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Effects of Nutritional Intervention on Vitamins and Minerals Intake at Overweight and Obese Patients

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Abstract

Background and Aims- To evaluate the impact of nutritional intervention on vitamins and minerals from intake food and anthropometric parameters at overweight and obese patients.

Material and methods- To a sample of 40 overweight and obese patients we evaluated the nutritional content of food intake (kilocalories, macro and micronutrients). We also measured anthropometric parameters like weight, body mass index, body fat, percent of body fat, abdominal circumference and arterial tension.

Results- After the nutritional intervention, overweight and obese patients had significantly lower level of intake carbohydrates (*P*=.018), lipids (P=.002), B1 vitamin (*P*<.001), B3 vitamin (*P*=.02) and E vitamin (*P*=.016). There is a significantly increased level of proteins (P<.001). Regarding the minerals, we found that the intake levels of following's decreased: sodium (*P*<.001), magnesium (*P*=.006), zinc (*P*=.035), copper (*P*=.002), manganese (*P*<.001). Phosphorus is the only mineral of which the intake level increased significantly (*P*<.001). All the anthropometric parameters decreased significantly: weight (*P*<.001), body mass index (*P*<.001), body fat (*P*<.001), percent of body fat (*P*<.001), abdominal circumference (*P*<0.001), systolic arterial tension (*P*<.001), diastolic arterial tension (*P*=.002).

Conclusions- All the patients had imbalanced intake of vitamins and minerals both before and after intervention. There is a significant improved on anthropometric measures after nutritional intervention. We need to promote healthy lifestyle changes to prevent the risks associated with obesity.

Keywords: overweight; obese; intake food; vitamins; minerals; anthropometric measures.

Introduction

According to World Health Organization, in 2008 there were more than 1.4 billion adults persons with weight problems, of which 200 million men and nearly 300 million women were obese [1]. Obesity is a major risk factor for type 2 diabetes, cardiovascular diseases (mainly stroke and heart disease), cancer (endometrial, breast, colon), pulmonary diseases, osteoporosis, periodontal diseases. It has numerous consequences on lipid, glucose and protein metabolism with hiperglicemia and insulin resistance, hiperlipidemia and hiperuricemia. Obesity apears as a consequence of imbalance between energy intake (by food) and consumed energy (mainly by phisical activities). Sedentary life and unhealthy meals, riched in energy-dense foods (high-fat, high sugar, high-salt, micronutrient poor) are the main problem of the contemporany world.

Except the vitamin D, that is synthesized in the human body, in the cutaneous tissue, in response to sunlight exposure [2], all the other vitamins are provided by food intake. There are two types of vitamins- one's that are soluble in fat, like vitamins A, D, E. and K and other's that are soluble in water- like vitamins B1, B2, B3, B5, B6, B12, folic acid. Excess of fat-soluble vitamins can not be eliminated so this vitamins will be stored in human body if the intake level is high and it can lead to simptoms and diseases. The water soluble vitamins are eliminated through kidney or liver and the risk of intoxication is lower and the simptoms occurs rarely.

Minerals represent only 4-5 % of body weight but they are very important by participating to all vital functions [3].

The role of many vitamins is to act as coenzimes 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 [4].

A closer look to the dietary habits and to the nutritional content of the food intake is necessary considering the increasing number of overweight and obese people. The aim of our study is to evaluate the impact of nutritional intervention on intake of vitamins and minerals from food and effects of dieting on anthropometric parameters among overweight and obese patients Also we assesed the resting metabolic rate. Resting metabolic rate (RMR) is the largest component of the daily energy expenditure in most humans and, therefore, any increases in RMR in response to exercise interventions are potentially of great importance. The Harris- Benedict equations:

Men: RMR = 665 + (13.75 x weight in kg) + (5 x height in cm) – (6.78 x age in years)

Women: RMR = 655 + (9.56 x weight in kg) + (1.85 x height in cm) – (4.68 x age in years)

are only approximating the basal metabolic rate and the measurement of metabolic rate using an indirect calorimeter is more useful for the management of body weight. In this way we have the opportunity to change the unhealthy eating behaviours in order to reach to a normal weight. Knowing exactly what they eat, how many kilocalories, vitamins and mineral and calculating the energy needed for a healthy diet (using resting metabolic rate) we can modify the content of the meals and develop a well-balanced meal's program. Reaching and maintaining a normal weight, the overweight and obese patient have the posibility to prevent the risks associated with obesity.

