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Examination of Adult Population'Nutritional Status and Dietary Habits in Two Health Programmes

Theses of Doctoral (Ph.D.) Dissertation

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Introduction

Constant body weight is shaped by neural, hormonal and chemical mechanisms, as well as individual genetic polymorphisms that balance energy intake and energy expenditure. Disruptions in these complex mechanisms can result in changes in body weight. The two endpoints are underweight and obesity.

Underweight is mainly defined as low body weight-for-heigh (and age). Its causes are complex and multifaceted, but lack of adequate quality and quantity of food is one of the most important factors in its development.

Obesity is a complex, heterogeneous condition in which a number of environmental, genetic and epigenetic factors play a role. Excessive energy intake is one of the most important factors, but other lifestyle-related factors such as lack of physical exercise, deeply embedded dietary habits, over-processing of food, unavailability or unaffordability of healthy foods, inadequate dietary education also play a role.

The body mass index (BMI) is most commonly used to characterise nutritional status, such as diagnosing underweight and obesity at population level, because of its simplicity, it is also fast and inexpensive. Body composition estimation based on the principle of bioelectrical impedance analysis (BIA) can be used to assess, among other things, whether higher body weight is due to skeletal muscle or fat accumulation. By determining waist circumference, the presence of abdominal obesity can be assessed, but several other anthropometric indices/ratios (for estimating visceral adipose tissue, body fat percentage), less known and widely not applied in national practice, can be used to predict cardiometabolic morbidity and mortality.

University is a critical time for young adults, with lifestyle changes usually in negative directions due to the lack of physical activity, increased alcohol consumption, unhealthy food choices and consequent weight gain. Over the past decade, several Hungarian studies have investigated the nutritional status, lifestyle and diet of students in higher education, but a large overall study with body composition analysis has not yet been conducted.

From the data of the Hungarian Diet and Nutritional Status Survey in every 5 year, we know that the prevalence of obesity among the Hungarian population is very high and that the nutrient intake and food consumption of adults is a significant health risk, but we do not have in-depth, detailed knowledge at the regional level.

Objectives

The aim of the present study was to examine the nutritional status, dietary habits and lifestyle characteristics of a representative group of university students and adults aged 18-85 years. Furthermore, we aimed to identify data that could be used to define the nutritional and lifestyle characteristics of the participants included in the study.

In our research, we looked to answer the following questions.

For university and college students

- What characterises their nutritional status based on body mass index and body composition by sex?
- To what extent is there overlap between the body mass index and body composition categories?
- Is there a difference in nutritional status between medical/health science students and other students?
- What are their food consumption, smoking and exercise habits?
- What are the lifestyle characteristics identified by gender and the study of medicine/health sciences
- Is there a link between the different lifestyle characteristics?
- Is there a correlation between lifestyle characteristics and anthropometric parameters?

For adults population

- What characterises their nutritional status based on body mass index, body composition, waist circumference and other anthropometric indicators by sex and age group?
- To what extent is there overlap between the body mass index and abdominal obesity categories?
- Which anthropometric indicator is the best predictor of body fat percentage?
- Are there gender and age specificities in food consumption habits?
- Is there a link between the consumption of certain foods?
- Is there a correlation between food consumption habits and sociodemographic factors and certain lifestyle characteristics, anthropometric parameters, ratios/indices?
- Do dietary preferences influence the effect of age for certain anthropometric indicators?
- Are there gender and age group differences in energy and nutrient intake data?

Materials and Methods

In our quantitative, cross-sectional study, subjects were recruited from two national lifestyle programmes, the Energy-balance Health Programme for Undergraduates and the E-Harmony Health Programme.

In the **Energy-balance Health Programme for Undergraduates (E3)**, the Hungarian Association of Dietitians, in partnership with three Hungarian universities (Faculty of Food Sciences, Corvinus University of Budapest; Faculty of Medicine and Health, University of Debrecen; Faculty of Health Sciences, University of Pécs), assessed the body composition of active students from March 2013 to July 2015, eating and other lifestyle habits at events with a large number of students (university days, festivals, camps) and at lectures and individual dietetic consultations provided free of charge to students by the programme. In total, 5174 students over 18 years of age were involved in the E3 programme. Of these students, 2493 studied in Budapest, 1410 in Pécs and 1271 in Debrecen. In the present study, we excluded those who were over 35 years of age and those who lacked data on age, weight, body composition, height, so that our final sample consisted of **4465 persons** (1820 male and 2645 female).

The **E-Harmony Health Programme (E-Harmony)** is an innovative media-based (web and television) intervention programme of the Faculty of Health Sciences of the University of Pécs (PTE), which was conducted in 2014-2015. From Baranya (n = 764) and Zala county (n = 436), 1200 adults and children (through parents) were selected by quota sampling, representative of the Hungarian population according to age and gender. The aim of this programme was to increase the popularity of healthy eating and physical activity by creating energy balance. In our research, we analysed data with alimentation and nutritional status from the 2014 survey of adults aged 18-85 years, who had also completed the food records, resulting in a final sample of **1024** (482 male and 542 female).

Table 1 summarises the data collection **methods** used. In both programs, body weight and body composition (fat, skeletal muscle) were measured with the OMRON HBF-511B-E Body Composition Monitor (Omron Healthcare, Inc., Illinois, USA) based in BIA (Bioelectrical Impedance Analysis). The participants were asked to have their weight measured about 2 h after eating. During measurements the participants were fully clothed, but were asked to take off shoes, socks and heavy clothing and to empty their pockets.

