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HEALTHY EATING INDEX AND DIFFERENT FRUIT DIETARY HABITS IN SLOVAK ADULT FEMALE

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ABSTRACT

The healthy index is a tool for evaluation of nutrition recommendation aimed at prevention of chronic diseases. A lot of studies have been devoted to HEI of different aged groups of people but dates about Slovak population have been still missed. The goal of the study was to evaluate the Healthy Eating Index (HEI) in nutrition of adult female, determine their components in relation of parameters of anthropometry and body composition. Secondly, the research work was also aimed at the comparison of partial score HEI among groups of female with different fruit intake. Daily nutrition was evaluated by 24 hours dietary recalls. In set of female (average age 31.1 ±9.1 years) the average HEI index reached up 53.0 ±8.8 points in accord with medium degree of diet, it means dietary improvement has been highly recommended. In respect of all assayed components of index the best results achieved the variety of diet (8.8 ±1.3 points) and the worst the natrium intake (0.7 ±2.0 points). The average score for the individual components pointed to neccesary of increase in the grain intake and vegetable, on the other hand the intake of cholesterol, saturated fats and especially natrium should be decreased. The differences between groups with various intake of fruit (with recommended intake and insufficient intake) in the rest 9 components have not been proved as significant. The occurrence of risk values of body index, body fats determined by bioelectric impedance and android risk based on circumference of hips can not be considered between groups as significant. Average HEI has been in significance correlation with age ($r = 0.240$; $p < 0.05$), circumference of hips ($r = 0.2312$; $p < 0.05$) and body weight $r = 0.1748$; $p < 0.05$). Future studies have been needed to evaluate diet according to the HEI in different groups of population in Slovakia.

Keywords: diet quality; Healthy Eating Index; fruit intake; anthropometric parameters; Slovak female

INTRODUCTION

Nutritional factors and factors of life style have been significantly contributed to prevalence of chronic diseases. Composition of diet has been influenced by different socially-economic aspects and preferences of consumers **(MH SR, 2001)**.

Healthy Eating Index (HEI) has been implemented as measure of food quality of USDA (United States Department of Agriculture). USDA has been aimed at improvement of health with the diet recommendations for American population **(Guo et al., 2004)**. It has been introduced as a key tool to evaluate the extent to which Americans are following the dietary recommendations for safety and healthy food **(Willett and Skerrett, 2005)**. HEI represents the first and very simple model for generalization and monitoring of changes in dietary habits. Index expresses and measures how well a set of foods aligns with nutrition recommendations, dietary patterns and Food Guide Pyramid **(Variyam et al., 1998; Edelstein, 2011)**. HEI give general image about type and quantity of diet of individuals and their compliance with the specific nutrition recommendations for nutrients and food groups **(Gibson, 2005)**.

The HEI was originally developed in 1995 (HEI-1995) utilized dates from 1989 up to 1990 **(USDA, 1995)**. Dietary intakes of individuals were collected on 2 nonconsecutive days and using the 24-hour dietary recall method including 7500 respondents aged 2 years and older. In this approach it was necessary to separate probands into 3 energetic groups **(Dixon, 2008)**. Subsequently, the index has been periodically evaluated **(Bowman et al., 1998; Basiotis et al., 2002)**. Serving definitions based on Food Guide Pyramid **(USDA, 1997)** for different levels of energetic intake were reflected consistency with the serving definitions among people with different Recommended Energy Allowances as we can see at Table 2. The upper limits for intake of total fats, saturated fats, cholesterol and natrium were determined on the base of consultations with diet and nutrition experts and research of distribution intake of components

(Basiotis et al., 2002). Diet recommendations for American population, Food Guide Pyramid and National Research Council emphasized the importance of diet variety **(National Research Council, 1989a; USDA, 1996; Dietary Guidelines Advisory Committee, 2000)**. Unfortunatelly, nowdays there has not been accepted pattern how to quantify the measure of diet variety. HEI was utilized for evaluation of food quality within NHANES III with dates of reports 1999 – 2001. The results showed that only 10% nutrition of american population could be considered as good, 16% bad and the rest of american nutrition required to be improved. Subgroups of american population also displayed the lower quality of nutrition, especially men 15 – 18 years old, groups with lower incomes, non-hispanic Americans of African origin, persons with lower education. For 1999 – 2000 has been established the average HEI score for american population 63.8 **(Basiotis et al., 2002)**. In the same way **Dubois et al. (2000)** applicated HEI for evaluation of nutrition quality based on Canadian Nutrition Report, Quebec, 1990. HEI has been improved taken into account the Canadian Nutrition Recommendations from 1990 **(Health Canada, 1990)**. It has been also adapted in some countries, considering the local dietary habits **(Fernandes et al., 2015)**. HEI has been evaluated also in relation to plasmatic biomarkers. **Hann et al. (2001)** pointed to the fact that nutrition with high score of HEI has been in positive correlation with plasmatic concentration of carotenoids and ascorbic acid. It has been indicated that choice of food based on food pyramid leaded into healthy nutrition. On the other hand, the increased level of biomarkers has not been uniquely indicated decrease incidence of diseases.