Material and methods

1 Subjects and materials

We evaluated 40 subjects-overweight and obese patients. They were recruited from a private practice. We collected data regarding age, gender, height, abdominal circumference, weight, percent of body fat, resting metabolic rate. All this data were collected twice- at the beginning of the nutritional intervention and after 6 months. 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. We define a person overweight if her body mass index (BMI) defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2) is between 25 and 30kg/m2 and the patient is obese if he had the BMI greater than 30 kg/m2. 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, Jawon Medical, Korea). Resting metabolic rate was performed after eight hours fasting with an indirect calorimeter that uses the dilution technique for accurate measurements (Fitmate Pro, Cosmed, Italy). Based on resting metabolic rate we calculate the total calorie intake needed to lose weight. We also evaluated the total energy intake. Using a 7-day food self record questionnaire, we assessed in 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 were reported as a percent of dietary reference intake using US National Nutrient Database for Standard Reference release 24 [5]. We analyzed the frequency of a low intake of vitamins and minerals among overweight and obese patients and we also evaluated the mean sodium intake reported as mg/day and this level was only provided by food because the patients didn't self-confessed the salt add-on. 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, with weekly meetings in the first two months and twice a month meetings in the following 4 months. We encouraged increasing the level of physical activities for at least 30 minute /day.

2 Statistical analysis

For collection, analysis and interpretation of results we used the Microsoft Excel and Statistica var 4.3 software. For comparison of the means and frequencies we used Student and CHI^2 tests for independent samples. To confirm the null hypothesis we set a $p > 0.05$. For $p < 0.05$ the null hypothesis is disproven.

Results

The study included 40 overweight and obese patients. After the nutritional intervention the anthropometric parameters improved significantly, as shown in Figure 1.

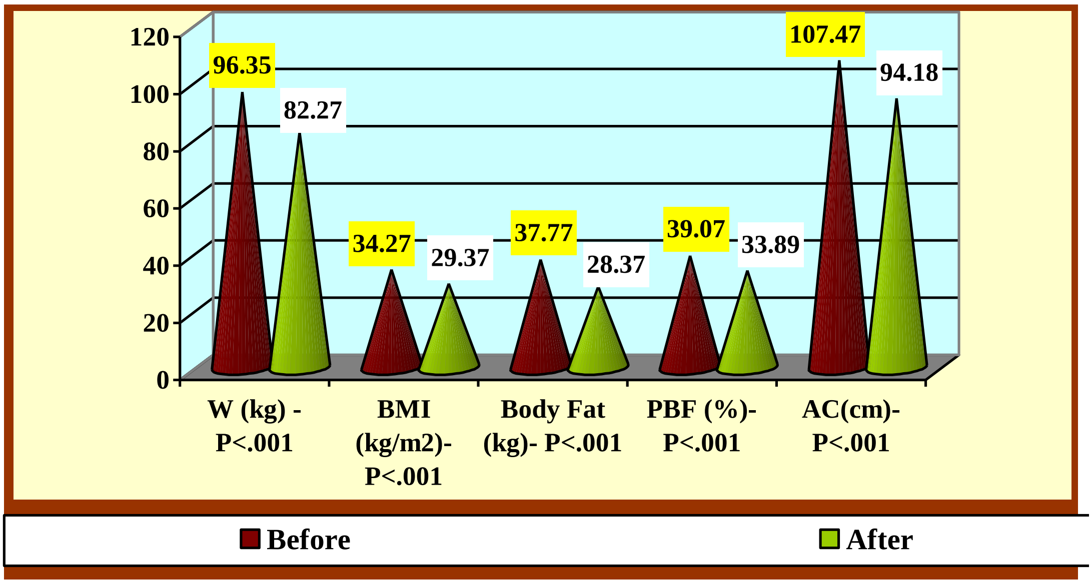

Figure 1. Significant changes in anthropometric measures after nutritional intervention (W-weight, BMI-body mass index, PBF-percent of body fat, AC-abdominal circumference)

Regarding the values of arterial tension, both systolic (P<.001) and diastolic (P=.002) improved significantly, as well as the values of plasma total cholesterol which has reached normal limits (from 231.42 mg/dl to 181.33 mg/dl, P=.015). The plasma values for iron, calcium, HDL cholesterol, glucose and thyroid stimulating hormone have not changed significantly (table 1).

Table 1: Changes in arterial tension and biochemical parameters during nutritional intervention

Variables	Before	After	*P*
Systolic Arterial Tension (mmHg)	**133.50±13.28**	*120.92±12.60*↓	**<.001**
Diastolic Arterial Tension(mmHg)	**79.13±8.19**	*73.63±8.80*↓	**.002**
Plasma iron (ug/dl)	102.18±13.67	95.91±21.82	.41
Plasma calcium (mg/dl)	9.46±0.45	9.32±0.58	.26
Plasma total cholesterol (mg/dl)	**231.42±55.71**	*181.33±27.12*↓	**.015**
Plasma HDL-cholesterol (mg/dl)	49.50±13.72	52.20±16.29	.59
Plasma glucose (mg/dl)	89.75±15.09	89.42±16.28	.89
Thyroid Stimulating Hormone (uUi/ml)	1.72±1.08	1.53±0.93	.61

We evaluated the daily food intake in kilocalories and established the macronutrients content. Also, we measured resting metabolic rate and we considered that a patient had a slow resting metabolic rate (Slow RMR) if the ratio RMR measured with indirect calorimetry/ RMR estimate by Harris-Benedict equation x 100 is less than 86 %, a normal RMR if that ratio is 86-114% and a rapid RMR if the ratio is above 114% (based on the limits recommended by Fitmate Pro RMR measuring device). Based on this classification, resting metabolic rate is normal, both before and after intervention.