Table 1.
Applied Methodology.

	Energy-balance Health Programme for Undergraduates	**E-Harmony Health Programme**
Sample size	4465 adults	1024 adults
Age	18–34 years	18–85 years
Anthropometry measurements	Weight, body composition	Height, weight, body composition, waist circumference, hip circumference
Applied group of questions, questionnaires	▫ Sociodemographic issues ▫ Questions with eating, smoking, and doing sports (frequency)	▫ Sociodemographic issues ▫ Questions with eating, smoking, and doing sports (frequency) ▫ Food Frequency Questionnaire (FFQ) ▫ 72-hour food records ▫ 3 items from the long version of the International Physical Activity Questionnaire (IPAQ)

Body mass index, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), weight-adjusted-waist index (WWI), a body shape index (ABSI), adiposity index (BAI), relative fat mass (RFM), body-roundness index (BRI), abdominal volume index (AVI), conicity index (CI) were calculated from anthropometric data. BMI were categorised according to the WHO and Lipschitz classification. Cut-off points for waist circumference and waist-to-hip ratio groups were based on WHO classification too. The normal value of waist-to-height ratio was determined at <0.5 cm (according to the recommendation of Hungarian Cardiovascular Consensus Conference). Cut-off points for body fat percentage and skeletal muscle percentage groups were categorised by studies of Gallagher et al., McCarthy et al., and Omron Healthcare. Dietary intake data was analysed using NutriComp Diet 4.0 software.

Anthropometric measurements, dietary and lifestyle data were collected in a face-to-face meeting. In the E3, only dietitians were involved, in the E-Harmony dietitians and other health professionals (for example physiotherapist, doctor) were accompanied.

The data were **statistical analysed** using descriptive statistics, Mann-Whitney U test, Chi-square-test, Spearman's rank-order correlation, nonparametric partial correlation, multiple linear regression with stepwise method, hierarchical cluster analysis, Kruskall-Wallis's test and principal component analysis, mediation analysis by the SPSS Statistics 22.0, MS Excel, PROCESS 3.5 Macro. The value of significance was determined at the value of $p \leq 0.05$ and the confidence interval 95%. In mediation model, the confidence interval 95% was based on 5000 bootstrapping, the effect was significant when confidence interval did not include zero.

Results

Energy-balance Health Programme for Undergraduates

The average age of the participants in the study was 22.1 ± 3.1 years, showing a difference among males (22.7 ± 3.2 years) and females (21.7 ± 3.0 years) (U = 1540596; p<0.001). In terms of their discipline within in higher education (n = 4172), the highest proportions were in health science (18.7%), medicine science (12.5%), economics (11.2%), science (9.2%) and engineering and computer science (9.1%). Overall, 36.6% of students were studied in medical/health sciences, 23.7% of men and 45.1% of women (χ^2 = 197.5; p<0.001).

Expected gender differences were observed for mean anthropometric data (body weight, height, body fat percentage, skeletal muscle percentage) and BMI values (p<0.001). The average body mass index was in men and women within the normal range (24.0 ± 3.3 versus 21.5 ± 3.2 kg/m^2).

Based on body mass index, 7.9% of participants were underweight with a significant female predominance. Of the underweight students in our study, 4 had low skeletal muscle mass according to age-specific classification based on research by Gallagher et al. A higher proportion of males than females were overweight according to body mass index (26.9 versus 9.6%), which may indicate a higher muscle mass, so we examined the body composition of those in this category. Although 78.7% of the overweight men had a high/very high body fat percentage, nearly a third (29%) had a high/very high skeletal muscle percentage, so body mass index indicated a skeletal muscle percentage in one in five overweight men. 19% (men) and 17% (women) of those with a normal body mass index was in high/very high body fat percentage category.

When looking at the diet of students, 75.3% of them included a wholegrain cereal product in their diet at least once a day. Vegetables and fruit were eaten four times a day by 5.5% and five times a day by 2.5%. As expected, women were slightly more aware of their diet, eating vegetables, fruit, and wholegrain cereals more often, although they consumed more sugary foods and coffee than men. 41.6% of students drank alcohol once a week, 29.4% more than once a week, 72.2% did not smoke at the time of the survey and 46.1% did sport regularly. There was a weak positive correlation for both sexes between fruit, vegetable consumption and whole grain intake (males r = 0.212; females r = 0.244; p<0.001), doing sport (males r = 0.211; females r = 0.212; p<0.001) and fluid intake (females r = 0.213; p<0.001). For men, exercise showed a weak positive correlation with fluid intake (r = 0.247; p<0.001), coffee drinking with smoking (r = 0.277; p<0.001). For both sexes, there was a weak positive correlation between alcohol consumption and smoking (men r = 0.240; women r = 0.286; p<0.001).

The BMI of those studying medicine/health sciences did not differ significantly from the others of the university students, but men studying in this field had a slightly higher body fat percentage and a lower skeletal muscle percentage (48.3% of medicine/health students; 39.1% of non-medicine/health students; χ^2 = 12.6; p<0.006), which can be explained by the fact that they were less likely to participate in sports. Medicine/health studies were associated with more beneficial dietary habits (more frequent inclusion of whole grains, vegetables, fruits, and fewer alcoholic beverages in their diet) but less frequent exercise (p<0.05), the latter effect being confirmed in body composition results for men.