There has been lack of evidence between food intake, biomarkers and diseases. It has been confirmed only a weak correlation between HEI and risk of chronic diseases (cardiovascular and oncological) **(McCullough et al., 2000a; McCullough et al., 2000b)**. Development of new nutrition recommendations for american population in 2005 was motivation for revision HEI (HEI-2005). Standards for food groups have been based on new recommendation of food pyramid („My Pyramid“) **(Britten et al., 2006)**. HEI-2005 has been standardized and can be used in nutrition monitoring, intervention and research as well. It consists of 12 components **(Guenther et al., 2006)**. **Guenther et al. (2008)** found out that score in 9 – 12 components was lower in group of smokers in comparison with non-smokers.

The study of HEI is requisite and necessary for the Slovak population as well **(Fatrcová-Šramková, 2010; Fatrcová-Šramková, 2013)**. The aim of study was to evaluate the Healthy Eating Index (HEI) in nutrition of adult female, to determine their components in relation of parameters of anthropometry and body composition. The research work was also aimed at the comparison of partial score HEI among groups of female with different fruit intake.

Scientific hypothesis

The average HEI of the set of female has been minimally in the medium level according to descriptors (it has not been in accord with the worst level “bad nutrition”).

Group of female with the recommended consumption of fruit achieved the better evaluation in HEI, anthropometric parameters and body composition than female with insufficient intake of fruit.

MATERIAL AND METHODOLOGY

Characteristic of the research sample

The set of analyses was performed using dates from the group of adult female (n = 165). The average age reached up 31.1 ±9.1 (range 21.0 – 49.4 years, median 38.9). The age characteristics and distribution of research sample is presented at Table 1.

Evaluation of the Healthy Eating Index (HEI)

It has been used 24 hour dietary recalls and 3 day – day food intake records. 24 hours dietary recalls were processed by nutrition software Alimenta version 4.3e originated from Food Research Institute, utilised The Slovak Food Composition Data Bank.

Daily consumption of food has been evaluated by 10 components of index HEI (Healthy Eating Index) (Table 1). All components from HEI-1995 have been taken into account. Ten components represented the different aspects of healthy nutrition. Healthy Eating Index from 1995 consists of 10 components (Table 2). The components 1 – 5 (the first partial index) deal with adequency of food composition of individuals reflected recommendations of Food Guide Pyramid from 1992. They measured the compliance of nutrition of individuals with recommendation for 5 basic food groups of Food Guide Pyramid as: cereals (bread, grain, rice and pasta), fruit, vegetable, milk (milk, youghurt and cheese), meat and its substitutions (poultry, fish, legumes, eggs and nuts). The second partial index (components 6 – 10) devotes the part of food that should be intaken minimally: total fats, saturated fats, cholesterol and natrium. The final component examines variety in person´s diet. The each component of index can reach maximum score 10 and minimum 0 **(Kennedy et al., 1995; Basiotis et al., 2002; Guenther et al., 2008; Guenther et al, 2013)**. Food Guide Pyramid expresses the diet recommendations for Americans (Dietary Guidelines for Americaners) **(Dietary Guidelines Advisory Committee, 2000)**.

The recommended servings of food lead to healthy diet. The recommended servings in pyramid have been in accord with energy intake for individuals **(National Research Council, 1989b)**. Table 2 showed recommended servings for different groups of people in relation to age, gender and for energy level 1600 kcal, 2200 kcal and 2800 kcal, i.e. 6700 kJ, 9200 kJ and 11700 kJ **(USDA, 1997)**. According to Food Guide Pyramide is the recommended servings per day (Table 2) for female aged 11 – 24 years and as well 25 – 50 years (energy intake 2200 kcal, i.e. 9200 kJ) for grains 9 servings, vegetable 4 servings, fruit 3 servings, milk 2 servings, meat 2.4 servings **(USDA, 1996)**.

Each component within HEI (Table 1 and Table 2) was scored by minimal point 0 (in case of insufficient nutrition) up to 10 points (in case of sufficient nutrition). High component score indicates intake close to recommended range or amount, low component score indicates less compliance with recommended range or amount. The maximum overall score for the 10 combined

Table 1 Distribution of female in relation to age (%).

Age	Consumption of fruit			
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B	***p*-value**
25 – 30 years	32.2	33.3	32.7	**0.998**
31 – 35 years	6.9	15.4	10.9	**0.384**
36 – 40 years	12.6	12.8	12.7	**0.999**
41 – 45 years	12.6	9.0	10.9	**0.903**
46 – 50 years	35.6	29.5	32.7	**0.871**

Note: group A – recommended consumption of fruit (higher than score 10 point); group B – insufficient consumption of fruit (lower than score 10 point); $p \geq 0.05$.

