Low Calorie Diet- the Impact of Vitamins and Minerals Intake to Overweight and Obese Patients

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We have evaluated the nutritional content of food intake (kilocalories, proteins, carbohydrates, lipids, vitamins and minerals) before and after a low caloric diet in a sample of 25 overweight and obese patients. We have also measured several biochemical parameters such as glucose, magnesium, iron, calcium, total cholesterol, high-density lipoprotein (HDL) cholesterol and thyroid stimulating hormone (TSH). We have found an imbalanced intake of vitamins and minerals during the low calorie diet in all of the patients included in the study. In order to assure the Daily Recommended Intake of vitamins and minerals we need to be more careful regarding both food quantity and quality during a nutritional intervention. Medical professionals should also promote the vitamins and minerals as dietary supplements in patients undergoing a low calorie program.

Keywords: vitamins, minerals, overweight, obese, nutritional intervention

In January 2015, World Health Organization (WHO) declared that, in 2014, about 13% of the world's adult population (11% of men and 15% of women) were obese and 39% of adults aged 18 years and over (38% of men and 40% of women) were overweight [1]. In Romania, the most recent study regarding the prevalence of obesity and overweight to adult people, the ORO study (2014), found that the prevalence of obesity it was 21.3% and for overweight was 31.1 % [2].

Obesity is the consequence of increased energy intake by high caloric meals (rich in energy-dense foods like high-fat, high-sugar, high-salt, micronutrient poor foods) to the disadvantage of energy expenditure by physical activities.

In Romania, the most frequent unhealthy eating habits are the irregular meals together with eating while watching TV [2].

This major health problem of obesity has numerous consequences on lipid, glucose and protein metabolism with hyperglycemia and insulin resistance, hyperlipidemia and hyperuricemia. It is a risk factor for many diseases: type 2 diabetes, cardiovascular diseases (mainly stroke and heart disease), cancer (endometrial, breast, colon), pulmonary diseases, osteoporosis, periodontal diseases.

Vitamins and mineral assist to all vital function of human body. The major minerals like sodium, calcium, phosphorus, magnesium, iron play an important role in nerve transmission, muscle contraction, immune system health, acid-base balance or are found in bones and teeth. The trace minerals (micro minerals) like iron, zinc, selenium, copper, manganese are needed for energy metabolism, for making proteins and genetic material, play an antioxidant role or are part of many enzymes. The role of many vitamins is to act as coenzymes or as part of enzymes responsible for essential chemical reactions, *e.g*., the synthesis of fat and neurotransmitters. A high level of vitamins may also affect the degradation of neurotransmitters and one-carbon metabolism. Therefore, the excess of vitamins may trigger obesity through multiple ways, including increasing fat synthesis, causing insulin resistance and disturbing neurotransmitter metabolism [3]. The only vitamin synthesized by our body is D vitamin that is produced in response to sunlight exposure [4]. All the other vitamins are provided by food intake. There are two types of vitamins- some that are soluble in fat, like vitamins A, D,E. and K and others that are soluble in water- like vitamins B1, B2, B3, B5, B6, B12, folic acid. Excess of fat-soluble vitamins cannot be eliminated so these vitamins will be stored in human body if the intake level is high and it can lead to symptoms and diseases. The water soluble vitamins are eliminated through kidney or liver and the risk of intoxication is lower and the symptoms occur rarely.

Considering the increasing number of overweight and obese patients we need to find methods to reach a healthy weight, changing bad habits and learning a new lifestyle. Our study aimed to evaluate the impact of a low calorie diet on vitamins and minerals intake. We wanted to find out the nutritional content of the intake food regarding kilocalories, macronutrients like proteins, fats and carbohydrates, and micronutrients like vitamins and minerals. Knowing all that information we will be able to modify and develop a well-balanced meals' program so that people with weight problems will have the possibility to prevent the risks associated with obesity by losing weight. We also followed the effect of a low calorie diet on selected biochemical parameters like glucose, magnesium, iron, calcium, total cholesterol, HDL cholesterol and thyroid stimulating hormone.