Using hierarchical cluster analysis, we were able to distinguish three groups based on the students' lifestyle characteristics: 'health-conscious', 'stimulant-liking', 'no sport'. For both genders, the "health-conscious" lifestyle had better body composition (higher skeletal muscle percentage: males 41.1 ± 4.0%. females 30.5 ± 3.3%), which is more likely to be attributed to the more sporting of the group. Also, more regular sporting was due to the higher proportions of non-medical/health science students in the "health-conscious" group (49.5 versus 40.7% of men, 36.1 versus 29.3% of women; p<0.05). No differences were found in the quality of fluid consumption (‘water drinkers’, ‘all drinkers’, ‘tap water drinkers’ groups) in relation to each lifestyle characteristic.

E-Harmony Health Programme

The average age of the E-Harmony study subjects was 47.3 ± 17.3 years, 45.7 ± 16.7 years for men and 48.7 ± 17.8 years for women. 86.3% lived in a city and 70.4% in a county capital. In terms of their official marital status, 24% were single, 51.5% married, 10.2% cohabiting, 6% divorced, 8.3% widowed. Compared to the average monthly net earnings, 28.6% estimated their net monthly income as well below average, 22.9% as slightly below average, 22.0% as average, 13.9% as slightly above average, 4.7% as well above average (7.9% did not know or did not answer). 26.3% of men and 14.7% of women had above average incomes (χ^2 = 24.5; p<0.001). On average, 2.7 ± 1.2 persons lived in a household with the respondent, showing a difference between men (2.8 ± 0.1 persons) and women (2.6 ± 0.1 persons) (U = 115969; p =

0.006). 43% of the participants had a general certificate of secondary education and 32.7% had a college/university degree (36.1% of those living in Baranya, 22.7% of those living in Zala county), the latter not showing a significant difference between genders. A total of 171 persons had a health qualification, 9.8% of men and 22.9% of women (χ^2 = 31.6; p<0.001).

At the time of the survey, 19.2% were smokers, 23.1% had already quit and 57.7% had never smoked. In terms of leisure-time physical activity, they exercised an average of 103.4 ± 5.7 minutes per week. For both sexes, those with a health qualification exercised more per week (men 144.7 ± 180.6 minutes versus 111.1 ± 211.4 minutes p = 0.029; women 108.1 ± 157.1 minutes versus 89.3 ± 154.6 minutes p = 0.01). Smoking did not show a significant difference between persons with health and non-health qualification.

As expected, we found significant differences between the age groups 18-34 and 35-64 years for all measurement parameters for both sexes (p<0.001). Older individuals had higher BMI, waist circumference, waist-to-hip ratio, waist-to-height ratio, body fat percentage. In our case – similar to the undergraduates studied – a higher percentage of men belonged to the overweight and obese category (41.3% and 25.5% of men; 29.3% and 24.3% of women) and a lower percentage of men belonged to the underweight and obese category (by WHO and Lipschitz criterion) compared to women. When looking at body composition data, 82.4% of overweight men and 83.6% of overweight women had a high/very high body fat percentage, with a high/very high skeletal muscle percentage of 7% for both sexes by category. The latter was more prevalent in young men and middle-aged women. The average body fat percentage was higher, then normal value (>22% for men and >31% for women) in all three age groups at, the highest value was in the older age group. The underweight was most common among young women (10.1%) and was not significant in women aged 65 and over (2.5%). Compared with the E3 results, young adults in the E-Harmony programme were twice as likely to be obese (10%) on the basis of body mass index. Abdominal obesity as defined by waist circumference was found in 31.5% of men and 45.8% of women in our study. In the under 35 years, we recorded an increased waist circumference (in 31.5% of persons), waist-to-hip ratio (in 39.4% of persons), and waist-to-height ratio (in 34.7% of persons). Abdominal obesity was also present in those with a normal BMI, with a unit increase in BMI (1 kg/m^2) increasing waist circumference by more than 2 cm in both sexes. When we compared above-normal waist circumference, waist-to-hip ratio and waist-to-height ratio with BMI categories, the abnormal waist-to-height ratio (≥0.5 cm) covered the largest percentage of obese individuals (99.6%), completely (100%) in men and 99.2% in women.

Multiple linear regression with stepwise method was used to test which anthropometric indicator or combination of indicators could be used to estimate body fat percentage, using the fewest possible significant variables. BMI became the baseline index, determining the measured body fat percentage in 67.5% of women; 42.9% of men. For men, the combined combination of the three indices/ratios (BMI, WHtR, WWI) indicated body fat percentage in 45.6%. In women, BMI could be replaced by a combined calculation of RFM and ABSI, but the determination of the conicity index did not add any substantial extra.

Spearman's rank correlation was used to examine the association of age with food consumption frequency items by gender. For both genders, there was a moderately strong negative significant ($p<0.001$) correlation between age and frequency of consumption of fast food ($r_{men} = -0.537$; $r_{women} = -0.534$), dairy desserts ($r_{men} = 0.466$; $r_{women} = -0.400$), salty snacks ($r_{men} =-0.408$; $r_{women} = -0.407$), younger people more preferred these foods. A weakly positive significant correlation was observed between age and the frequency of consumption of vegetables for cooking ($r_{men} = 0.353$; $r_{woman} = 0.230$), older people being more popular for these foods. There was a weak negative correlation for age and butter ($r = -0.265$), ice cream/gelato ($r = -0.276$), spirits ($r = -0.247$), in a women ($p<0.05$)

The results of the food frequency questionnaire were subjected to principal component analysis to explore the structure of the 63 meal items. The resulting analysis was considered reliable, supported by statistical criteria. The components generated using the Anderson-Rubin method (Table 2) explained 42.21% of the variance.