Table 2 HEI (Healthy Eating Index) **(Basiotis et al., 2002)**.

Parameters	**Score ranges**[a] (points)	Criteria for Maximum Score of 10 points	Criteria for Minimum Score of 0 points
Consumption of different group of food			
1. grain	0 – 10	6 – 11 servings[b]	0 servings
2. vegetable	0 – 10	3 – 5 servings[b]	0 servings
3. fruit	0 – 10	2 – 4 servings[b]	0 servings
4.milk	0 – 10	2 – 3 servings[b]	0 servings
5. meat	0 – 10	2 – 3 servings[b]	0 servings
Nutrition recommendations			
6. total fat intake	0 – 10	30% or less energy from fat	45% or more energy from fat
7. saturated fat intake	0 – 10	Less than 10% energy from	15% or more energy from
8. cholesterol	0 – 10	saturated fat	saturated fat
9. natrium	0 – 10	300 mg or less	450 mg or more
10. food variety	0 – 10	2400 mg or less	4800 mg or more
		8 or more different items in a day	3 or fewer different items in a day

Note: [a] People with consumption or intakes between the maximum and minimum ranges or amounts were assigned scores proportionately. [b] Number of servings depends on Recommended Energy Allowance; see Table 3. All amounts are on a per day basis.

Table 3 The recommended food servings per day according to Food Guide Pyramid **(USDA, 1996; USDA, 1997)**.

Energy (kcal)	**Grain**	**Vegetable**	**Fruit**	**Milk**	**Meat**
1600	6	3	2	2	2
2200	9	4	3	2	2.4
2800	11	5	4	2	2.8

components is 100. Scores were calculated using the population ratio method. The calculation of HEI index was provided in accord with recommendations of **Kennedy et al. (1995); Dietary Guidelines Advisory Committee (2000); Basiotis et al. (2002); Guenther et al. (2008); Guenther et al. (2013)**.

For HEI evaluation the descriptors on the base of USDA recommendation were used **(Gibson, 2005)**. An HEI score over 80 implies a „good" diet, an HEI score between 51 and 80 implies a diet that „needs improvement", and an HEI score less than 51 implies a „poor" diet. Except for HEI score for all components we also aimed at partial score (for selected components). For partial score (evaluation of 5 parameters from 10) the adequate proportion of points (50% evaluation) was used. The following descriptors were utilised for evaluation of the partial score: „good diet" over 40 points, „need improvement" 25.5 – 40 points, „poor diet" less than 25.5 points.

In aspect of for evaluation of partial HEI adult female were separated according to quantitative intake of fruit. It has been established 2 groups of female. Group A („recommended fruit consumption) can be characterised by daily minimally consumption of fruit 3 servings. Group B („insufficient consumption of fruit") mean the low intake of fruit in amount less than 3 servings.

Evaluation of the body composition, anthropometry

It has been characterised and evaluated the anthropometric parameters, parameters of body composition: body weight (kg), height (cm), waist circumference (cm), hip circumference (cm), body fat (absolut in kg, relative in %), body mass index – BMI ($kg.m^{-2}$) as relation weight to height, and waist to hip ratio – WHR (index of centrality). BMI was evaluated according to criteria of **WHO (2018)**, index centrality according to **Kleinwächterová and Brázdová (2001)**. For determination of body composition the bioelectrical impedance analysis (BIA) by Bodystat Quadscan 4000 (Bodystat Ltd, Doubles, Isle of Man, UK) has been used.

Statisic analysis

Statistical evaluation was provided by Statistica.cz (verzia 10, StatSoft, Inc., Česká republika). The differences among groups were tested by one-way t-test and chi-squared test ($\chi 2$–test). Statistical significant

differences were stated as *p*-values ($p = 0.05$). Correlations were expressed by correlation coefficient r.

There has not been confirmed the significant differences in age distribution of female between group A and group B (Table 1).

RESULTS AND DISCUSSION

According to assayed scores the evaluation of components of HEI index has declined tendency in the following order: diet variety > total fat > fruit > milk > meat > grains > vegetable > cholesterol > saturated fats > natrium (Table 4). The highest score reached up the variety of diet (8.8 ±1.3 points). On the other hand, the lowest score had natrium (0.7 ±2.0 points) in exceeded daily intake. The biggest problem in nutrition of female was the daily recommended intake of natrium.

In respect of intaken food, nutrients and quantification of diet variety there has been proved statistically significant differences between real and recommended intake in case of all 10 components of HEI ($p < 0.001$, $p = 0$). Of the first 5 components of the HEI, the most favourable group was represented by fruit and fruit products (7.2 ±3.7 points). On the contrary, the most insufficient was the daily consumption of vegetable. Of the rest nutrition recommendations (components 6 – 9) the highest score achieved diet variety, the mostly insufficient was natrium intake.

