

Research Article

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Lipedema and Nutrition: High Fat Ketogenic Diet as Treatment of Choice

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Lipedema can have a significant impact on physical appearance, mental health, and well-being: people with lipedema, lovingly called "Lippies", not only complain about their physical appearance, but also the presence of a bunch of symptoms that worsen the quality of life, which is why it is important to study treatments that may have positive effects mainly in the affected areas.

Reducing inflammation is the main target of the multidisciplinary treatment of lipedema.

Many studies have shown a significant reduction in body fat and in the painful component of lipedema following integrated treatment and, above all, the high fat ketogenic diet.

Therefore, we compared the efficacy of a High Fat Ketogenic Diet (HFKD) in patients suffering from lipedema to test the hypothesis that this approach is more effective than a Low Carb Anti-inflammatory non-ketogenic Diet (LCAD) on reducing the anthropometric measures in the affected areas and on improving symptoms.

Methods: Forty-eight female patients followed two different dietary regimens, for 8 weeks. Group A (24 subjects) was assigned a HFKD, based on 1100 Kcal daily, 70% fat, 20% protein, 10% carbohydrates. Group B diet was a low carb with starchy carbohydrate, average daily Kcal around 1400, 45% fat, 25% protein, 30% carbohydrates.

To evaluate the effectiveness of both dietary regimens, anthropometric measurements were carried out and a questionnaire evaluating the degree of symptoms was administered at time zero (first meeting) and at time 1 (after 8 weeks).

Results: Although both regimens had a very positive effect on the analyzed parameters, HFKD proved to be more effective than LCAD in reducing the circumferences in the affected areas and in improving the main symptoms such as pain, heaviness, fatigue and swelling.**Conclusions:** High fat ketogenic diet led to significant fat loss in the lower limbs, the most affected area by the development of lipedema, and a greater improvement in the key symptoms afflicting Lippies.

HFKD can be used as a real therapeutic tool capable of improving the typical symptoms of lipedema, pain, heaviness and swelling of the lower limbs, and of promoting the reduction of circumference in the areas most resistant to conventional diets.

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Received: March 30, 2024; **Accepted:** April 08, 2024; **Published:** April 12, 2024**Keywords:** Lipedema, Ketogenic Diet, Low Carbohydrate Diet, High Fat Diet, Low-Glycemic Index Diet, Anti-Inflammatory Diet, Body Composition**Introduction**

Lipedema is a disease of the subcutaneous adipose tissue that was first clinically recognized in the mid-1900s [1].

Numerous scientists are currently studying it to understand the triggering causes, consequences, and possible treatments. It mainly affects women, and its onset normally occurs during puberty or following periods of hormonal stress, such as pregnancy or the transition to menopause [2,3].

Although currently the pathogenesis of lipedema is not entirely clear, the following hypotheses have been suggested: altered adipogenesis, hormonal alterations, microangiopathy, dysfunctions of the lymphatic system, all on the basis of apparent polygenetic susceptibility [3-5].

Classification is according to both anatomical distribution and stages, although it should be emphasized that the latter is not always progressive, therefore it is not certain that stage 1 will, sooner or later, develop into stage 4 [1-4].

The presence of lipedema causes evident disproportion between the lower limbs and the upper part of the body, accompanied by constant feelings of pain, internal tension in the limbs, swelling and sometimes, in the most serious cases, problems walking and performing everyday activities.

Many patients receive an incorrect diagnosis, usually obesity or lymphedema, which is why it is necessary for a differential diagnosis that carefully analyses the symptoms and any complications that may have arisen.

Lipedema and its common comorbidity, obesity, are considered as inflammatory diseases, essentially because both demonstrate an immune response at the adipose tissue level. This excessive immune response is caused by repeated exposure to endogenous or exogenous stress factors, resulting in chronic low-grade inflammation with negative effects on adipose tissue.

Managing lipedema requires a multidisciplinary approach to achieve symptoms relief, improve the patients' ability to take care of themselves, optimize health and prevent the disease from getting worse.

The treatment includes: the use of compression garments, manual lymphatic drainage, physical therapy and/or myofascial treatment, physical activity suitable for the pathology, diet therapy, self-care, psychological support and in some cases, medical or even surgical procedures [6].

Lipedema

Lipedema was identified for the first time in 1940 in the USA (Mayo Clinic) (1) and is part of the pathologies affecting the Subcutaneous Adipose Tissue (SAT), which also include Dercum's disease, Madelung's disease, and the various types of lipomatosis [7].

In 1940, Drs. Allen and Hines first identified this condition since the affected areas offered "a poor resistance of the fat against the hydrostatic passage of fluid from the capillaries into the interstitium", allowing the appearance of edema [1,8].

Thanks to this definition, it became evident that lipedema is a connective tissue disease in which the loss of elasticity of the adipose tissue allows fluids to accumulate, rather than flow, into the lymphatic vessels [9].