Table 2.
Factor Loadings of Food Groups in Dietary Components Identified Using Principal Component Analysis.

Component	Item	Factor Loading
1. Component ‘Fatty meats/meat products/organ’	Yorkshire pudding, brawn	0.679
	Other organ: gizzard, kidney, heart, tripe, lung	0.646
	Poultry meat: chicken, turkey with skin, duck, goose	0.584
	Pork: fatty (shoulder, rib)	0.574
	Bacon, cracklings	0.550
	Liver products	0.501
	Smoking products: smoking sausage, ham, and shoulder	0.488
	Spreading fat: lard	0.405
2. Component ‘Not interpretable’	Fruit juice, fresh, fibrous	0.575
	Spreading fat: butter	0.486
	Spreading fats: butter cream	0.472
3. Component ‘Foods chosen consciously’	Tea without sugar	0.483
	Fish, canned	0.480
	Kefir, yogurt	0.476
	Fish	0.448
	Bread, roll, brown/whole grain	0.442
4. Component ‘Fruits, vegetables’	Vegetables, raw	0.631
	Fruits: fresh, frozen	0.619
	Pickles	0.570
	Fruits: preserves, jam, marmalade	0.437
5. Component ‘Low-fat milk, sour cream’	Sour cream, low-fat	0.725
	Sour-cream, fatty	–0.708
	Milk, milk drinks, low-fat	0.673
	Milk, milk drinks, fatty	–0.670
6. Component ‘Meat/cold cuts-free’	Ham cold cuts	–0.663
	Parisian, Zala cold cuts, Frankfurter, crinoline	–0.600
	Poultry meat: chicken, turkey without skin	–0.539
	Pork: lean (leg, loin)	–0.504
7. Component ‘Convenience products’	Convenience products: instant soup, soup powder	0.754
	Convenience products: stock, broth cube	0.702
	Ready, semi-prepared meals: frozen, canned	0.627
8. Component ‘Sweets form shop’	Kefir, yogurt	0.438
	Biscuits	0.598
	Chocolates	0.547
	Dairy desserts	0.532
	Ice cream, gelato	0.461
9. Component ‘Side dishes, vegetables for cooking’	Potato: mashed, boiled	0.687
	Rice	0.606
	Boiled pasta	0.557
	Vegetables for cooking (without dried legumes)	0.461
10. Component „Non-alcoholic”	Alcoholic drink: spirits	–0.804
	Alcoholic drink: beer, wine	–0.786
	Alcoholic drink: cocktails	–0.544

Spearman rank correlations were used to examine the correlations between the components remaining after excluding the second component (Table 3, where only significant results are shown). In this case, the strengths of the correlations are not relevant, since the Direct Oblimin (delta = 0) setting results in essentially weak correlations between the resulting scales. The components 'fatty meats/meat products/organ' and 'foods chosen consciously' showed the highest number (5) of significant correlations with other dietary patterns.

Table 3.
Correlations between Dietary Components.

Components	Components	r	p
'Fatty meats/meat products/organ'	'Foods chosen consciously'	−0.086	0.009*
	'Low-fat milk, sour cream'	−0.204	<0.001*
	'Convenience products'	0.127	<0.001*
	'Side dishes, vegetables for cooking'	0.164	<0.001*
	'Non-alcoholic'	−0.099	0.003*
'Foods chosen consciously'	'Fruits, vegetables'	0.130	<0.001*
	'Low-fat milk, sour cream'	0.114	0.001*
	'Convenience products'	−0.117	<0.001*
	'Side dishes, vegetables for cooking'	−0.071	0.032*
	'Non-alcoholic'	−0.084	0.011*
'Fruits, vegetables'	'Side dishes, vegetables for cooking'	0.094	0.004*
'Low-fat milk, sour cream'	'Non-alcoholic'	0.141	<0.001*
'Meat/cold cuts-free'	'Non-alcoholic'	0.142	<0.001*
'Convenience products'	'Non-alcoholic'	−0.085	0.010*
'Side dishes, vegetables for cooking'	'Non-alcoholic'	−0.068	0.039*

*p<0.05

Spearman's correlation coefficients between dietary pattern scores and sociodemographic/lifestyle factors were calculated. These are displayed in Table 4. The 'fatty meats/meat products/organ' group showed negative correlations with gender, education and health qualification, and positive correlations with age and smoking. A positive correlation was found between 'foods chosen consciously' and gender, education, health qualification, monthly income and leisure physical activity, and there was a negative correlation with the number of household members. The preference for 'meat/cold cuts-free' was positive correlations to age and gender, there was negative correlation to the number of household members. There was a positive correlation between the 'non-alcoholic' component and age, gender, and a negative correlation between education qualification, number of household members, monthly income, smoking and leisure physical activity.