Tangney et al. (2001) studied HEI index of elder people and found out that the lowest proportions of perfect scores occurred for grains, vegetables, milk and meat. The highest proportions with perfect scores occurred for total and saturated fat (as a percentage of energy), cholesterol and sodium intakes.

In the base of fruit component the set of female was divided into 2 groups (with recommended intake of fruit – group A and insufficient intake of fruit – group B). For more detailed comparative evaluation the set was dividing according to food group with the best score – fruit. There has been confirmed differences between group A of female meet recommended serving of fruit (minimally 3 servings) *versus* group B of female with insufficient fruit in the rest of 9 components of HEI as well (Table 4 and 5). In group A except for fruit consumption the best evaluation (from maximum 10 points) reached up variety of diet (8.9 ±1.2 points) and total fats (7.9 ±2.8 points) (Table 4). The same order was estimated also in group B: variety of diet 8.8 ±1.4 points and total fats 7.9 ±2.2 points. Similarly, the worst score in group A and B displayed natrium (1.0 ±2.3 points; 0.5 ±1.5 points). The daily natrium intake significantly exceeded the recommendation (group A 9071.1 ±4089.8 mg and group B 8897.2 ± 3999.0 mg). The daily recommended natrium intake represented 2400 mg and less (Table 5).

The insufficient intake of fruit regularly 5 times a day has been evaluated in research work of **Juríková et al. (2016)**. The majority of college students consumed fruit and vegetable only once a day. The vegetable as a source of natural antibiotics has been intaken only once a week as well **(Juríková et al., 2017)**.

It was also interesting observed not only intake of recommended dose of fruit but also vegetable as an important source of bioactive compounds (Table 6).

The results showed that 40% of respondents did not meet criteria for the recommended daily intake of fruit and vegetable, non respondents from group A and majority from group B (0% *versus* 84.6%). Only one of recommendations – fruit was covered by 47.3% of female in group A. There has been proved statistically significant differences between evaluated groups (75.9% *versus* 15.4%, $p = 0.000$). Generally, the recommendations for fruit and vegetable were taken into account in 12.7% female, minimally 1 recommendation (fruit/vegetable) had 60% of probands (all respondents of group A and 15.4% respondents of group B).

In case of fruit the maximum score (10 points) achieved 52.7% female (Table 7). The order of components in accord to maximum score was following: fruit > meat > milk > total fat > variety of diet > cholesterol > vegetable > grains > natrium > saturated fats. Generally, female did not meet the guidelines in parameters of nutrition in consumption of grains (96.4%), natrium intake (98.2%) and saturated fat (all respondents). Our results are in accord with the study of **Ervin (2008)** (56% of older female met the recommendation for diet variety). Similarly, **Shah et al. (2010)** reported that participants according to HEI 2005 consumed more than recommended amounts of sodium, saturated fats, and discretionary calories.

The assayed female groups were significantly differed in component fruit, the rest differences in components has not been proved as significant. The recommended daily intake of milk had more probands of group B (47.4%) *versus* group A (34.5%). On the contrary, the higher consumption of vegetable and total fats was higher in group A (24.1%; 42.5%) *versus* group B (15.4%; 37.2%).

Particularly it was determined the distribution of female in components of HEI at least 50% (score 5 points or more for the individual components) (Table 8). The groups were represented by female has not been covered recommendation of fruit intake (on 50% with score less than 5 points) (B group) and female has been covered at least 50% of recommendations with 5 points and more) (A group). The most significant differences between groups have been determined in consumption of fruit (in group A higher value by 52.6%) and milk (higher value by 14.3% in group B). Differences in consumption of vegetable represented only 5.8%, cholesterol 5.5% and total fats 4.6%. The results pointed to the fact that group B with lower consumption of fruit has achieved weeker results also in another components (in 6 components was determined score under 5 points). Group A displayed also better results in consumption of milk (by 14.3%), total fats (by 4.6%), cereals intake (by 2.8%) and meat (1%). On the other hand, in group B were more female with insufficient diet and score under 5 points in consumption of fruit (by 52.6%), vegetable (by 5.8%), cholesterol (by 5.5%), natrium (by 4.1%), saturated fat (by 0.6%) and diet variety (by 0.6%).

It was monitored the occurence of worst score with 0 points in case of cereals (0.6%), vegetable (16.4%), fruit (13.3%), milk (2.4%) and meat (12.1%) (Table 9). Extremely high proportion of fats (more than 45% of daily energy intake) had only 3.6% probands. The proportion of fats in energy intake must cover 30% (saturated fat acids 10%, monounsaturated fatty acids 10 – 12% and

Table 4 Score for components HEI (mean ±SD).

