	ns	99.3	42.5	98.8	56	83	40.6	ns	96.2	51.4	<0.001
Total fats (% TE)	27.8	6.6	30.7	9.1	30.5	8.7	ns	30.1	8.6	ns	32.9	10.3	30.5	10.1	29.9	11.4	ns	30.8	10.3	<0.001
Total carbohydrates (g)	216	96	236	93	261	96	ns	237	94	ns	295	151	325	129	302	112	ns	316	129	
Total carbohydrates (% TE)	51	9	47.5	9.9	47.5	8.9	ns	48.2	9.5	ns	43.5	11.5	46.2	11	47.1	11.9	ns	45.9	11.1	
Total sugars (g)	60.4	44.7	45.4	35.9	48.6	31.4	ns	49.1	37.2	0.031	55.5	30.2	54.1	37.9	54.2	33.6	ns	54.4	35.6	0.042
Total sugars (% TE)	13.7[b]	7.6	9.3[a]	7.5	9.3[a,b]	5.2	0.049	10.2	7.3	ns	8.7	5	8.4	7.2	9	5.7	ns	8.6	6.6	
Dietary Fibre (g)	14.4	6.1	16.5	7.3	17.5	8.8	ns	16.2	7.4	ns	17.7	10.5	23.6	11.4	25.1	12	ns	22.8	11.4	<0.001

Urban

	Females										Males									
	18–24 (n=29)		25–64 (n=121)		≥65 (n=34)		p†	Total (n=184)		p‡	18–24 (n=18)		25–64 (n=88)		≥65 (n=32)		p†	Total (n=138)		pᵀ
	Mean	SD	Mean	SD	Mean	SD		Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	
Energy (MJ)	10	4.1	8.3	3.2	8.7	2.8	ns	8.6	3.3	ns	12.8[a]	3.7	10.3[b]	3.5	10.2[a,b]	3.8	0.033	10.6	3.7	<0.001
Proteins (g)	97.4	43.9	83.5	36.5	85.5	34.9	ns	86	37.6	ns	132.7	45.2	106	42.5	101.8	39.4	ns	108.5	43	<0.001
Proteins (% TE)	16.6	3.3	16.9	4.2	16.5	3.9	ns	16.8	4	ns	17.9	5.1	17.3	4.2	17	3.8	ns	17.3	4.3	
Total fats (g)	92[b]	43.7	70.9[a]	35.7	74.1[a,b]	26.9	0.038	74.8	36.3	ns	110.1[a]	40.7	94.7[a,b]	9.8	79.5[b]	40.4	0.032	93.2	42.7	<0.001
Total fats (% TE)	33.9	5.9	31.9	9.4	32.1	7.3	ns	32.2	8.6	ns	31.7[a,b]	6.2	34.1[a]	9.4	28.6[b]	8.1	0.01	32.5	9	
Total carbohydrates (g)	272	121	233	102	250	89	ns	242	104	ns	345[b]	104	273[a]	107	301[a,b]	120	0.042	289	112	<0.001
Total carbohydrates (% TE)	45.7	5.5	46.9	10	46.8	8.2	ns	46.7	9.1	ns	44.6	6.4	43.4	10.3	48.3	8.5	ns	44.7	9.7	
Total sugars (g)	56.2	34.8	52.1	29.5	56.1	30.4	NS	53.5	30.5	ns	57.7	29.8	46.9	28.6	56.5	26.6	ns	50.5	28.5	<0.001
Total sugars (% TE)	10.6	7.5	11.2	6.5	11.5	6.3	NS	11.2	6.6	ns	8	4.4	8	5.4	9.8	5.2	ns	8.4	5.2	
Dietary Fibre (g)	18.9	8.2	17.8	9.1	19	10.8	NS	18.2	9.3	ns	25[a,b]	11	20.9[a]	9.7	29.3[b]	18	0.03	23.4	12.7	<0.001

MJ – mega joules; TE – total energy; † – comparison between age groups within gender and type of settlement; ‡ – rural vs. urban within gender (excluding age factor); ᵀ – total male vs. total female within the type of settlement; a–b – Different superscripts indicate significantly different values between age groups identified by post-hoc test (p < 0.05)

Table 4. Results of univariate linear regression model analyses for the relative contribution of macronutrients classified by predictor factors (coefficient and 95% confidence intervals)