Subcutaneous adipose tissue diseases involving adipose tissue and its fascia, also known as adipofascial disorders, are characterized by a type of fat that is difficult to eliminate using standard methods of weight loss, traditional exercise, drug therapy and even bariatric surgery. This partly depends on the tissue fibrosis that is present in the affected areas and partly on the hormonal imbalances that can accompany these conditions. Therefore, it is necessary for health professionals to be aware of this difficulty in order to provide appropriate advice and treatment.

Lipedema Pain

Lipedema has been described in medical literature as a "painful fat disorder" [10]. Recent studies have reported that the presence of this daily pain in adipose tissue can be a serious factor in worsening the quality of life and the loss of mobility. Furthermore, women with lipedema may have a high incidence of joint pain due in part to concurrent walking problems and osteoarthritis [11].

The underlying mechanism of pain in lipedema is unclear, therefore it is difficult to treat and control. Increased sensitivity to palpation may be labelled as nociceptive pain, neuropathic pain or central sensitization and be caused by increased inflammation and/or compression of peripheral nerves by adipose tissue enlargement and fluid accumulation in the affected area [3].

Nutrition

Many types of diets have been suggested over time to be able to ameliorate lipedematous fat, both from an aesthetic and from a symptomatic point of view: the Modified Mediterranean Diet, the Rare Adipose Disorder Diet (RAD) developed by Dr. Herbst, the Ketogenic Diet and its variants Very Low Calories Ketogenic Diet (VLCKD) and High-Fat Ketogenic Diet (HFKD), the Paleo diet and the extreme Carnivore Diet. Of these, the diets that have shown to be among the most effective in the treatment of the various signs and symptoms are the HFKD, that appears to be the most effective, immediately followed by the RAD or anti-inflammatory diet [12,13].

Antiinflammatory Diet (RAD)

The antiinflammatory protocol includes the intake of wholegrain carbohydrates, elimination of simple sugars and carbohydrates with a high glycemic index to reduce insulin levels and inflammation and, therefore, reduce adipogenesis; high consumption of fruit and vegetables containing enzymes and phytochemicals that help reduce inflammation; noble proteins such as eggs, blue fish and white meat, legumes, but above all "good" fats, such as coconut and extra virgin olive oil (evo); lower consumption of pasteurized dairy products, processed meats and animal fats which, in addition to being rich in calories and saturated fats, promote lipogenesis and inflammation; significant reduction or elimination of foods containing soy to counteract any intestinal problems and to avoid worsening hormonal imbalance; elimination (or drastic reduction) of foods that contain chemicals, such as artificial preservatives, flavorings, synthetic sweeteners, dyes, and stabilizers; reduction of advanced glycation end products (AGEs), pro-oxidant and inflammatory, by paying attention to cooking and, therefore, avoiding meat turning black during grilling or browning; reduction of salt intake.

Ketogenic Diet

The ketogenic diet is a nutritional protocol which is characterized by an extreme limitation of carbohydrates intake, normal (or moderate) protein content and an increase in the amount of fat, in different proportions, based on individual needs and the degree of ketogenic ratio desired; all aimed at making the body change the way it works and using fats as a source of energy, instead of carbohydrates [14,15].

Ketogenic diet for the conservative treatment of lipedema is linked to the effects of keton bodies, especially β -hydroxybutyrate, which play a central role in decreasing inflammation by inhibiting the activation of NLRP3 inflammasome, in modulating hormonal secretion, in the reduction of oxidative stress and in the improvement of mitochondrial respiration [16].

Clinical studies involving women with lipedema, demonstrated the efficacy and safety of HF KDs even in the long-term period, whereby, in addition to significant weight loss, decreases in body circumferences are also obtained in the areas typically affected by lipedema, but above all there is an improvement in the symptoms and consequently in the quality of life [17].

Some of the mechanisms attributable to the therapeutic effects of HF KDs are the reduction of appetite, lipogenesis, glycemia, insulin blood values and the increase of lipolysis and the thermal effect induced by proteins [13].

The HF KDs are characterized by a high intake of “good” fats, about 70-75% of the total caloric intake, 20-25% of proteins and 5% of carbohydrates, solely in the form of vegetables.

On these bases, the aim of our study was to evaluate the effectiveness of a HF KD versus a low carb with starchy carbohydrate antiinflammatory diet (LCAD) on body composition parameters, health status, pain perception and quality of life.