Components HEI (points)	**Consumption of fruit**		
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B
Grains	6.8 ±2.6	7.0 ±2.8	4.9 ±2.4
Vegetable	5.1 ±3.6	4.4 ±3.7	4.7 ±3.7
Fruit	10.0 ±0.0	4.0 ±3.2	7.2 ±3.7
Milk	6.4 ±3.7	7.7 ±3.4	7.0 ±3.6
Meat	6.7 ±3.8	6.7 ±3.6	6.7 ±3.7
Total fat	7.9 ±2.8	7.9 ±2.2	7.9 ±2.5
Saturated fat	2.2 ±2.0	1.7 ±1.9	2.0 ±1.9
Cholesterol	3.3 ±4.3	2.8 ±4.2	3.0 ±4.3
Natrium	1.0 ±2.3	0.5 ±1.5	0.7 ±2.0
Diet variety	8.9 ±1.2	8.8 ±1.4	8.8 ±1.3

Note: SD – standard deviation.

Table 5 Evaluation of components HEI (mean ±SD).

Components HEI	**Consumption of fruit**		
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B
Grains (servings)	4.3 ±2.1	4.5 ±2.2	4.4 ±2.1
Vegetable (servings)	2.5 ±2.3	1.9 ±1.8	2.2 ±2.1
Fruit (servings)	5.2 ±1.9	1.2 ±1.0	3.3 ±2.5
Milk (servings)	1.6 ±1.2	2.1 ±1.6	1.9 ±1.4
Meat (servings)	2.4 ±2.1	2.4 ±1.9	2.4 ±2.0
Total fat (% of energy)	31.6 ±7.1	32.0 ±5.7	31.8 ±6.5
Saturated fat (% of energy)	8.4 ±3.0	8.6 ±2.4	8.5 ±2.7
Cholesterol (mg)	629.2 ±420.9	583.0 ±338.4	607.3 ±383.7
Natrium (mg)	9071.1 ±4089.8	8897.2 ±3999.0	8988.9 ±4035.8
Diet variety (number of items)	7.12 ±0.96	7.04 ±1.12	7.04 ±1.04

Table 6 Keeping for selected components of HEI (%) – fruit and vegetable.

Number of kept recommendations	**Consumption of fruit**			***p*-value**
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B	
0	0.0	84.6	40.0	-
1 (for fruit and vegetable)	75.9	15.4	47.3	0.000
2 (for fruit and vegetable)	24.1	0.0	12.7	-

Note: p <0.001.

polyunsaturated fatty acids 8 – 10%) **(Kajaba et al., 1999; MH SR, 1997; PHA SR, 2015)**. Limit maximally 30% of daily energy intake has been overlapped by majority of Europeans **(MH SR, 2001)**. The recommended energy value from saturated fats (max. 10%) was highly overlapped by 25% of probands (with values higher than 15% of saturated fat from energy intake).

In USA and Europe saturated fat acids represent 12 – 15% from total energy intake. On every 1% of energy intake in the form of saturated fatty acids has been increased level of LDL cholesterol in comparison with oleic acid by 2 $mg.dL^{-1}$ (0.025 $mmol.L^{-1}$) **(Grundy, 2003)**. The content of n-6 fatty acids should not be 4 – 10 higher in comparison with n-3 fatty acids. Oil originated from sea fish represents a very valuable source of eicosapentaenoic (EPA and docosahexaenoic acid (DHA) decreased the probalibility of trombosis in veins. Nutritionally fats and oils can be considered as healthy if the proportion of fatty acids has been approximate to mentioned relation **(MH SR, 2001)**.

In the set of assayed female was noticed overlapped intake of cholesterol (450 mg and more) among 60% of female with negative impact on incidence of cardiovascular diseases. The better results in cholesterol intake achieved **Ervin (2008)**, 72% of older adults met the guidelines for cholesterol. Human body is able to synthetize essential amount of cholesterol, its excessed intake increase the risk of cardiovascular diseases. It is a reason for recommendation of nutrition experts not consumed more than 300 mg cholesterol **(MH SR, 2001)**. On every 200 mg of intaken cholesterol it has been increased the concentration of serum LDL-cholesterol (LDL – low density lipoproteins) on average by 6 $mg.dL^{-1}$ (0.155 $mmol.L^{-1}$) **(Grundy, 2003)**. Saturated fatty acids increase, polyunsaturated fatty acids decrease the level of cholesterol **(MH SR, 2001)**.

The daily intake of natrium significantly overlapped the recommended dose reached up 4800 mg in case of (83.6%) probands. Female had minimally 0.5 serving from all food groups so diet variety represented the smallest problem in

Table 7 Distribution of female in the evaluated groups based on scores for componenents of HEI.