Variables	n	%	Protein			Carbohydrate			Fat		
			Coefficient	95% CI	p-value	Coefficient	95% CI	p-value	Coefficient	95% CI	p-value
Age groups (years)											
25–65 (ref.)	319	64.3									
18–24	80	16.1	0.53	-0.503; -1.568	ns	0.398	-1.996; 2.791	ns	-0.0266	-2.479; 1.947	ns
> 65	97	19.6	-0.23	-1.191; 0.730	ns	1.53	-0.690; 3.749	ns	-1.709	-3.761; 0.343	ns
Gender											
Female (ref.)	277	55.8									
Male	219	44.2	-0.49	-1.241; 0.255	ns	-2.077	-3.799; -0.355	0.018	0.389	-1.214; 1.991	ns
BMI											
Weight within recommended range (ref.)	207	41.7									
Underweight	18	3.6	-0.99	-3.014; 1.034	ns	1.092	-3.616; 5.801	ns	0.371	-3.991; 4.733	ns
Overweight	184	37.1	0.68	-0.151; 1.518	ns	-0.279	-2.220; 1.662	ns	-0.735	-2.534; 1.063	ns
Obese	97	19.6	1.21	0.159; 2.263	0.024	-1.452	-3.900; 0.996	ns	-0.541	-2.805; 1.727	ns
Education level											
Primary (ref.)	35	7.1									
Secondary	305	61.5	0.32	-0.423; 1.056	ns	-1.486	-3.187; 0.214	ns	1.296	-0.276; 2.867	ns
Tertiary	156	31.5	0.63	-0.923; 2.177	ns	-4.304	-7.869; 0.739	0.018	4.213	0.919; 7.508	0.012
Urbanicity											
Urban (ref.)	322	64.9									
Rural	174	35.1	-0.44	-1.219; 0.338	ns	1.266	-0.533; 3.065	ns	-1.957	-3.616; -0.298	0.021

ns – not significant

participants according to gender, we found, as expected, that males have significantly higher intake of energy, proteins, fats, carbohydrates and fibre than females. Level of significance was < 0.001 for these variables. Females had significantly higher total sugar intake than males (p=0.042). Results were the same among urban participants but higher sugar intake among females was noticed for relative sugar intake (p<0.001). Differences in relative macronutrients intakes across age, gender, BMI groups, education levels, and type of settlement were assessed using univariate linear regression models (Table 4). There were no statistically significant differences in relative proteins intake between age, gender, education and type of settlement. Obese participants had significantly higher relative proteins intake comparing to participants with weight within recommended range (p=0.024, β=1.21, 95% CI: 0.2–2.3). Unlike proteins, relative carbohydrates intake was significantly lower among males (p=0.018, β=−2.077, 95% CI: −3.8–3.4) as well as among participants with tertiary education comparing with those with primary one (p=0.018, β=−4.304, 95% CI: −7.9–0.7). For the relative fats intake, only education and type of settlement showed an impact. Participants with tertiary education had 4.2% higher relative fats intake comparing to those with primary education (p=0.012, β=4.213, 95% CI:

0.919–7.508), while participants from rural areas had significantly lower relative fats intake comparing to those living in urban settlements (p=0.021, β=−1.957, 95% CI: −3.616, −0.298). Inadequacy of macronutrients intake of the total sample according to each socio-demographic factor separately, as well as differences within factors, are shown in Figure 1. As shown there, the highest adherence to the national dietary guidelines was associated with consumption of proteins, with no significant differences in any of the examined socio-demographic factors. Still, low portions of primary educated (5.7%) and underweight (5.6%) subjects did not meet the national dietary recommendations. Carbohydrates are mostly consumed either according to the guidelines or below it. Primary educated participants had highest adherence to recommendations but also above it, and more than half of the obese participants consumed carbohydrates below national guidelines. Significantly higher adherence was observed among females than males (p=0.018) and among urban comparing to rural participants (p=0.05). There was significantly higher adherence (p=0.01) in carbohydrates intake of rural female participants (62.4%) comparing to rural males (39.5%). Adherence for fats was examined both for recommended intake according to the national guidelines and to WHO/FAO ones. Comparisons
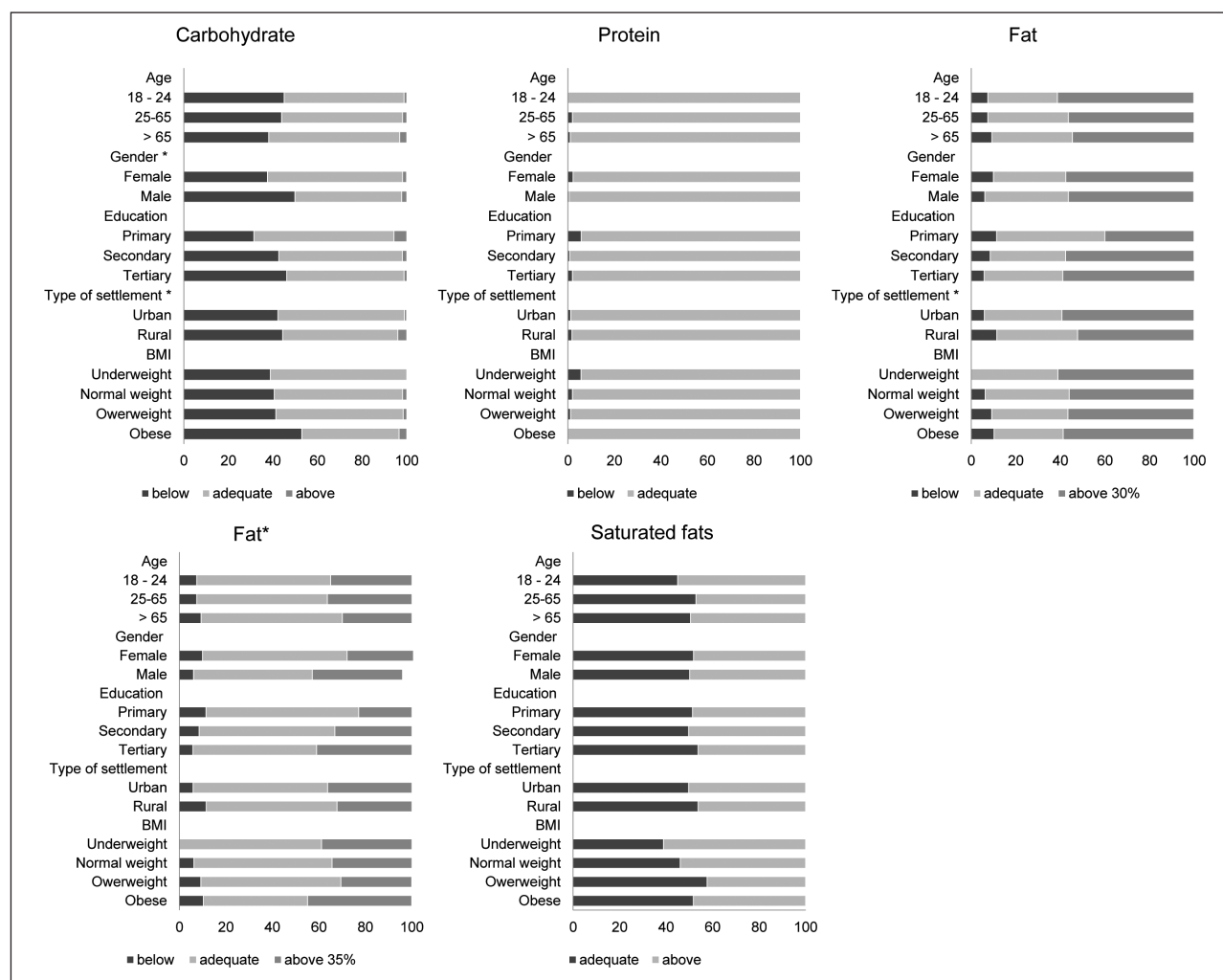

Fig. 1. *Percentage of Macedonian adults with intake levels met, below and above the National Dietary Reference Intake (DRI) for macronutrients.*