The normal intake of carbohydrates we considered to be from 55 to 60 % of total energy intake; the normal range for proteins is 15-20 % and for lipids is 25 to 30 % of total energy intake. With this limits, we found that the majority of intake energy is derived from carbohydrates. After the intervention the contribution of carbohydrates (P=.018) and lipids (P=.002) to total energy intake decreased significantly and increased the contribution of proteins (P<.001) (table 2).

Table 2: Resting Metabolic Rate and macronutrients content of food intake (RMRm- resting metabolic rate measured, RMRc- resting metabolic rate calculated with Harris Benedict formula)

Variables	Before	After	P
Food Intake (kilocalories)	**1983.59±632.42**	*1087.00±323.8*↓	**<.001**
RMRm (kilocalories)	**1655.10±398.44**	*1527.29±390.53*↓	**.003**
RMRm/RMRc x 100	**92.73±13.52**	92.88±18.11	**.96**
Carbohydrates (%)	**40.65±7.04**	*34.95*±11.22↓	**.018**
Proteins (%)	**20.16±3.06**	32.73±9.58↑	**<.001**
Lipids (%)	**37.17±5.89**	*31.48±6.49*↓	**.002**

We evaluated the mean dietary intake of vitamins as a percent of the Recommended Daily Intake (RDI) and we consider that a mean intake between 90% and 110% is normal. Except for D and E vitamins, all the other vitamins were above the recommended daily level at the beginning of the nutritional intervention. The intake level of B1 vitamin (P<.001), B3 vitamin (P=.02) and E vitamin (P=.016) have decreased. The intake of A, B2, B5, B6, B12 and C vitamins has not changed significantly, as shown in Table 3.

Table 3: Changes in vitamins intake level during nutritional intervention

Variables	Before	After	P
Folic acid (%)	100.91±56.63	82.77±54.6	.24
A vitamin (%)	259.82±180.82	316.68±204.98	.30
B1 vitamin (%)	**149.18±53.089**	*83.45±30.59*↓	**<.001**
B2 vitamin (%)	189.14±75.29	146.95±72.66	.12
B3 vitamin (%)	**203.77±57.27**	*168.27±58.07*↓	**.02**
B5 vitamin (%)	131.32±56.45	*109.91±53.93*	.22

B6 Vitamin (%)	185.50±82.22	169.82±134.34	.64
B12 vitamin (%)	364.82±175.88	328.41±234.99	.60
C vitamin (%)	145.91±95.70	211.59±154.84	.08
D vitamin (%)	30.18±19.51	24.23±33.27	.048
E vitamin (%)	**62.45±29.53**	**43.41±24.57↓**	**.016**

We are presenting in the following lines the evolution of the frequencies of the cases with below/normal or above limits of vitamins.

The frequencies of the cases with folic acid intake below the recommended daily limits increased significantly (P=.03) after nutritional intervention and the frequencies of the cases with intake level normally decreased (P=.02) after the intervention as seen in figure 2.

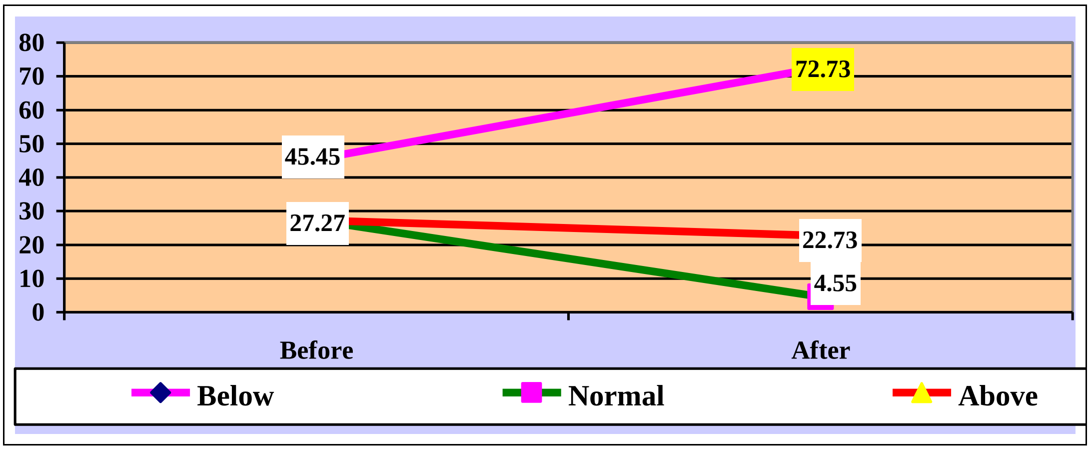

Figure 2. The evolution of the level of folic acid during nutritional intervention