Components HEI (score)	Consumption of fruit			*p*-value
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B	
1. cereals				
<9 porcií	96.6	96.2	96.4	-
≥9 porcií*	3.4	3.8	3.6	
2. vegetable				
<4 porcie	75.9	84.6	80.0	**0.578**
≥4 porcie*	24.1	15.4	20.0	
3. fruit				
<3 porcie	0.0	100.0	47.3	-
≥3 porcie*	100.0	0.0	52.7	
4. milk				
<2 porcie	65.5	52.6	59.4	**0.413**
≥2 porcie*	34.5	47.4	40.6	
5. meat				
<2,4 porcie	58.6	57.7	58.2	**0.999**
≥2,4 porcie*	41.4	42.3	41.8	
6. total fat				
>30 %	57.5	62.8	60.0	**0.921**
≤30 %*	42.5	37.2	40.0	
7. saturated fat				
≥10 %	100.0	100.0	100.0	-
<10 %*	0.0	0.0	0.0	
8. cholesterol				
>300 mg	74.7	78.2	76.4	**0.964**
≤300 mg*	25.3	21.8	23.6	
9. natrium				
>2400 mg	96.6	100.0	98.2	-
≤2400 mg*	3.4	0.0	1.8	
10. diet variety				
<8 položiek	70.1	67.9	69.1	**0.992**
≥8 položiek *	29.9	32.1	30.9	

Note: * criteria for maximum score (10 points); $p \geq 0.05$.

nutrition. On the other hand, the biggest problem of female was overlapped sodium intake.

Average HEI score achieved the mean value 53.0 ±8.8 points (58.2 in the first and 51.4 in the second group, Table 10). This result is in accord with medium level of nutrition according to **Gibson (2005)** with necessary improvement of diet. This value represented also lower value in comparison with **Basiotis et al. (2002)** (HEI 63.8%) monitoring American population in 1999 – 2000. In the same way in the project Chicago Health and Aging was studied adult population 65 year and more (4932 participants) and the average HEI index was calculated 70.7 it means very close to healthy diet **(Tangney et al., 2001)**. According to research study of **Ervin (2008)** only 17% of older adults consumed a "good" quality diet. HEI-2015 for the american population for the years 2013 – 2015 was calculated as following: 59 for 2013 – 2014, 60 for years 2011 – 2012, 59 for 2009 – 2010, 57 for 2007 – 2008, 56 for 2005 – 2006 (from top score 100). HEI-2015 demonstrated that the nutrition of Americans are in medium level and did not align with the nutrition guidelines "2015 – 2020 Dietary Guidelines for Americans" **(USDA, 2015; USDA, 2018)**. Partial score for parameters 1 – 5 was compared with partial score for parameters 6 – 10 (Table 10). The better results were achieved in first partial score for parameters 1 – 5 (30.5 versus 22.5) within set of female and group of A and B with different intake of fruit. Evaluation of partial score 1 – 5 was in accord with medium level of nutrition with needs for improvement of diet, score 6 – 10 is in agreement with bad level of nutrition.

For HEI index, also partial HEI (1 – 5) and HEI (6 – 10) has been confirmed significant differences in comparison real and recommended score ($p < 0.001$; $p = 0$).

In set there have been evaluated anthropometric parameters as well (Table 11). On the basis of BMI classification **(WHO, 2018)** the proportion of female with normal weight took 60%, pre-obesity in 27.3% and overweight in 12.7% (Table 12). Obesity class III or underweight were not be noticed. Cumulative evaluation pointed to high prevalence of pre-obesity and obesity (BMI 25 $kg.m^{-2}$ and more) in 40%. Between groups A and B with different fruit intake there has not been proved statistically significant differences in BMI ($p \geq 0.05$). Normal weight had 54.0% and 66.7% probands in groups A and B, pre-obesity 32.2% a 21.8%, obesity class I – III 13.7% a 11.5%. Only third of respondents in group B displayed risk BMI. Pre-obesity or obesity was identified more often in group A with higher intake of fruit (45.9% *versus* 33.3%). According to index of centrality there has been higher occurence of android body type in group A than in group B (WHR ≥0.85, 16.1% *versus* 0%,

Table 8 Groups of female according to 50% score for HEI components.

Components HEI (score)*	**Consumption of fruit**			*p*-value
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B	
1. grains				
<5 points	20.7	17.9	50.3	**0.977**
≥5 points	79.3	82.1	49.7	
2. vegetable				
<5 points	50.6	56.4	53.3	**0.904**
≥5 points	49.4	43.6	46.7	
3. fruit				
<5 points	0.0	52.6	24.8	-
≥5 points	100.0	47.4	75.2	
4. milk				
<5 points	31.0	16.7	24.2	**0.201**
≥5 points	69.0	83.3	75.8	
5. meat				
<5 points	35.6	34.6	35.2	**0.999**
≥5 points	64.4	65.4	64.8	
6. total fat				
<5 points	14.9	10.3	12.7	**0.846**
≥5 points	85.1	89.7	87.3	
7. saturated fat				
<5 points	94.3	94.9	94.5	-
≥5 points	5.7	5.1	5.5	
8. cholesterol				
<5 points	70.1	75.6	72.1	**0.888**
≥5 points	29.9	24.4	26.7	
9. natrium				
<5 points	90.8	94.9	88.5	-
≥5 points	9.2	5.1	8.5	
10. diet variety				
<5 points	0.0	0.6	0.6	-
≥5 points	100.0	100.0	93.3	

Note: * criteria for evaluation 5 points (50% of the maximum score) according to HEI **(Basiotis et al., 2002)**, $p \geq 0.05$.