The χ² test was used to examine association between the three levels of meeting DRI and socio-demographic factors; a analysed according to the upper cut of value of 35% TE; *p<0.05
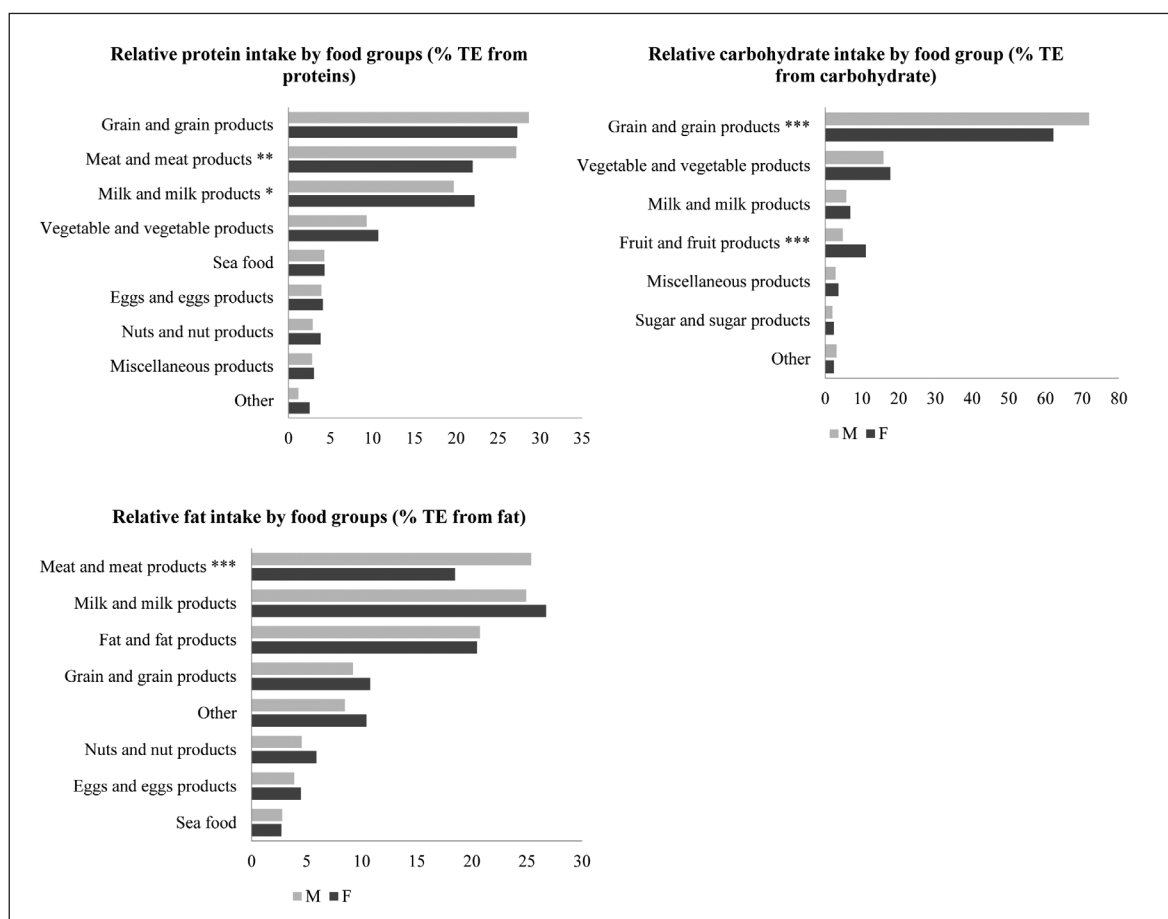
Fig. 2. *Contributions of food groups to mean daily macronutrients intake of Macedonian adults according to gender.*

The χ² test was used to examine association between the three levels of meeting DRI and socio-demographic factors; ***p<0.001; **p<0.01; *p<0.05

between and within the socio-demographic factors were similar, when different intake guidelines for fats were compared. However, there was significant difference between participants living in urban and rural settlement when adherence to fats consumption according to WHO/FAO guidelines was examined (p=0.05). The adherence to WHO/FAO guidelines of the urban males over 65 was significantly higher comparing to other two age groups of urban males (p=0.05). We have also examined the consumption of saturated and other fatty acids and its adherence towards national dietary guidelines (Figure 1). As presented there, no significant difference existed in adherence to the recommended intake within any socio-demographic characteristic of the participants, with overweight subjects having the highest adherence to the recommended intake of saturated fats. When more thoroughly examined, the adherence for the saturated fatty acids among females aged 25–64 living in urban settlements was significantly higher compared to other two age groups of urban females (p=0.004, data not shown). The lowest level of adherence to the national dietary guidelines (>25 g for females, >38 g for males) was seen in fibre. The lowest adherence was observed among urban males (10.1%), which was significantly lower (p=0.004) compared to urban females (21.7%). Among age groups of urban participants, there was significantly higher adherence, within gender, in females aged 18–24 (p=0.05) and males over 65 years of age (p=0.03). Contributions of food groups to mean daily macronutrients intake of Macedonian adults, according to gender, is presented in Figure

2. Grain and grain products are primary source of carbohydrates in the diet of Macedonian adults. Statistically significant difference between genders was observed in grain's contribution in relative carbohydrates intake (p<0.001). Female's consumption of fruits and fruit products contributed significantly more to the relative carbohydrates intake comparing to male's one (p<0.001). Grains and meat were almost equally contributing as primary source of proteins in the diet. Meat and meat products were primary source of fats. Both for proteins and fats, there were statistically significant differences in relative meat intake in males and in females, as males consume more of these foods (p=0.003 for proteins, p<0.001 for fats).