During nutritional intervention, there are singnificant less patients (P=.04) with an intake level of A vitamin below normal amounts. The number of the patiens that eat A vitamin excesivelly or normally does not change significantly (figure 3).

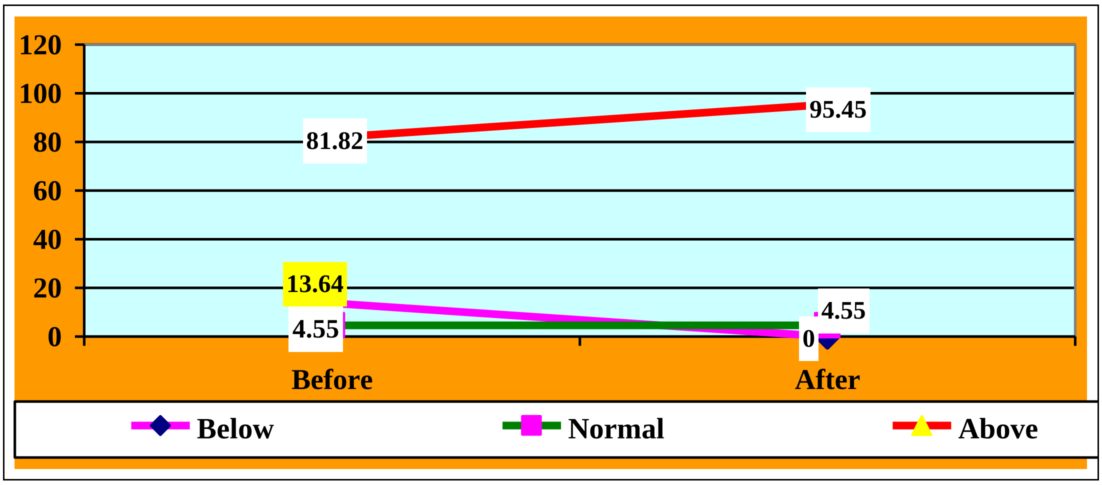

Figure 3. The evolution of the level of A vitamin during nutritional intervention

Regarding the level of B1 vitamin, the frequencies of the cases with excessive intake decreased significantly (P<.001) and the frequencies of the cases with deficient intake have increased after the intervention (P=.002) (Figure 4).

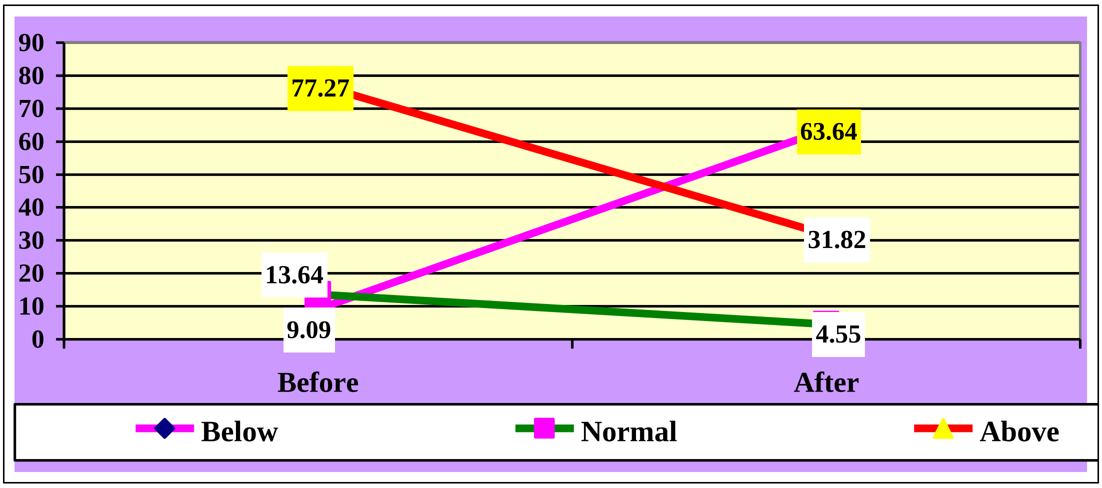

Figure 4. The evolution of the level of B1 vitamin during nutritional intervention

There are more patients that have an intake level of B2 vitamin below the RDI (P=.04) after the nutritional intervention (figure 5).