As gender showed significant associations for all components, we examined the relationships when controlling for gender. The significance has disappeared between the 'foods chosen consciously' component and health qualification, between the number of household members and 'foods chosen consciously', 'non-alcoholic' component; between the smoking and the 'fatty meats/meat products/organ' dietary items. We examined the change in associations controlling for age in addition to gender. Educational qualification attainment no longer showed a significant correlation with the 'fatty meats/meat products/organ' item, but a negative directional correlation between it and 'convenience products' (r = -0.069; p = 0.045) appeared.

The significant association between health qualification and 'fatty meats/meat products/organ' preference disappeared, as did the negative significant correlations of smoking, leisure physical activity and 'non-alcoholic'.

Table 4.
Correlations between Dietary Patterns and Sociodemographic/Lifestyle Factors.

	Gender	Age	Education qualific.	Health qualific.	Number of household members	Monthly income	Smoking	Leisure physical activity
'Fatty meats/meat products/organ'								
r	−0.306	0.147	−0.091	−0.110	0.051	0.030	0.083	−0.047
p	**<0.001***	**<0.001***	**0.006***	**0.001***	0.123	0.390	**0.012***	0.154
'Foods chosen consciously'								
r	0.132	−0.016	0.264	0.079	–0.090	0.223	−0.043	0.233
p	**<0.001***	0.626	**<0.001***	**0.017***	**0.006**	**<0.001***	0.192	**<0.001***
'Fruits, vegetables'								
r	0.095	0.092	0.089	0.007	0.011	0.151	−0.178	0.054
p	**0.004***	**0.005***	**0.007***	0.834	0.744	**<0.001***	**<0.001***	0.103
'Low-fat milk, sour cream'								
r	0.124	−0.078	−0.088	0.097	–0.054	–0.051	−0.009	0.014
p	**<0.001***	**0.017***	**0.008***	**0.003***	0.104	0.137	0.788	0.671
'Meat/cold cuts-free'								
r	0.105	0.273	−0.048	−0.048	–0.186	–0.027	0.006	0.023
p	**0.002***	**<0.001***	0.150	0.151	**<0.001***	0.436	0.848	0.482
'Convenience products'								
r	−0.074	−0.091	−0.043	0.033	0.034	–0.063	0.020	0.018
p	**0.025***	**0.006***	0.190	0.316	0.307	0.068	0.541	0.592
'Side dishes, vegetables for cooking'								
r	−0.065	0.302	−0.321	−0.144	0.034	–0.185	−0.042	−0.198
p	**0.049***	**<0.001***	**<0.001***	**<0.001***	0.306	**<0.001***	0.202	**<0.001***
'Non-alcoholic'								
r	0.233	0.379	−0.277	0.015	–0.094	–0.216	−0.096	−0.180
p	**<0.001***	**<0.001***	**<0.001***	0.648	**0.004**	**<0.001***	**0.004***	**<0.001***

qualific. = qualification *p<0.05

We examined the correlation between dietary patterns and individual anthropometric indicators by gender (Table 5 and 6). In the case of both sexes, the 'fatty meats/meat products/organ' dietary preference showed a positive significant correlation with waist circumference, BMI, waist-hip ratio, and waist-height ratio, and in women with body weight and body fat percentage. The 'side dishes, vegetables for cooking' and 'non-alcoholic' dietary patterns showed a positive correlation in both gender with waist circumference, waist-hip ratio, waist-height ratio, and body mass index in women. The 'foods selected consciously' preference indicated a negative correlation with waist circumference and waist-height ratio in men, and waist-hip ratio in women.

Table 5.
Correlations between Dietary Patterns and Anthropometric Indicators in Men.

Components	Weight	WC	BMI	WHR	WHtR	Body fat %
‘Fatty meats/meat products/organ’						
r	0.069	0.158	0.135	0.161	0.186	0.034
p	0.152	**0.001***	**0.005***	**0.001***	**<0.001***	0.479
‘Foods chosen consciously’						
r	0.005	−0.111	−0.060	−0.074	−0.133	−0.044
p	0.918	**0.021***	0.212	0.126	**0.006***	0.362
‘Fruits, vegetables’						
r	0.044	0.067	0.077	0.029	0.084	0.044
p	0.364	0.167	0.110	0.547	0.081	0.361
‘Low-fat milk, sour cream’						
r	0.007	−0.012	−0.021	−0.100	−0.032	0.022
p	0.881	0.810	0.670	**0.039***	0.515	0.650
‘Meat/cold cuts-free’						
r	−0.092	0.004	−0.008	0.051	0.060	−0.034
p	0.056	0.927	0.875	0.288	0.217	0.488
‘Convenience products’						
r	-0.036	−0.021	−0.033	0.013	−0.027	0.003
p	0.460	0.669	0.491	0.793	0.581	0.951
‘Side dishes, vegetables for cooking’						
r	−0.002	0.134	0.058	0.125	0.164	0.039
p	0.972	**0.005***	0.230	**0.010***	**0.001***	0.425
‘Non-alcoholic’						
r	0.010	0.189	0.092	0.095	0.233	0.098
p	0.843	**<0.001***	0.056	**0.048***	**<0.001***	**0.042***

WC = waist circumference, BMI = body mass index, WHR = waist-to-hip ratio, WHtR = waist-to-height ratio
*p<0.05

Controlling for age, in men the 'foods chosen consciously' preference (in addition to the previous ones) showed a negative correlation with body weight (r = –0.148; p = 0.002), BMI (r = –0.118; p = 0.015) and body fat percentage (r = –0.123; p = 0.011). All other correlations between dietary patterns and anthropometric indicators disappeared. In women, controlling for age, a significant correlation between the 'non-alcoholic' pattern and body weight, the 'foods chosen consciously' and waist-to-hip ratio, as well as the 'side dishes, vegetables for cooking' and waist circumference, BMI, WHR, WHtR, body fat percentage was disappeared. Among them, the significant correlation of the dietary characteristic 'meat/cold cuts-free' with abdominal obesity indicators disappeared, the positive correlation of 'fatty meats/meat products/organ' remained only with body fat. As a novelty, the correlation between 'convenience products' and body fat percentage (r = 0.100; p = 0.027); 'fruits, vegetables' and WHR (r = –0.093; p = 0.040) appeared.