DISCUSSION

Energy, macronutrients and fibre intake presented in this paper was observed in relation to age, gender and urbanization type of the participants. Males, both in urban and rural households, as confirmed in other research, had significantly higher intake of energy, proteins, fats, carbohydrates, and fibre compared to women (11). As we examined the effect of the age factor within the gender and type of urbanization, we saw the largest impact of age factor on urban males, since significant differences in total energy, proteins, fats and carbohydrates intake were observed among all age groups. Linear regression model implemented to

assess the relative intake of macronutrients showed that there were no statistically significant differences in relative proteins intake between age, gender, education, and type of settlement. As expected, relative proteins consumption of men and obese participants was significantly higher than that of the participants with BMI within recommended range. Relative fats intake was higher among more educated participants and in those living in urban settlements. Intake of macronutrients in relation to education level and urbanicity has been explored in previous research and findings were different, with more recent ones showing lower fats intake among more educated consumers (12–14). We have assessed the adherence of macronutrients intake to dietary guidelines and the findings are similar with other research for all macronutrients (15, 16). Around half of the adults met the carbohydrates recommendations. This indicates that there is room for improvement, particularly in men and those living in rural settings, who should increase their carbohydrates intake. Fibre intake should be significantly increased, particularly in men below 65 years of age. This is important having in mind the evidence that intake of fibre is inversely associated with some types of cancer (17). Fats intake is frequently assessed in the dietary guidelines since it is related to the occurrence of cardiovascular diseases and other major NCDs. As expected, adherence to intake recommendations of fats was lowest compared to adherence to carbohydrates and proteins intakes, due to higher intake of fats. The nutritional transition that followed economic transition in MKD largely contributed to this phenomenon also described in research in other neighboring countries (18).

Premature mortality from major NCDs in MKD is higher compared to most countries in Europe (19). Previous research has proven that adherence to dietary guidelines may reduce the risk of premature and all-cause mortality (20–23). This makes strong case for public health nutrition professionals and decision makers to shape and implement policies that will promote adherence to dietary guidelines as important factor in improving health outcomes of the population. Data for contribution of food groups in daily macronutrients intake shows that grains, fruits and vegetables are primary source of carbohydrates in Macedonian population. It is interesting that gender difference is significant for grains and fruits, with women consuming more fruits and men grains. This is in accordance with previous research showing that women are the ones who take care for families to consume healthier foods (24). When it comes to meat and meat products, as less recommended foods and primary source of fats, males consume it significantly more than females. Results showed that meat and grain almost equally contribute to relative proteins intake of the adults in MKD. Even it is not common that meat and meat products alone are not primary source of proteins, we explain it with the high consumption of white bread in Macedonian population and the tradition to eat bread with every meal (25). This survey was also extremely important for obtaining data about anthropometric characteristics of the nutritional status since those data are not routinely collected for adults in the country. The rise of overweight and obesity are worldwide phenomenon and one of the most important public health issues of today (26). In MKD, overweight and obesity are more prevalent among males compared to females, as it is common in the countries of the nearest surrounding (27). The highest prevalence of overweight and obesity was observed among the elderly. This finding is in line with the similar ones in other research but we should

be cautious with drawing conclusions since this does not necessary reflect the true age-adjusted difference (28). Obesity prevalence was the highest among primary educated participants and this finding confirms those in recent research concluding that there was larger increase in obesity prevalence in the low educational group, making education one of the main drivers of the increase of absolute inequalities in obesity in Europe over time (29–31). Newly adopted documents at European and global levels reconfirm the importance of nutrition and diet to prevent NCDs. MKD is aligning with those documents and actions but additional attention is needed in order to expect better health outcomes (32). There were, however, some limitations of the study. Those mostly apply to implementation of Computer Assisted Telephone Interview (CATI) for both 24-hour recalls. Although highly trained interviewers performed interviews by following specific protocol, this methodology did not allow using portion size measurement aids, like picture books, that may influence the accuracy of the reported quantities of foods consumed. However, these limitations do not affect the significance of the study results and the importance of data obtained towards NCDs prevention strategies.

CONCLUSION

This was the first population based and nationally representative study on food consumption among adult population in MKD. Its added value is the assessment of the prevalence of overweight and obesity among the adults in the country. The survey provides a detailed insight into the energy, macronutrients and fibre intake in relation to age, gender, education, and type of settlement of the household. The findings indicate that in MKD men are at greater risk of obesity related NCDs. Macronutrients intake of adults should be improved. There is higher intake of dietary fats and need for an increase of carbohydrates intake, with special focus on dietary fibre. Findings can be used in shaping, fine-tuning and implementing food and nutrition policies that will stimulate healthier diets as one of the major determinants in prevention of the diet related NCDs. It is expected that once established the food consumption surveys will run in regular time intervals in the future and for all population groups.

Conflict of Interest
None declared

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