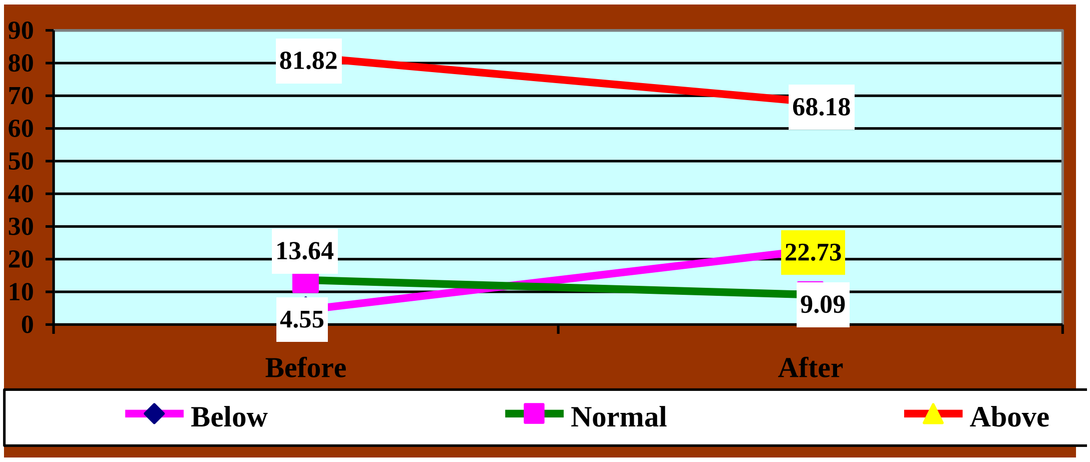

Figure 5. The evolution of the level of B2 vitamin during nutritional intervention

There are no significant changes regarding the number of the cases that meet the RDI or that have an increased intake level of C vitamin, but there are significant less patients (P=.018) that eat below the RDI (figure 6).

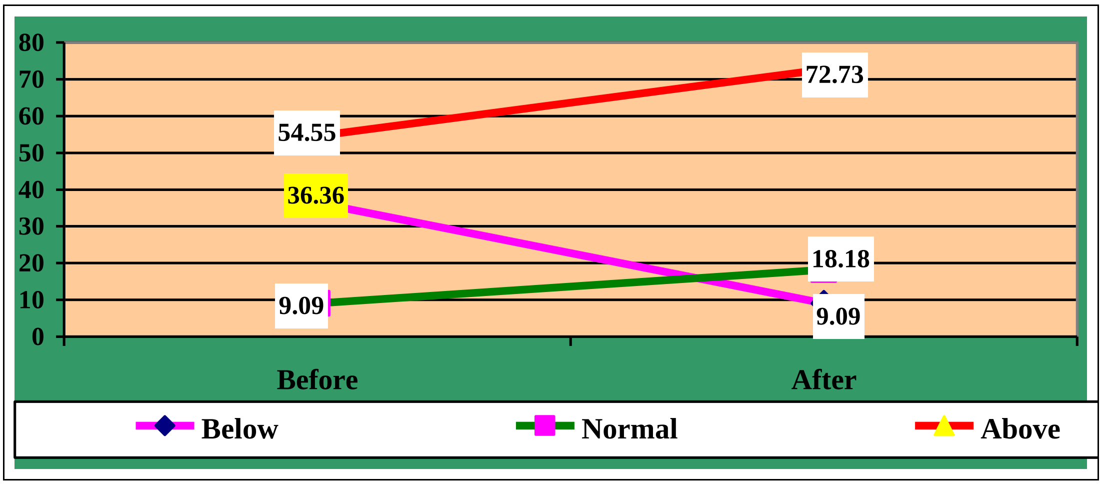

Figure 6. The evolution of the level of C vitamin before during nutritional intervention

The frequency of the patients with below RDI of E vitamin have increased (P=.04) and there are no changes about the normal/above level of E vitamin (figure 7).

