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Impact of Nutritional Supplements and Food for Weight Reduction on Body Composition of Adults

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Abstract

The increasing prevalence of obesity has led to the approach of various diet-pharmaceutical methods for reducing body fat. The present study monitored the impact of using special nutritional foods and nutritional supplements on body mass and composition on a sample of adults who followed a slimming programme. 97 subjects, most women (71.1%) replaced two main meals with such products over an average time of 4.1 months, leading to a significant decrease in the initial weight ($12.8\% \pm 7.2\%$), the index body mass by $12.7 \pm 7.4\%$ and the body fat mass percentage of $24.6 \pm 13.7\%$, but with insignificant changes in fat-free mass ($4.3 \pm 4.1\%$). There were significant differences between men and women in body composition, but the differences were not significant in terms of the rate and magnitude of changes during the program.

Keywords: body composition, food for weight reduction, nutritional supplements, hypocaloric diet, obesity.

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Introduction

According to the World Health Organization (WHO), obesity is one of the greatest public health challenges of the 21st century and the specific causes and solution for this trend are controversial; it is estimated that 1.9 billion people are overweight, and 650 million of these are obese. Of particular concern is the emerging data clearly showing that the epidemic is not confined to developed countries, with many developing countries and those in transition also affected (Crawford & Jeffery, 2005). Obesity and overweight tend to constitute a public health problem. In most European countries more than half the population is overweight and 15-30% is obese (WHO, 2013). Overweight is still an emerging public health problem in Romania and also in developed and developing countries and a challenge to develop modern anthropic food with a balanced nutritional profile, adapted to actual individual metabolic needs and responsive to current changes in eating habits. WHO reported for Romania 51.0% overweight (49.1% females and 53.1% males) and 19.1% obesity (21.2% females and 16.9 % males) . In Iasi county, previous data show that more than 40 % of men and women were overweight and more than 21% were obese, and overweight was related with physical inactivity (Chirila, Paulik, Petrariu, Albu, & Drug, 2014) and digestive illness (Chirila, Drug, & Morariu, 2017; Chirila, Drug, Petrariu, & Gavata, 2012),

Methods for prevention and treatment of obesity include nutritional education, physical activity, diets, drug administration, psychological therapies or bariatric surgery. Diets using conventional or prepackaged foods are frequently used in weight loss programs. Although mainstream drugs for body weight reduction must demonstrate efficacy before receiving a license, food supplements do not need to meet this requirement. Few food supplements have therefore been submitted to clinical trials, and many health-care professionals feel uncertain about their therapeutic value (Onakpoya, Wider, Pittler, & Ernst, 2011). Legislation in Romania provides regulation for three categories of foods for specific groups: 1) processed cereal-based foods and food for infants and young children, 2) dietary foods for special medical purposes and 3) foods used in energy-reduced diets for weight loss (Bartos & Sarbu, 2002). The last category includes specially formulated foods which, if used according to manufacturer's instructions, replace totally or partially daily diet.

Foods intended to be used in energy restricted diets for weight reduction are: total diet replacement products and meal replacement products for weight control. The compositional criteria include requirements on energy, protein quantity and quality, fat quantity and type, minimum and maximum levels for dietary fiber and minimum levels for certain vitamins and minerals (Ministry of Health, 2002). Nutritional substances that may be used in the manufacture of these products

are laid down in European Commission Regulation (EC) No 953/2009. Foods for weight reduction are a category of calorie-controlled diets which include nutritional fortified shakes snack bars, and low-calorie frozen meals (Uchegbu & Kopelman, 2005). Low-energy liquid diets of around 3MJ (750 kcal) daily have been popularized, often as part of an overall behavior modification program, or in the form of sachets intended to be used as foods for weight reduction. Both approaches have been shown to have potential for success in short-term studies lasting up to 1 year (Finer, 2005).