Table 9 Groups of female according to minimum score (0 points) for HEI components.

HEI components (criteria)*	**Consumption of fruit**			*p*-value
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B	
Grains (0 serving)	0.0	1.3	0.6	-
Vegetable (0 serving)	14.9	17.9	16.4	**0.965**
Fruit (0 serving)	0.0	28.2	13.3	-
Milk (0 serving)	3.4	1.3	2.4	-
Meat (0 serving)	13.8	10.3	12.1	**0.922**
Total fat (45% of energy intake or more)	5.7	1.3	3.6	-
Saturated fat (15% or more)	24.1	26.9	25.5	**0.982**
Cholesterol (450 mg and more)	58.6	61.5	60.0	**0.985**
Sodium (4800 mg and more)	80.5	87.2	83.6	**0.715**
Diet variety (0 items)	0.0	0.0	0.0	-

Note: * criteria for minimum score (0 points) according to HEI **(Basiotis et al., 2002)**, ($p \geq 0.05$).

$p \geq 0.05$). By measurement of body fat was also observed the higher occurence of health hazard in group A. In the same way **Kant and Graubard (2005)** reported that the HEI score was associated with obesity and biomarkers of cardiovascular diseases and *diabetes mellitus*. The occurence of the risk values of anthropometry and body composition of female with recommended intake of fruit can be caused by total structure of intaken diet and also with presence of nutrition risk factors as well as with

Table 10 Scores for total HEI, partial HEI (1 – 5) and partial HEI (6 – 10) (mean ±SD).

HEI (components)	**Consumption of fruit**		
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B
HEI (1 – 5) [a]	34.9 ±7.2	29.8 ±7.7	30.5 ±7.6
HEI (6 – 10) [a]	23.2 ±7.8	21.7 ±5.9	22.5 ±7.0
HEI (sum 1 – 10) [b]	58.2 ±7.7	51.5 ±8.6	53.0 ±8.8

Note: [a] partial score HEI, [b] total score HEI.

Table 11 Characteristic of female groups with different fruit consumption (mean ±SD).

Parameters	**Consumption of fruit**		
	Recommended Group A	**Insufficient** Group B	**Together** Group A +B
Age (years)	37.6 ±9.7	35.7 ±9.5	36.7 ±9.6
Body height (cm)	165.4 ±5.5	165.3 ±5.7	165.4 ±5.6
Body weight (kg)	68.1 ±12.2	65.7 ±12.7	67.0 ±12.5
Waist circumference (cm)	80.4 ±10.6	77.4 ±10.0	79.0 ±10.4
Hip circumference (cm)	102.6 ±9.8	101.4 ±10.1	102.0 ±9.9
Body fat (%)	21.1 ±8.7	20.0 ±8.8	20.6 ±8.8
Body fat (kg)	30.0 ±7.1	29.4 ±6.9	29.7 ±7.0
BMI (kg.m^{-2})	24.9 ±4.9	24.1 ±4.6	24.5 ±4.6
WHR	0.8 ±0.1	0.8 ±0.1	0.8 ±0.1

Note: BMI – body mass index, WHR – waist to hip ratio.

Table 12 Body mass index (BMI), waist to hip ratio (WHR), body fat (BF) and classification in female groups (%) with different fruit consumption.

Classification	**Criteria**	**Consumption of fruit**			
		Recommended Group A	**Insufficient** Group B	**Together** Group A +B	*p*-**value**
Nutritional status*	**BMI (kg.m^{-2})**				
Underweight	<18,5	0.0	0.0	0.0	**-**
Normal weight	18.5 – 24.9	54.0	66.7	60.0 -	**0.433**
Pre-obesity	25.0 – 29.9	32.2	21.8	27.3 -	**0.524**
Obesity class I	30.0 – 34.9	10.3	7.7	9.1 -	**0.950**
Obesity class II	35.0 – 39.9	3.4	3.8	3.6	**-**
Obesity class III	≥40	0.0	0.0	0.0	**-**
Health risk*	**WHR (kg.m^{-2})**				
Gynoid	<0.85	83.9	100.0	89.1	**-**
Android	≥0.85	16.1	0.0	10.9	**-**
Healthy risk	**BF (%)**				
Without risk	≤25	65.5	80.8	72.7	**0.185**
Risk	>25	34.5	19.2	27.3	**0.185**

Note: $p \geq 0.05$.

lifestyle (the level of moving activity). Overlapped intake of fruit has been in relation with increased intake of sugar over dairy recommendations. Separately it has been evaluated relation between HEI score and anthropometric parameters. HEI index was in significant correlation with age ($r = 0.2402$; $p < 0.05$), body weight ($r = 1748$, $p < 0.05$) and hip circumference ($r = 0.2312$; $p < 0.01$). The mentioned anthropometric parameters were correlated to partial HEI (1 – 5) for group of food and HEI 6 – 10 for diet recommendations. The statistically significant relations have been confirmed between partial HEI (6 – 10) and anthropometric parameters: body weight, body height, waist circumference, hip circumference, BMI ($p < 0.001$) and body fat (% BF, $p < 0.001$; kg BF, $p < 0.05$). There have been proved significant correlation between HEI (1 – 5) and body weight ($p < 0.01$), age, height, waist circumference, body fat (% BF), BMI, WHR ($p < 0.05$).