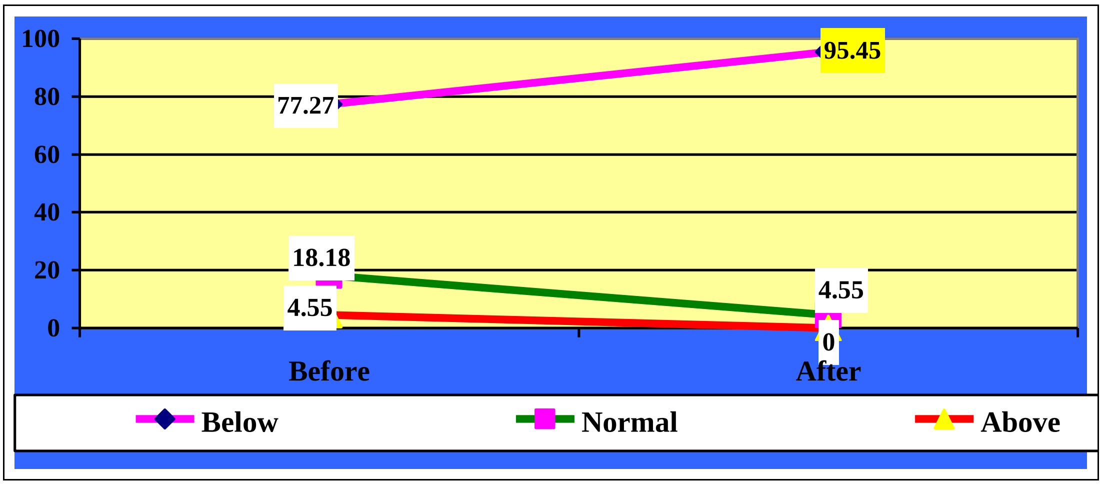

Figure 7. The evolution of the level of E vitamin during nutritional intervention

The frequencies of the cases with intake level below, normal or above the RDI of B3, B5, B6, B12 and D vitamins didn't change significantly after the nutritional intervention.

The mean intake of minerals have changed in this way: the mean intake level of sodium (P<001), magnesium (P=.001), zinc (P=.035), copper (P=.002) and manganese (P<.001) decreased; the levels of calcium, iron and selenium didn't changed significantly but the mean intake of phosphorus has increased (P<.001) (table 4).

Table 4: Changes in minerals intake level during nutritional intervention

Variables	Before	After	P
Sodium (mg/day)	**3144.32 ±1036.34**	*2077.09±924.54↓*	**<.001**
Calcium (%)	64.91±31.08	53.68±19.98	.10
Magnesium (%)	**81.64±37.49**	*58.91±17.84↓*	**.006**
Phosphorus (%)	**87.23±43.48**	*151.50±56.19↑*	**<.001**
Iron (%)	146.55±100.31	112.18±80.53	.15
Zinc (%)	**129.27±49.14**	*98.14±38.86↓*	**.035**
Copper (%)	**139.00±47.27**	*98.18±37.49↓*	**.002**
Manganese (%)	**147.09±56.91**	*93.09±44.53↓*	**<.001**
Selenium (%)	234.05±83.19	205.73±97.73	.18

Regarding the magnesium intake, after the intervention there is no patient that eat more magnesium that RDI (P=.02); also, the frequency of the patients with insufficient intake increased significantly (P=.001) (figure 8).

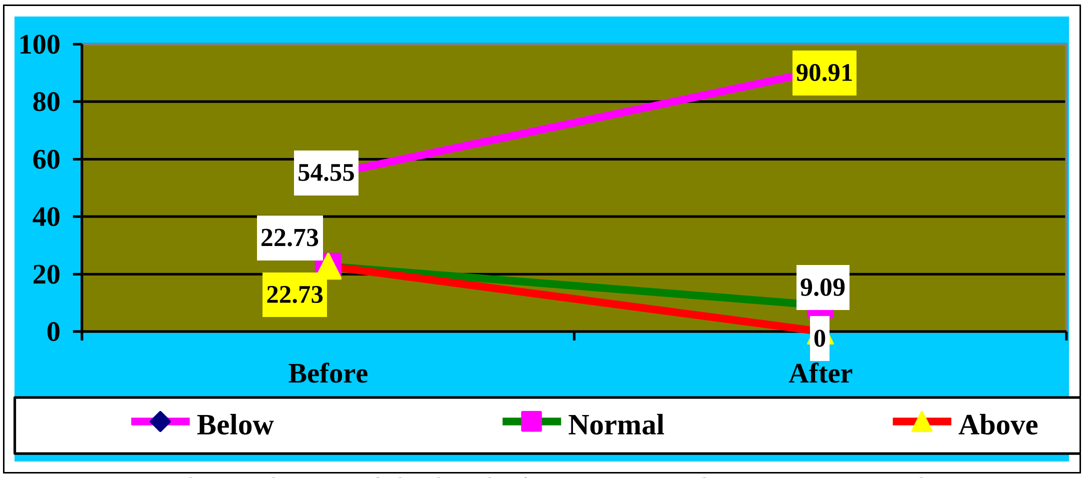

Figure 8. The evolution of the level of magnesium during nutritional intervention

The number of cases with excessive intake of phosphorus increased significantly (P<.001) and there are less patients that eat a normal (P=.05) or below level (P<.001) (figure 9).