Most weight loss programs that use foods for weight reduction recommend replacing two meals and one snack a day to lose weight and then replacing one meal per day to maintain weight lost. Foods for weight reduction are designed to be eaten with additions of conventional foods that supply dietary fiber, other nutrients, additional calories, and water. This strategy generally provides 1200-1600 kcal (5040–6729 kJ) per day and the regular meal should meet the recommendations of a healthy diet. In 2003 Heymsfield made first systematic evaluation of randomized controlled trials utilizing meal replacement plans for weight management and suggested that these types of interventions can safely and effectively produce significant sustainable weight loss and decrease risk factors of weight-related diseases (Heymsfield, van Mierlo, van der Knaap, Heo, & Frier, 2003). This meta-analysis that summarized the efficacy of this approach compared to conventional energy-restricted diets suggests that it is an effective weight-loss strategy both in the short and long term in a clinical trial setting. The aim of the study was to assess the impact in of using meal replacement diets in body weight and composition in adults.

Methodology

Our research was conducted in the Department of Environmental Health of the Institute of Public Health for weight and body composition monitoring in a framework of a weight loss program. Participants in this retro-prospective study has been overweight or obese adults who followed personalized low-calorie diets for more than two months. The selected subjects were invited to participate as volunteers in this study and the rules of bioethics and research ethics were followed. Informed written consent was obtained from all the participants. Subjects were monitored at least once a month and we recorded the evolution of parameters. In this study we present measurements of the first investigation, and at the end of weight loss (final weight).

The recommended daily calorie intake has been close to Basic Energy Expenditure (BEE) of the person, which means 1100-1500 calories /day for women and 1300-1700 calories / day for men. BEE (kcal /day) was calculated using the following formula: $370 + (21.6 \times \text{lean mass in kg})$ (Graur *et al.*, 2006).

A balanced nutritional program is targeted not only for weight loss but also maintain or even increase muscle mass. Protein intake was slightly increased (1-1.6 g/kg, 20-35% of energy intake) to preserve muscle mass. Main source of protein in foods for weight reduction was soy and milk protein (whey and casein). Fat intake was low (15-25% of energy intake), over ½ of the fat was a source of essential or unsaturated fatty acids. Carbohydrates (CH) have covered 35-60% of the necessary and were low or medium glycemic index. Combinations of different nutritional supplements were used to provide daily intake of nutrients. For example, the main formula provides 39 g of protein, 19.8 g of CH, 12.7 g of lipids per 100 g of powder, and prepared with 250 ml of skimmed milk (1.5 % fat) provide 18.9 g of protein, 18.1 g of CH and 16.3 g of lipids per portion. For an increased intake of protein (esp. for men) another formula provided 83 g of protein per 100 g. For weight loss period two meals per day were replaced with meal replacement and one additional meal was from conventional food, respecting the recommendations of appropriate nutrition.

The following anthropometric indicators were monitored: height (measured in the morning), weight (measured on an electronic scale with a deviation of ±100g, morning fasting and after using the toilet), body mass index (BMI) and the percentage of body fat. Self-measurement of these indices and their reporting can have sufficient accuracy for trained subjects (Dekkers *et al.*, 2008), but we prefer to be performed by the same assessor. During the 1990s, body mass index (BMI = weight/height²) has become a universally accepted tool for measuring nutritional status, recognized and recommended by WHO (Crawford & Jeffery, 2005: 4; Ogden *et al.*, 2000). BMI has limited value for measuring body composition, because subjects with the same BMI or body weight can vary greatly in the amount of fat. A greater weight can be given not only fat but also increase muscle mass (for athletes), the extracellular fluids (in case of edema). So, we assessed anthropometric parameters using also waist and hip circumferences and waist-hip ratio (Graur *et al.*, 2006; Heymsfield *et al.*, 2008), because excess of abdominal fat is an independent risk factor for associated diseases (NIHLBP, 2000).