Experimental part

Material and methods

We evaluated 25 adult patients, aged 18 and more, overweight and obese. All of the subjects had no health problems like diabetes, thyroid disorders. We used body mass index (BMI) to define overweight and obesity which is a person weight in kilograms divided by the square of his height in meters (kg/m^2).

The WHO definition:

- a BMI greater than or equal to 25 is overweight;
- a BMI greater than or equal to 30 is obesity [1].

All the patients were recruited from a private practice where they came to follow a nutritional intervention for

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All authors equally contributed to this paper; a part is from author M.P. PhD thesis.

	Group (n=25)
Age (years)	40.88±11.12
Sex (F/M)	18/7
Weight (kg)	95.3±21.11
BMI (kg/m^2)	33.39±5.77
Body Mass Fat (kg)	36.26±10.17
Percent of Body Fat (%)	37.85±5.17
Abdominal Circumference (cm)	107.71±16.90
Resting Metabolic Rate (kilocalories)	1664.92±380.74
FI (kilocalories)	1979.20±608.22

Table 1
CHARACTERISTICS OF SUBJECTS

reaching a lower weight. We collected data regarding age, gender, height, abdominal circumference, weight, percent of body fat, resting metabolic rate. All data were collected twice- at the beginning of the nutritional intervention and after 6 months. We recorded the body weight and percent of body fat using a body composition analyzer that performed whole body and segmental measurements, with three frequency ranges and eight touch electrodes (IOI 353 Body Composition Analyzer, Korea). Waist circumference (WC) was measured at the umbilical level using an unscratched tape meter, without any pressure to body surface and measurements were recorded to the nearest 0.1 cm. Resting metabolic rate was performed after eight hours fasting with an indirect calorimeter that uses the dilution technique for accurate measurements (Italy).

All the plasma parameters were collected fasting and processed in private accredited laboratories.

We also evaluated the total energy intake. Using a 7-day food self record journal, we assessed to all the patients the intake of macro and micronutrients, including energy (total kilocalories), carbohydrates, proteins, lipids, cholesterol, vitamins A, B1, B2, B3, B5, B6, B12, C, D, E, folic acid, and minerals like calcium, iron, magnesium, phosphorus, zinc, copper, manganese, selenium, and sodium. All these data (except for sodium and cholesterol) were reported as a percent of dietary reference intake using US National Nutrient Database for Standard Reference release 24 [5]. The sodium and cholesterol intake were reported as milligrams/day. We analyzed the frequency of a low intake of vitamins and minerals among overweight and obese patients before and after the nutritional intervention and we also evaluated the mean sodium and cholesterol intake. All the patients were informed about a healthy diet- having 3 meal/day and 2 snacks, with increasing the consumption of fruits, vegetables and avoiding the high-energy dense food. They came weekly to the clinic in the first two months and twice a month in the following four months. We encouraged increasing the level of physical activities for at least 30 min/day.

Statistical analysis

For collection, statistical analysis of data and interpretation of the results we have used the Microsoft Excel and Statistica var 4.3 software. For comparison of the means and frequencies we have employed Student and x^2 tests for independent sample with a level of significance of $p<0.05$.

After the nutritional intervention, overweight and obese patients exhibited significantly lower mean level of intake in carbohydrates (P=0.003), lipids (P=0.006), B3 vitamin (P=0.027) and E vitamin (P=0.029). There are more patients that eat below the levels of the Dietary Reference Intakes (DRI) regarding folic acid (P=0.02), B1 vitamin (P=0.036), B5 vitamin (P=0.04), calcium (P<0.001), magnesium (P<0.001), zinc (P=0.016), copper (P<0.001) and manganese (P<0.001). There is a significantly increased mean level of proteins (P<0.001). Regarding the minerals, we found that the mean intake levels of followings has decreased: sodium (P<0.001), magnesium (P<0.001), calcium (P<0.001), phosphorus (P<0.001), zinc (P=0.016), copper (P<0.001) and manganese (P<0.001). All the other biochemical parameters had not significantly changed.