Table 6.
Correlations between Dietary Patterns and Anthropometric Indicators in Women.

Components	Weight	WC	BMI	WHR	WHtR	Body fat %
‘Fatty meats/meat products/organ’						
r	0.108	0.132	0.143	0.125	0.147	0.136
p	**0.017***	**0.003***	**0.001***	**0.006***	**0.001***	**0.003***
‘Foods chosen consciously’						
r	0.061	−0.053	0.001	−0.085	−0.079	−0.037
p	0.182	0.239	0.977	**0.060***	0.082	0.414
‘Fruits, vegetables’						
r	−0.010	−0.036	−0.013	−0.062	−0.041	−0.030
p	0.829	0.430	0.774	0.174	0.367	0.507
‘Low-fat milk, sour cream’						
r	0.012	0.035	0.037	0.007	0.040	0.064
p	0.793	0.442	0.417	0.876	0.372	0.160
‘Meat/cold cuts-free’						
r	0.029	0.104	0.053	0.090	0.115	0.020
p	0.530	**0.022***	0.245	**0.047***	**0.011***	0.654
‘Convenience products’						
r	0.026	0.008	0.035	0.001	0.004	0.043
p	0.561	0.863	0.446	0.982	0.937	0.346
‘Side dishes, vegetables for cooking’						
r	0.045	0.157	0.090	0.160	0.172	0.106
p	0.319	**<0.001***	**0.047***	**<0.001***	**<0.001***	**0.020***
‘Non-alcoholic’						
r	0.124	0.327	0.249	0.282	0.379	0.250
p	**0.006***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***

WC = waist circumference, BMI = body mass index, WHR = waist-to-hip ratio, WHtR = waist-to-height ratio
*p<0.05

We used a series of mediation tests to analyse the effect of age through dietary preferences (mediators) on individual anthropometric indicators (Figure 1).

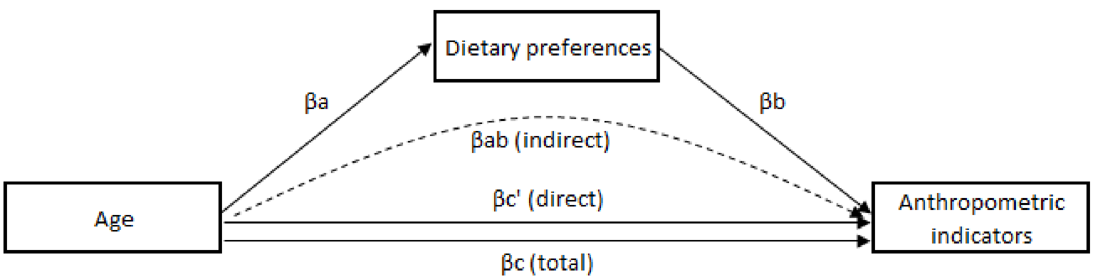

Figure 1.
Mediation Analyses Model.

Mediators from dietary preferences were 'fatty meats/meat products/organ', 'foods chosen consciously', 'fruits, vegetables', 'meat/cold cuts-free', 'low-fat milk, sour cream', 'convenience products', 'side dishes, vegetables for cooking', 'non-alcoholic'. Among anthropometric indicators, BMI, waist circumference, waist-to-hip ratio, waist-to-height ratio, and body fat percentage were used as outcome variables. The effect of age through the mediating effect of dietary patterns was most consistently observed in the waist-to-hip ratio, with six of the eight dietary preferences having a mediating effect, and therefore the mediating effect of dietary habits was examined in more detail for the waist-to-hip ratio.

With age, the preference for 'fatty meats/meat products/organ' increased, and this had a significant effect on the increase in the waist-to-hip ratio (βb = 0.217; CI = [0.155; 0.278]; p<0.001). The effect of age on the waist-to-hip ratio was partially direct (βc' = 0.247; CI = [0.185; 0.310]; p<0.001) and partly indirectly through a preference for 'fatty meats/meat products/organs', which is more typical in older age (βab = 0.032; CI = [0.016; 0.051]).

The same phenomenon was seen for the preference for 'low-fat milk, sour cream', where older individuals were less likely to include skimmed milk and dairy products in their diet, which could also lead to an increase in the waist-to-hip ratio (βb = −0.073; CI = [−0.136; −0.100]; p<0.001). The effect of age on waist-to-hip ratio was correspondingly also detected through the preference for 'low-fat milk, sour cream' (βab = 0.005; CI = [0.000; 0.014]).

Older people preferred more frequent consumption of 'fruits, vegetables', which may lead to a lower waist-to-hip ratio (βb = −0.101; CI = [−0.164; −0.039]; p<0.001) and the effect of age is therefore partially direct (βc' = 0.289; CI = [0.287; 0.285]; p<0.001) and partly indirectly (βab = −0.010; CI = [−0.020; −0.002]) through the consumption of 'fruits, vegetables' in the direction of lower waist-to-hip ratio.