Body fat percentage (FAT%) is relevant for metabolic implications and was measured by Bioelectrical Impedance Analysis (BIA) using an OMRON BF306 bimanual Body-Fat Monitor, respecting the conditions specified by the manufacturer. Using BIA is relatively simple, rapid, non-invasive, the results are immediate and reproducible with an error of 1-4% for repeated measurements (Graur *et al.*, 2006). Validity of bimanual method (Omron BF 306BIA) was tested on participants from Asia and results in the assessment of body fat percentage showed acceptable levels of bias (SEE = 4.5%), due in particular age and length of arms (Demura *et al.*, 2002; Deurenberg & Yap, 2002). A normal percent varies from one author to another, but it would correspond to 13-20% for men and 17-30% for women. Fat content exceeding 25% in men and, respectively, 35% of women identify people with obesity (Dehghan & Merchant, 2008; Deurenberg, Yap, & van Staveren, 1998). Optimal weight – with minimal health risk – was

calculated using the Metropolitan Life Insurance formula that takes account of height in cm (H), age in years (A) and gender: Theoretical optimal weight (kg) = $50 + 0.75 (H-150) + 0.25 (A-20)$ for men; in women, the result is multiplied by 0.9 (Graur *et al.*, 2006).

For statistical analysis, data were loaded and processed by use of Microsoft Excel and EPIINFO 7.2 (CDC, 2013). For descriptive statistics we use mean and standard deviation. We used χ^2 test to compare frequencies and t-Student test for calculation of significant difference between the two media. Significance was agreed for p value < 0.05. All analyses were performed separately for males and females.

Results

Characteristics of participants

The study consisted of 97 subjects, 68 women and 29 men. Mean age of patients at study entry was 43.1 ± 14.07 years, ranging from 18 to 74 years. The basic epidemiological characteristics – age, marital status, number of children and level of education – were similar (χ^2 test, $p > 0.05$) by gender.

Anthropometric characteristics at the first investigation

Table 1 shows the initial anthropometric characteristics of the participants. Average height and weight were significantly higher in men than in women ($p < 0.001$). BMI did not differ significantly between sexes ($p > 0.05$), while average FAT% was significantly higher in women compared with men ($p < 0.001$).

Table 1. Initial anthropometric characteristics (mean \pm SD) by gender

	Women (n=68)	Men (n=29)	t-test	p value
Height (cm)	164.2 ± 6.1	176.5 ± 7.0	8.62	<0.001
Weight (kg)	92.4 ± 13.9	106.1 ± 21.3	3.69	<0.01
Optimal weight (kg)	61.3 ± 4.74	76.5 ± 7.8	11.7	<0.001
BMI (kg/cm ²)	34.4 ± 5.7	33.8 ± 5.0	0.48	>0.05
FAT%	43.9 ± 5.6	34.1 ± 5.7	7.77	<0.001

Excess weight over optimal weight was 31.1 ± 13.0 kg for women (51.1%) and 29.5 ± 17.2 kg (38.3%) for men ($p > 0.05$). The fat mass was 30.5 ± 9.56 kg for

women and 29.2 ± 13.7 for men ($p > 0.05$). Calculated BEE was significantly lower in women (1366 ± 142 kcal /day) than in men (1929 ± 280 kcal /day) and determined the type of weight loss program and the recommended daily intake (average 1275 kcal/day and 1550 kcal/day, respectively).

Evolution of the participants during the weight loss program

In a time of 4.1 ± 2.34 months, the entire group lost an average of -12.14 ± 6.79 kg, i.e. $12.8 \pm 7.2\%$ of body weight (Table 2). All the changes were statistical significant ($p < 0.001$).