Results and discussions

The study included 25 overweight and obese patients (age: 40.88±11.25 years). Distribution by age, sex, weight, body mass index (BMI), body mass fat, percent of body fat (PBF), abdominal circumference (AC), resting metabolic rate (RMR) and food intake (FI) is showed in table 1.

In our group there are more women than men, and the mean age of this sub-group is 42.89 ± 12.019 years, comparing to 35.71 ± 6.525 years in male patients. This difference, although is insignificantly (p=0.15) can denote that obesity appears at younger age in males than females.

We measured plasma parameters like magnesium, iron, calcium, total cholesterol, HDL cholesterol, glucose and thyroid stimulating hormone. There were not significantly changes in mean values at the end of the nutritional intervention, as seen in table 2.

Evaluating the total intake energy using a 7-day food self record journal, we found that there are significant changes regarding the food consumption and the macronutrients. After the low calorie diet, overweight and obese patients had significantly lower mean level of kilocalories, intake carbohydrates, lipids and they ate more proteins as showed in table 3. Also, the mean level of cholesterol provided by food (dietary cholesterol) did not change significantly.

We evaluated the mean dietary intake of vitamins as a percent of the Daily Recommended Intake- DRI (we consider that a mean intake between 90 % and 110 % is

Variables	Before	After	
	Mean	Mean	P
Magnesium (mg/dl)	2.10±0.14	2.06±0.09	0.47
Iron (µl/dl)	99.33±15.08	113±28.61	0.46
Calcium (mg/dl)	9.40±0.34	9.71±0.52	0.10
Total Cholesterol (mg/dl)	242.33±39.75	193.67±33.92	0.11
HDL Cholesterol (mg/dl)	63.67±14.51	64.67±19.49	0.92
Glucose (mg/dl)	88.83±10.82	89±10.49	0.97
Thyroid Stimulating Hormone (TSH) (µUi/ml	1.70±0.93	1.32±0.58	0.35

Table 2
CHANGES IN MEAN PLASMA PARAMETERS BEFORE AND AFTER THE NUTRITIONAL INTERVENTION

Variables	Before	After	p
	Mean	Mean	
Food Intake (kilocalories)	**1979.20**±608.22	*1071.08*±321.18↓	**<0.001**
Carbohydrates (%)	**41.66**±6.83	*35.22*±10.55↓	**0.003**
Proteins (%)	*19.66*±3.18↓	**32.06**±9.39	**<0.001**
Lipids (%)	**36.67**±5.90	*31.94*±6.93↓	**0.006**
Dietary cholesterol (mg)	346.72±155.03	333.32±251.88	0.76

Table 3
CHANGES IN ENERGY, MACRONUTRIENTS AND DIETARY CHOLESTEROL BEFORE AND AFTER NUTRITIONAL INTERVENTION

Variables	Before	After	p
	Mean	Media	
Folic acid (%)	101.76±52.27	81.20±52.91	0.14
Vitamin A (%)	261.72±185.11	317.40±204.31	0.28
Vitamin B1 (%)	1482.60±50.94	141.08±75.09	0.70
Vitamin B2 (%)	188.28±72.67	161.92±128.61	0.40
Vitamin B3 (%)	193.40±59.05	*162.24*±59.36↓	**0.027**
Vitamin B5 (%)	127.16±54.33	106.80±52.65	0.19
Vitamin B6 (%)	176.64±80.25	163.36±127.99	0.65
Vitamin B12 (%)	327.56±184.49	313.52±228.75	0.82
Vitamin C (%)	162.16±122.82	211.28±153.64	0.15
Vitamin D (%)	49.36±75.47	22.04±31.72	0.12
Vitamin E (%)	**59.08**±29.09	*43.48*±23.70↓	**0.029**

Table 4
CHANGES IN MEAN DIETARY LEVEL OF VITAMINS BEFORE AND AFTER NUTRITIONAL INTERVENTION

normal) and found there is not enough intake of vitamin E neither before nor after the nutritional intervention. The mean intake of B3 vitamin before and after low calorie diet decreased significantly but maintained above the normal DRI. Except for D vitamin, whose level remained below DRI, and for folic acid (whose level decreased below the normal DRI, but not significantly) all the other vitamins had increased intake levels at the beginning and they maintained at high levels after the intervention, as seen in table 4.