The frequency of consumption of 'side dishes, vegetables for cooking' showed an increasing preference with age, and this had a positive effect on the waist-to-hip ratio (βb = 0.074; CI = [0.008; 0.139]; p = 0.027). The indirect effect of age also was significant (βab = 0.021; CI = [0.003; 0.040]) through the consumption of 'side dishes, vegetables for cooking'.

'Meat/cold cuts-free' and 'non-alcoholic' dietary patterns had a negative effect on waist-to-hip ratio, with an indirect negative effect of age on waist-to-hip ratio ('meat/cold cuts-free' βab = −0.019; CI = [−0.037; −0.002]; 'non-alcoholic' βab = −0.028; CI = [−0.055; −0.002]).

In addition to the waist-to-hip ratio, three dietary factors stand out when looking at anthropometric indicators: 'fatty meats/meat products/organ', 'meat/cold cuts-free' and 'non-alcoholic' dietary pattern. Their indirect mediating effects were consistently detected (Table 7).

Preference for 'fatty meats/meat products/organ' had a positive effect on BMI (βb = 0.103; CI = [0.041; 0.165]; p = 0.001), waist circumference (βb = 0.172; CI = [0.112; 0.231]; p<0.001), p<0.001), waist-to-height ratio (βb = 0.105; CI = [0.048; 0.161]; p<0.001), and indirectly positively reinforced the effect of age on these parameters. However, the preference for 'fatty meats/meat products/organ' had a negative effect on body fat percentage (βb = −0.123; CI = [−0.186; −0.060]; p<0.001) and indirectly negatively mediated the effect of age, thus somewhat attenuating the increase in body fat percentage with age, although older people preferred 'fatty meats/meat products/organ'.

Table 7.
Indirect Significant Effect of Age on Anthropometric Indicators through Different Dietary Habits.

Predictor	Mediators	Outcome	βab	95 % CI
Age	‘Fatty meats/meat products/organ’	Body mass index	0.015	**0.005; 0.028***
		Waist circumference	0.025	**0.012; 0.041***
		Waist-to-height ratio	0.015	**0.006; 0.028***
		Body fat percentage	-0.018	**−0.032; −0.008***
	‘Meat/cold cuts-free’	Body mass index	-0.023	**−0.042; −0.006***
		Waist circumference	-0.028	**−0.047; −0.011***
		Waist-to-height ratio	-0.020	**−0.037; −0.004***
	‘Non-alcoholic’	Waist-to-height ratio	0.039	**0.016; 0.065***
		Body fat percentage	0.072	**0.046; 0.100***

CI = confidence interval *p<0.05

'Meat/cold cuts-free' dietary preference had a negative effect on (βb = −0.092; CI = [−0.155 −0.028]), waist circumference (βb = −0.110; CI = [−0.172; −0.049]) waist-to-height ratio (βb = −0.078; CI = [−0.135; −0.020]), his indirect effect attenuating the effect of age on the increase in these anthropometric indicators (Table 8).

'Non-alcoholic' dietary pattern, in contrast to the waist-to-hip ratio, had a positive effect on waist-to-height ratio (βb = 0.102; CI = [0.041; 0.162]; p = 0.001) and body fat percentage (βb = 0.185; CI = [0.118; 0.251]; p<0.001) with an indirect effect of age. In this case, the mediating effect of 'non-alcoholic' preference was more uncertain for each anthropometric indicator.

Analysing the food records, the average energy intake was 2187.6 ± 744.7 kcal (Table 8). Men had significantly higher energy and monounsaturated fatty acid energy intakes. Fibre intake did not reach the recommended 25 g per day for either gender (men 22.8 ± 11.4 g; women 21.8 ± 16.6 g). When micronutrient intakes were examined, the average sodium intake was 5.4 ± 1.9 g for men and 4.5 ± 1.6 g for women, and potassium intake was below 3000 mg for both sexes. Magnesium intake was around 350 mg and calcium intake averaged 688.6 ± 349.6 mg. Phosphorus intake exceeded 700 mg in both sexes. Iron intake was above 10 mg for both men and women, but when looking at age groups, it was below 10 mg for women aged 18-34 years.

Table 8.
Average Daily Energy Intake and Average Energy Ratio of Macronutrients and Fatty Acids by Gender and Age Group.