Table 2. Evolution of anthropometric characteristics during the weight loss program (t-test: paired two samples for means, two-tail)

	Initial			Final			p value initial vs. final
	Mean	SD	Median	Mean	SD	Median	
Total (n=97)							
Height (cm)	167.80	8.5	167				
Weight loss period (months)				4.1	2.3	3	
Weight (kg)	96.5	17.6	92.5	84.4	18.6	80.5	<0.001
BMI (kg/m ²)	34.2	5.4	32.6	29.8	5.3	29.2	<0.001
Fat (%)	40.9	7.2	40.7	35.1	7.1	36.2	<0.001
Women (n=68)							
Height (cm)	164.1	6.1	163				
Weight loss period (months)				4.55	2.6	4	
Weight (kg)	92.4	13.9	90.5	79.3	14.2	79	<0.001
BMI (kg/m ²)	34.4	5.7	33.9	29.4	5.24	28.6	<0.001
Fat (%)	43.9	5.6	43.5	37.7	5.6	38.1	<0.001
Men (n=29)							
Height (cm)	176.5	7.0	176				
Weight loss period (months)				3.05	0.9	3	
Weight (kg)	106.1	21.3	96	96.3	22	87	<0.001
BMI (kg/m ²)	33.8	4.9	32	30.7	5.2	29.2	<0.001
Fat (%)	34.1	5.7	33.1	29.1	6.6	29.2	<0.001

Adherence to the proposed weight loss schedule was higher in women (who have followed the rules for 4.55 ± 2.6 months) than in men (3.05 ± 0.93 months). The average rhythm of weight loss was -3.2 ± 1.3 kg/month, up to -6.7 kg/month. Weight loss was made on account of fat mass, which was significantly reduced by 9.8 ± 6.16 kg ($24 \pm 13.7\%$) compared to initial (average $21.8 \pm 15.3\%$ in men and $25.8 \pm 12.8\%$ in

women) and insignificant on account of fat-free mass ($4.3 \pm 4.1\%$) (Figure 1).

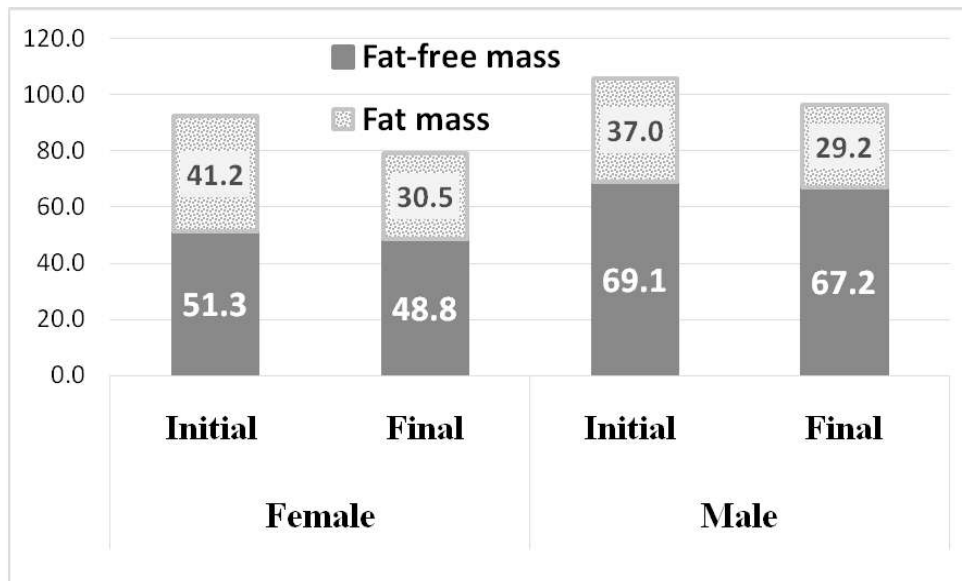


Figure 1. Evolution of average values of fat and fat-free mass (kg)