Comparing the frequencies of the cases with intake levels below DRI we found that there are more patients that eat less folic acid, B1 vitamin, B5 vitamin and fewer

Table 5
CHANGES OF FREQUENCIES OF BELOW, NORMAL OR EXCESSIVE INTAKE BEFORE AND AFTER NUTRITIONAL INTERVENTION (DRI- DAILY RECOMMENDED INTAKE)

Vita-mins	Dietary level of vitamins												p
	Below DRI				Normal DRI				Excessive DRI				
	Before		After		Before		After		Before		After		
	no	%	no	%	no	%	no	%	no	%	no	%	
Folic acid.	11	44.00	18	**72.00↑**	8	**32.00**	1	4.00↓	6	24.00	6	24.00	**0.02; 0.007;**
Vitamin A	3	**12.00**	0	0.00↓	1	4.00	1	4.00	21	84.00	24	96.00	**0.048;**
Vitamin B1	2	8.00	7	**28.00↑**	4	16.00	3	12.00	19	76.00	15	60.00	**0.036;**
Vitamin B2	1	4.00	4	16.00	3	12.00	2	8.00	21	84.00	19	76.00	NS
Vitamin B3	1	4.00	2	8.00	1	4.00	1	4.00	23	92.00	22	88.00	NS
Vitamin B5	6	24.00	12	**48.00↑**	5	20.00	4	16.00	14	56.00	9	36.00	**0.04**
Vitamin B6	2	8.00	3	12.00	5	20.00	3	12.00	18	72.00	19	76.00	NS
Vitamin B12	1	4.00	2	8.00	2	8.00	0	0.00	22	88.00	23	92.00	NS
Vitamin C	9	**36.00**	3	12.00↓	3	12.00	4	16.00	13	52.00	18	72.00	**0.026**
Vitamin D	23	92.00	23	92.00	0	0.00	1	4.00	2	8.00	1	4.00	NS
Vitamin E	20	80.00	24	**96.00↑**	4	16.00	1	4.00	1	4.00	0	0.00	**0.04**

Variables	Before	After	p
	Mean	Media	
Sodium (mg)	**3206**±976.71	*2257.64*±768.58↓	**<0.001**
Calcium (%)	**82.88**±35.68	*54.68*±20.41↓	**<0.001**
Magnesium (%)	**80.80**±20.56	*58.24*±18.82↓	**<0.001**
Phosphorus (%)	**194.32**±60.10	*146.88*±56.03↓	**<0.001**
Iron (%)	141.48±96.01	106.60±77.49	0.098
Zinc (%)	**126.08**±47.36	*94.52*±40.30↓	**0.016**
Copper (%)	**142.80**±48.49	*97.72*±41.37↓	**<0.001**
Manganese (%)	**151.80**±57.37	*91.12*±46.17↓	**<0.001**
Selenium (%)	229.52±81.94	195.40±97.62	0.079

Table 6
CHANGES IN MEAN DIETARY LEVELS OF MINERALS BEFORE AND AFTER THE NUTRITIONAL INTERVENTION

patients with below level of DRI of C vitamin. At the end of the intervention there is no single patient that eats below the DRI of A vitamin. Regarding the intake of B2, B3, B6, B12 and D vitamins there are no significant changes of the number of patients that eat below, normal of above the DRI level. All these data are showed in table 5.

Comparing the mean intake values for minerals we assessed that, except for iron and selenium, all the mean levels have decreased, as seen in table 6. Although the mean intake of sodium has decreased, it remained above the recommended level of 2000 mg/day.