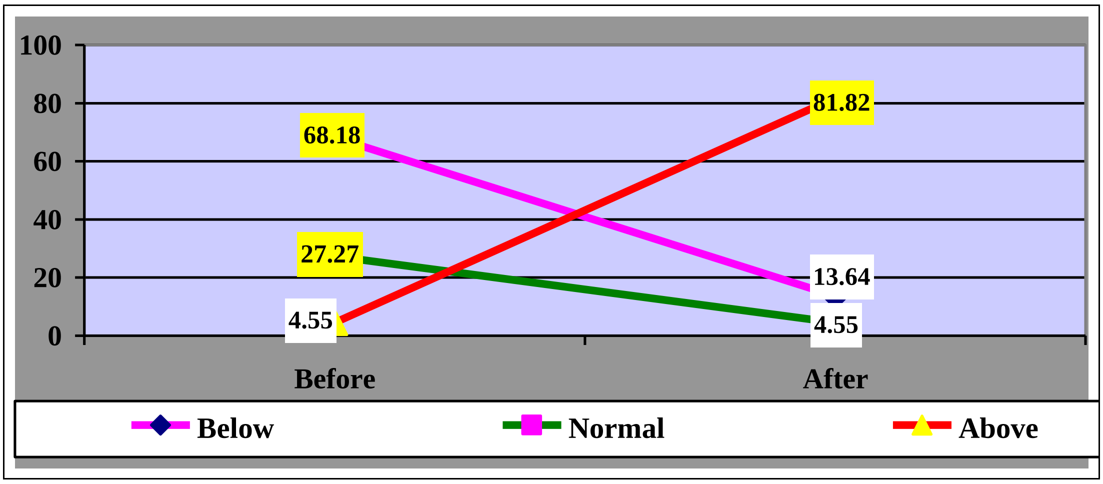

Figure 9. The evolution of the level of phosphorus during nutritional intervention

The frequency of patients with excessive intake of copper decreased (P=.004) and there are significantly more cases that eat below recommended intake level (P=.026) (figure 10).

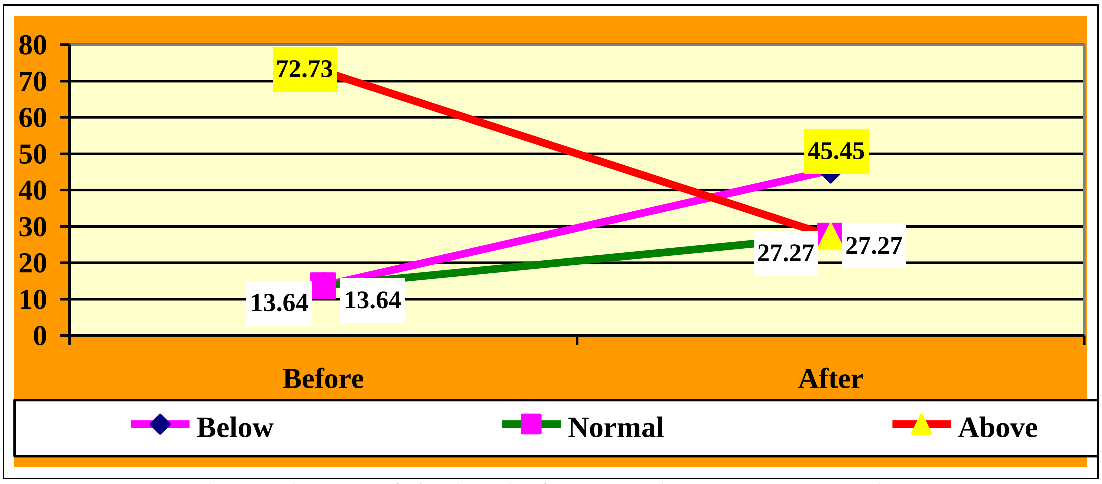

Figure 10. The evolution of the level of copper during nutritional intervention

Regarding the manganese, there are significantly less patients that eat more than recommended daily level (P=.004) and the number of cases with insufficient intake level increased after the nutritional intervention (P=.016) (figure 11).