	Males				Females			
	Total subsample *n = 482*	**18–34 ys** n = 140	**35–64 ys** n = 266	**≥65 ys** n = 76	***Total subsample*** *n = 542*	**18–34 ys** n = 139	**35–64 ys** n = 279	**≥65 ys** n = 124
Energy (kcal/day)								
Mean	*2373.0***	2460.4	2391.9	2146.0	*2022.8*	2078.3	1992.5	2028.7
SD	*744.2*	764.2	736.7	695.8	*706.1*	672.2	698.7	759.7
Protein (E%)								
Mean	*16.0*	16.0	16.0	16.3	*16.3*	16.3	16.2	16.4
SD	2.8	2.7	2.7	3.3	3.0	3.3	2.7	3.4
Total fat (E%)								
Mean	*36.2*	35.8	36.4	36.2	*36.0*	36.6	36.3	34.8
SD	*6.8*	6.5	67.0	6.9	*7.1*	6.3	7.3	7.1
SFA (E%)								
Mean	*11.0*	10.9	11.1	10.9	*10.9*	11.2	11.0	10.2
SD	*2.8*	2.8	2.8	2.9	*2.9*	2.7	2.9	2.8
MUFA (E%)								
Mean	*11.2**	10.9	11.3	11.1	*10,8*	10.9	11.1	10.3
SD	*2.8*	2.7	2.9	2.7	*3.0*	2.5	3.3	2.7
PUFA (E%)								
Mean	*8.9*	8.7	8.9	9.0	*9.0*	9.31	9.0	8.8
SD	*2.7*	2.5	2,7	2.9	*2.8*	2.7	2.8	2.7
Carbohydrates (E%)								
Mean	*48.4*	49.4	48.1	47.6	*49.1*	48.8	48.9	50.0
SD	*7.9*	7.5	8.0	8.2	*8.1*	7.3	7,9	9.1
Added sugar (E%)								
Mean	*9.4*	10.7	9.4	6.8	*9.0*	10.0	8.6	9.0
SD	*7.2*	7.9	7.1	5.1	*7.4*	7.0	7.1	8.2

Mann-Whitney U test *p<0.05 **p<0.001 SD = standard deviation
ys = years, E% = energy percent, SFA = saturated fatty acids; MUFA = monounsaturated fatty acids
PUFA = polyunsaturated fatty acids

Among fat-soluble vitamins, men had significantly higher intakes of vitamin A, vitamin D and vitamin E. Men had significantly higher intakes of water-soluble vitamins, except vitamin C.

5. Conclusions

In our research, we investigated the nutritional status and dietary habits of adult population through the Energy-balance Health Programme for Undergraduates and the E-Harmony Health Programme.

In Hungary, we were the first to study comprehensively the nutritional status and lifestyle characteristics of higher education students. We also identified a number of health risk factors in this sizeable population, similar to the Hungarian population. The region of South

Transdanubia is one of the most economically and health-wise underdeveloped areas of the country. In the past, neither Zala nor Baranya counties have been the subject of such a large-scale study of the nutritional habits, nutritional status, and health indicators of such a large number of individuals, and the analysis of the correlations between them.

By studying the whole spectrum of the adult population, our research also confirmed the high prevalence of obesity. When nutritional status was examined by body mass index, the vast majority of university students had a normal body weight, but they appeared to be underweight with a female, and overweight with a male predominance. Using a body composition analyser, it was shown that lower or higher body weight may indicate normal and/or higher skeletal muscle percentage. For a more nuanced assessment of nutritional status, body composition analysis can be easily achieved using a device based on the BIA principle. Even at normal body weight, significant body fat accumulation was already observed in young adults in both programmes, and abdominal obesity indicators indicated that one in three young adults was at risk of cardiometabolic disease. The waist-to-height ratio was an excellent predictor of obesity.

Our current results show that the alimentation and physical activity of university/college students are slightly better than the adult population, but still significantly below healthy levels. Participation in medical/health science education and health qualification also showed more favourable dietary habits in both women and men, but as age increased, health qualification had fewer positive dietary characteristics.

We were able to isolate gender and age-specific dietary patterns in the adult populations of the two counties. The dietary predominance of fatty meats/meat products was reflected in the increase in obesity indicators. A preference for a meatless diet alone may reduce the increase in age-related obesity indicators.

Our results have made a significant contribution to the evaluation of health indicators for the Hungarian population. We have increased the knowledge about the nutritional status and dietary characteristics of the Hungarian population, and have nuanced the definition of underweight, overweight, obesity by additional calculation of anthropometric indices/ratios beside the body mass index and by using a body composition analyser.

In conclusion, reducing prevalence of overweight, obesity and abdominal obesity and promoting healthy eating remains an extremely important public health task, in which regional health programmes targeting all age groups, including young adults, are essential.

Summary of new findings

1. From our largest-ever comprehensive study of university students' lifestyles in Hungary, we found that although a small proportion of Hungarian students were obese according to the body mass index - 5% of men and 2% of women - 16.3% of men and 6.9% of women had a particularly high body fat percentage.
2. Based on the responses of thousands of university students, we have shown for the first time that students in higher education in Hungary, studying medicine/health sciences, followed a healthier dietary pattern than students in other higher education fields for both sexes.
3. Based on anthropometric data from our survey of the largest representative sample of adults living in Baranya and Zala counties, we were the first to calculate and analyse obesity indicators that are less commonly used in our country.
4. We found that in our sample, those above the normal value (≥0.5 cm) of the waist-to-height ratio – one of the best indicators of cardiovascular risk – almost completely covered the category of obesity defined by BMI, so this indicator may be informative in itself.
5. We have shown that typical Hungarian dietary characteristics (preference for fatty meats, meat products, offal) are more prevalent in the older generation, men and those with lower education levels in the study region. These eating habits were often associated with a preference for alcohol, convenience products and starchy side dishes. This dietary pattern also increases the risk of obesity, which was confirmed by the indicators studied.
6. We have shown that different dietary preferences, through their indirect effects, may strengthen or weaken the effect of age on anthropometric indicators relevant to obesity, most consistently to the waist-to-hip ratio.
7. We are the first to demonstrate in a domestic adult sample that a ’meat/cold cuts-free’ diet has a beneficial effect on obesity parameters increasing by age, including the risk of CVD.

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