The number of patients that eat below the DRI level of calcium, magnesium, zinc, copper and manganese has increased significantly. Regarding the level of sodium, the number of patients that eat less than 2000 mg/day increased and there are fewer cases with excessive intake as showed in table 7.

In our group there are more women than men, and the mean age of this sub-group is 42.89 ± 12.019 years, comparing to 35.71 ± 6.525 years in male patients, showing that the interest for achieving a healthy weight is higher in female patients knowing that all the subjects were recruited from a private clinic where they came for a nutritional intervention. The difference between mean age,

Table 7
CHANGES OF FREQUENCIES OF BELOW, NORMAL OR EXCESSIVE INTAKE BEFORE AND AFTER NUTRITIONAL INTERVENTION

Minerals	Dietary level of minerals												
	Below DRI				Normal DRI				Excessive DRI				p
	Before		After		Before		After		Before		After		
	No	%	No	%	No	%	no	%	no	%	no	%	
Na	0	0.00	0	0.00	4	16.00	10	**40.00↑**	21	**84.00**	15	*60.00↓*	**0.03**
Ca	14	56.00	23	**92.00↑**	6	24.00	2	8.00	5	**20.00**	0	*0.00↓*	**<001; 0.01**
Mg	16	64.00	23	**92.00↑**	9	**36.00**	2	*8.00↓*	0	0.00	0	0.00	**0.01;**
P	2	8.00	4	16.00	0	0.00	1	4.00	23	92.00	20	80.00	NS
Fe	10	40.00	15	60.00	1	4.00	1	4.00	14	56.00	9	36.00	NS
Zn	5	20.00	12	**48.00↑**	5	20.00	5	20.00	15	**60.00**	8	*32.00↓*	**0.02; 0.026**
Cu	3	12.00	12	**48.00↑**	4	16.00	7	28.00	18	**72.00**	6	*24.00↓*	**<0.001; <0.001**
Mn	4	16.00	15	**60.00↑**	1	4.00	3	12.00	20	**80.00**	7	28.00	**0.001; <0.001**
Se	1	4.00	2	8.00	1	4.00	2	8.00	23	92.00	21	84.00	NS

although is insignificantly (p=0.15) can denote that obesity appears at younger age in males than females.

Although the mean dietary level of magnesium and calcium remained below the DRI, the mean level of magnesium and calcium in the plasma did not change significantly, showing that, the body has mechanism of regulating those levels but maintaining a longer period of time a low intake level will also change the plasma levels. The number of patients with low dietary level of calcium and magnesium has increased showing that foods highest in calcium and magnesium (like pumpkin and sesame seeds, wheat bran, soy flour, spices, almonds [6]) are not consumed constantly during the nutritional intervention. Also, the mean level of cholesterol provided by food (dietary cholesterol) did not change significantly, probably because the sources are mainly from proteins food and the consumption of that increased significantly.

The dietary sodium mean level maintained above 2000 mg/day, even after the nutritional intervention and probably is higher because the patients didn't self confess the salt add-on but the number of patients that eat less than 2000 mg/day has increased. We promoted a low level of sodium, as this mineral increases the blood pressure. This means that our patients were able to choose foods low in sodium and cut down on the processed food, salad dressing, cans, sausages, etc.

Because there are more women than men in the study groups and due to the limited number of patients this study cannot be representative for general population. Further studies are needed to evaluate this nutritional program supported by changing several parameters: number of participants, age, sex, duration of intervention.

Conclusions

There is an imbalanced intake of vitamins and minerals during the low calorie diet in all the patients included in our study. During the nutritional intervention there were more subjects that eat less that dietary recommended intakes for more minerals than at the beginning. In order to ensure a normal dietary vitamins and minerals level we need to pay more attention to both food quantity and quality during a nutritional intervention; medical professional should promote the vitamins and minerals as supplements during the low calorie program.

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