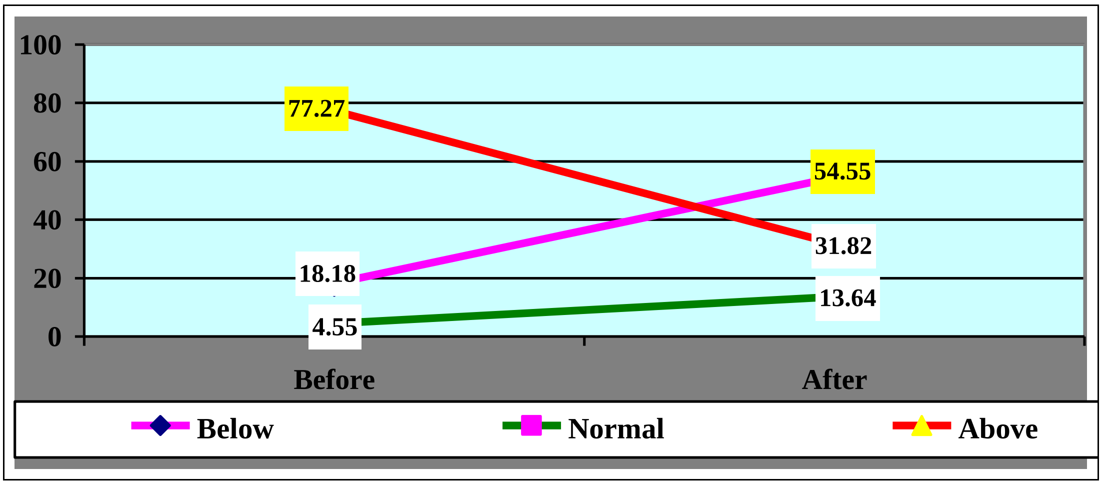

Figure 11. The evolution of the level of manganese during nutritional intervention

There are no significant changes regarding the frequency of below, normal or above intake levels of sodium, calcium, iron, zinc and selenium.

Discussions

As we expected, the anthropometric measures improved significantly (body weight, body mass index, body fat and percent of body fat, abdominal circumference) as well as arterial tension and plasma level for total cholesterol. All this parameters are known to be risk factors for cardiovascular diseases. We didn't found any significant improvement for plasma HDL cholesterol which is best recognized for its ability to shuttle excess cholesterol from peripheral tissues to the liver for excretion in the process of reverse cholesterol transport, likely contributing to the well-known inverse relationship between HDL-cholesterol and cardiovascular diseases [6]. Plasma level of glucose, in our study, didn't change significantly but it was in normal range.

The total energy intake decreased significantly in our study but it is well known that obese individuals underreport food intake by 20-40% when completing food records [7]. The participant were encouraged to write down all that they eat and drink in order to help them to change their habits.

We found that the normal targeted percentage of energy derived from carbohydrates (55-60%), proteins (15-20 %) and fat (25-30%) were not met- there were less carbs (40.65±7.04 %), normal proteins (20.16±3.06 %) and high lipids (37.17±5.89 %) at baseline, showing that the weight problems are not due to a high carbohydrate diet. At the end of the study the percentages changed in this way- carbohydrates decreased even more (*34.95*±11.22 %), proteins increased (32.73±9.58%) and lipids almost reached a normal range (*31.48±6.49%).* In a large study that included 811 overweight and obese patients (Pounds Lost Study) that compared the effects of diets with different macronutrient composition on weight loss and resting energy expenditure (REE or RMR) *Lilian de Jonge et all* showed that both body weight and REE decreased by 6 months, but were unaffected by diet composition [8]. Another study that compared the weight–loss diets with different composition of fats, proteins and carbohydrates showed that reduced-calorie diets result in clinically meaningful weight loss regardless of which macronutrients they emphasize [9].

We also found an unbalanced diet regarding the intake of vitamins and minerals in overweight and obese patients both before and after nutritional intervention. Except vitamin D (which can be produced by the body), all other vitamins must be acquired through a healthy diet. The amounts of B1 vitamin from diet decreased below the recommended daily doses. The intake levels of B3 vitamin have decreased but it remained above normal ranges. There are some minerals of which level have decreased but maintaining in normal range, such as zinc, copper and manganese. Magnesium is the only mineral that is found in small amounts in the diet of patients at the end of the study. Calcium is the only mineral that has no significant changes during the intervention, remaining below the RDI. The mean intake of sodium decreased significantly but it remained above the recommended limits. The amount of sodium was assessed only by the content of the food because the patients didn't self-confessed the salt add-on. In a study that included 240 participants with metabolic syndrome enrolled in a dietary intervention trial to lose weight and improve dietary quality, Wang J et al also examined patterns and amount of daily sodium intake and found that high percentage of participants consumed excess sodium even after a dietary intervention [10].

Because the study group included more women than men and due to the limited number of patients this trial cannot be representative for general population.

Conclusions

None of our patients didn't meet the recommended daily intake for vitamins and minerals, neither before nor after the nutritional intervention. We obtained an improvement of anthropometric parameters. The sodium intake decreased nearly the recommended ranges. We need to promote healthy lifestyle changes to prevent the risks associated with obesity. Given that the present study was a short-term study, novel approaches are needed to examine ways of encouraging long-term adherence to dietary advice before conclusions can be drawn with regard to the long-term importance of macronutrient and micronutrient composition.

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