Higher HEI 2005 scores have been associated with favorable lipid profile **(Shah et al., 2010)** and lower risk of obesity **(Gao et al., 2008)**. We can also conclude that components 6 – 10 significantly contributed to occurence of obesity and chronic diseases (especially increased proportion of total fat, saturated fatty acids, cholesterol or natrium). A version of the HEI calculated from food frequency questionnaires was associated with a lower risk of cardiovascular disease in men in the research study of **McCullough et al. (2000a; 2000b)**. The risk values of anthropometric parameters have been more often occured

Table 13 Correlation between HEI score and anthropometric parameters.

Parameter	HEI (1 – 5)	HEI (6 – 10)	HEI
Age (years)	$r = 0.1740$	$r = 0.1133$	$r = 0.2402$
	$p = 0.025$	$p = 0.147$	$p = 0.002$
Height (cm)	$r = 0.1747$	$r = 0.3715$	$r = 0.1425$
	$p = 0.025$	$p = 0.000$	$p = 0.068$
Weight (kg)	$r = 0.2287$	$r = 0.4715$	$r = 0.1748$
	$p = 0.003$	$p = 0.000$	$p = 0.025$
Waist (cm)	$r = 0.1901$	$r = 0.3288$	$r = 0.0954$
	$p = 0.014$	$p = 0.000$	$p = 0.223$
Hip (cm)	$r = 0.1393$	$r = 0.4450$	$r = 0.2312$
	$p = 0.074$	$p = 0.000$	$p = 0.003$
Body fat (%)	$r = 0.1591$	$r = 0.3405$	$r = 0.1314$
	$p = 0.041$	$p = 0.000$	$p = 0.092$
Body fat (kg)	$r = 0.0747$	$r = 0.1710$	$r = 0.0705$
	$p = 0.340$	$p = 0.028$	$p = 0.369$
BMI ($kg.m^{-2}$)	$r = 0.1806$	$r = 0.3585$	$r = 0.1270$
	$p = 0.020$	$p = 0.000$	$p = 0.104$
WHR	$r = 0.1552$	$r = 0.0028$	$r = 0.1366$
	$p = 0.046$	$p = 0.971$	$p = 0.080$

Note: HEI – healthy eating index, BMI – body mass index, WHR – waist to hip ratio.

in the group of female with recommended intake of fruit and their products. It can pointed to lower quantity level of nutrition despite the incorporation of nutritionally valued food from group of fruit. It has been confirmed also in assessment of the rest HEI components as well.

There has been surprisingly little dietary information and HEI data for Slovak population in literature. Many adults, and in particular, adults with insufficiet fruit intake, may have diets inadequate according to dietary recommendations.

There has not been existed food with ideal nutrition composition so food groups must be selected in the way that daily intake of diet include all sufficient nutrients in ideal proportion **(MH SR, 2001)**. Nutrition education programs and innovative interventions may help meet food and nutrients recommendations and daily nutrition requirements. Keeping of nutrition recommendations are essential for good healthy status of individuals.

CONCLUSION

This is the first study using the complete HEI to assess the quality of foods and nutrients in the diet of Slovak selected adult population. Results of the study indicate the necessity of diet improvements in adults.

The mean score for the individual components showed the needs to increase the proportion of consumed food especially grains and vegetable. On the other hand, it has been seen to be reasonable decrease the intake amount of cholesterol, saturated fats and especially natrium. The assayed results (total HEI 53.0 from 100.0; partial HEI (1 – 5) 30.5 from 50.0; partial HEI (6 – 10) 22.5 from 50.0 points) indicated the needs for distinct improvement of quality of intaken food as well as provide the necessary daily intake of food in accordance with nutrition recommendations. Average HEI has been corresponded with the medium evaluation level. It has been also confirmed correlation between HEI and partial HEI index and body weight. The group of female with insufficient fruit intake reached up the worse evaluation in comparison with group with recommended intake in all 10 HEI components. There has not been established statistically significant differences between groups in occurrence of risk values of the anthropometric parameters.

Future studies have been needed to evaluate diet according to the HEI in different population groups in Slovakia. Studies have been necessary to examine associations between HEI and components with individuals characteristics and additional factors.

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