Discussion

Our study demonstrated that the use of nutritional supplements and food for weight reduction in a well conducted weight loss program lead to significant changes in body composition, reducing especial the fat -mass of the body. These results has been comparable with the results published for clinical trials (Kahathuduwa *et al.*, 2018; Kuriyan *et al.*, 2017; Phelan *et al.*, 2018). A randomized, controlled 2-arm trial was carried out on 101 overweight/obese (Body Mass Index - 29.2 ± 2.4 kg/m²) females aged 18 to 44 years and, at the end of two weeks, the mean reductions in body weight and waist circumference were significantly greater in the intervention group, -0.53 kg for body weight which had a significantly higher increase in dietary intakes of certain vitamins, fiber and sugar, and significantly higher reductions in total and polyunsaturated fats and sodium intakes, as compared to the control group ($p \leq 0.05$) (Kuriyan *et al.*, 2017). A randomized controlled study investigated the effect of 12 weeks-long energy-restricted modified diet with or without foods for weight reduction on weight loss and body composition in 87 overweight women. Dietary intervention resulted in a significant weight loss in both groups (-5.98 ± 2.82 kg, $p < 0.001$ and -4.84 ± 3.54 kg, $p < 0.001$, respectively). However, the rate of responder (weight loss $> 5\%$) was higher in meal replacement

(77%) versus non-meal replacement group (50%) ($p=0.010$). A significant reduction was observed in body fat mass in both groups (Metzner *et al.*, 2011).

Although processed foods or preserved formulas may favor some gastrointestinal symptoms (Chirila, Morariu, Barboi, & Drug, 2015; Chirila, Morariu, Barboi, Mihai, *et al.*, 2015), the digestive tolerance of weight loss products was good; but a major disadvantage was monotony, as has been observed in other studies (Raynor, 2012).

A number of studies have suggested that proteins are the most important macronutrient regulator of satiety, and their increased consumption leads to weight loss with retention of lean mass. An increase in dietary protein intake has been shown to improve weight loss maintenance and the source of the dietary proteins influenced changes in body weight, body composition, and cardiometabolic risk factors to streamline regulation of body weight (van Baak *et al.*, 2017). In a randomized controlled trial soy and casein meal replacement shakes were compared with energy-restricted diets for obese women and concluded that both study groups with a highly structured behavioral 16 week long program incorporating four foods for weight reduction and vegetables and fruits lost significant amounts of weight and that differences in weight loss and body composition changes between casein and soy treatments were not significant (Anderson, Fuller, Patterson, Blair, & Tabor, 2007). Evaluation of the efficacy of two low-calorie diets with partial meal replacement plans (a high-protein plan (HP) and a nutritionally balanced conventional (C) plan in a 12-week randomized double-blind study with 75 participants) showed that the overall mean weight loss was 5 kg in the HP-plan group and 4.9 kg in the C-plan group ($p=0.72$). Body fat mass decreased 2.5 kg in the HP-plan group ($p<0.05$) and 2.3 kg in the C-plan group ($p<0.05$) and the HP-plan was more effective in reducing body fat among subjects with $\geq 70\%$ dietary compliance (Lee *et al.*, 2009). Our participants, during 4 months period, lost 8.29 ± 5.26 kg of body fat mass - these better results can be explained by a better adherence to the program and a stronger motivation.

Rapid weight loss has been related with a larger loss of fat free mass and a reduction in resting metabolic rate but the influence on the body composition have a significant impact on body composition once energy balance is re-established (Coutinho *et al.*, 2018).

Use of nutritional supplements and food for weight reduction may be an important strategy in combating obesity, because of its efficacy, simplicity and convenience of use (Treyzon *et al.*, 2008). These formulas may increase compliance of patients, reducing confusion and simplifying the composition of energy-restricted diets (defined contents of nutrients and calories).

Conclusions

Excess of body weight is still a major public health issue both globally and national, and it still looking for effective weight loss methods applied at individual and population levels. The modern challenge is to develop diets, foods and supplements suitable for current changes in lifestyle and eating habits and which meet a balanced nutritional profile adapted for individual metabolic needs. Loss of fat mass can be achieved by adopting a personalized diet which takes into account basic energy expenditure and caloric needs of the individual. The study showed that replacing two meals a day with food for weight reduction is an effective way for slimming. Energy-restricted diets using nutritional supplements and food for weight reduction which ensure a slightly increased protein intake resulted in a loss of fat mass with retention of muscle mass.

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