Materials and Methods

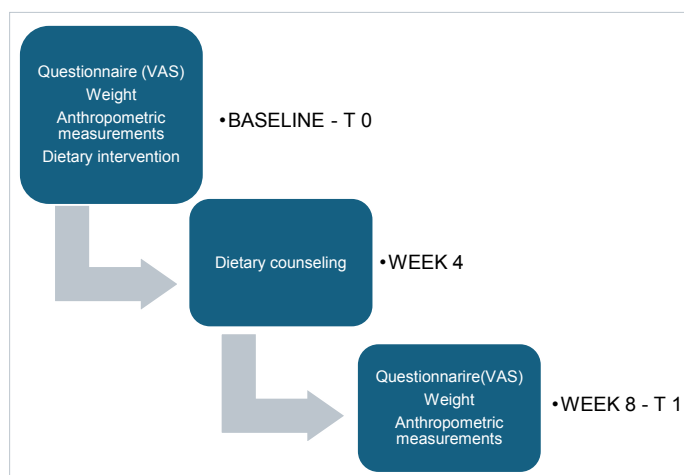
A total of 48 women diagnosed with lipedema (stages 2 to 3) based on typical clinical signs were enrolled in the study. Clinical evaluation and diagnosis of lipedema was confirmed by a specialist in angiology. Written informed consent was obtained from all patients.

The participants were divided into 2 groups. One group received a HF KD (n = 24) and the other group a LCAD (n = 24).

The exclusion criteria included: male gender, pregnancy, diabetes. The patients were not on an ongoing surgical treatment for lipedema, and they were not adhered to any specific diet.

An anthropometric evaluation and a questionnaire of symptoms caused by lipedema were performed for each patient.

Timeline of Data Collection



Anthropometric Measurements

The evaluation of the anthropometric measurements was carried out during the first visit (t0) and after 8 weeks (t1). Body weight was measured using a Seca professional mechanical scale during the first visit (t0) and after 8 weeks (t1), and height was measured with a Seca stadiometer.

All the circumferences (waist, hips, root of the thigh and mid-thigh) were measured using a Seca professional tape measure, on the following landmarks:

- Waist at the navel
- Hips at the height of the greater trochanter
- Root thigh under the gluteal crease of the right limb
- Mid-thigh midway between the greater trochanter and the distal epiphysis of the right femur

Questionnaire

To measure the perceived pain and other symptoms, a visual analog scale (VAS, scale 0–10) was used [18]. Participants were asked to refer the rate of several parameters of typical pain and discomfort at baseline during the first visit (t0) and after 8 weeks (t1). (0 = No symptoms at all 10 = As much you can possibly imagine).

Questionnaire	
Rate the level of pain on a scale of 1-10 (no pain to very severe pain)	keine -----X----- sehr starke 0 1 2 3 4 5 6 7 8 9 10
Are the affected areas painful?	keine ----- sehr starke 0 1 2 3 4 5 6 7 8 9 10
Are the affected areas sensitive to touch or pressure?	keiner ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you bruise easily (hematoma)?	keine ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you feel tension in your legs?	keines ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you feel excessive warmth in the legs?	keines ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you legs feel cold?	keines ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you have muscle cramps?	keine ----- sehr häufig 0 1 2 3 4 5 6 7 8 9 10
Do your legs feel heavy?	keines ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do your legs feel tired?	keines ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you something have swelling?	keine ----- sehr starke 0 1 2 3 4 5 6 7 8 9 10
Is there skin involvement?	keine ----- sehr starke 0 1 2 3 4 5 6 7 8 9 10
Is there itching?	keiner ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
Do you have difficulty walking?	gar nicht ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
How much does the condition affect your quality of life?	keine ----- sehr stark 0 1 2 3 4 5 6 7 8 9 10
How satisfied are you with the appearance of your legs?	sehr zufrieden ----- sehr unzufrieden 0 1 2 3 4 5 6 7 8 9 10
Total score	(maximum 150)

Box 1: Questionnaire for measuring symptoms of lipedema by visual analogue scale and results. Modified from the original [18].

We decided to change the scale of the last question. In the original questionnaire the question was: “How satisfied are you in the appearance of your legs?”. We asked the question the other way around: “How not satisfied are you in the appearance of your leg?” to obtain graphs that go in the same direction.

Data Management and Statistical Methods

The data collected are expressed as mean ± standard deviation. The differences obtained in the period of 8 weeks were evaluated with the t-test for dependent samples, the results being significant for p value < 0.05; all p-values shown are two-tailed. Statistical analysis was performed using the Social Science Statistics software and the graphs were elaborated using the GraphPad Prism software.

Nutritional Plan

Duration of Food Treatment: 8 weeks.

Group A Diet: HFKD, approximately 1100 Kcal, distributed over 4 meals with the following total breakdown of macronutrients: 70% fat, 20% protein, 10% carbohydrates.

Group B Diet: LCAD, average daily Kcal around 1400, distributed over 5 meals with the following breakdown of macronutrients: 45% carbohydrates, 25% protein, 30% fat.

Supplements: both groups were supplemented with Magnesium (200-400mg), Potassium (1.100/1650 mg) and vitamins to make up for shortcomings, and bromelain 500mg (1250 GDU/g) BID, for its enzymatic and anti-inflammatory activity.

Bromelain is a fundamental and essential supplement for lipedema, in fact it is an important proteolytic enzyme extracted from pineapple stems, which has anti-inflammatory, antioxidant and anticoagulant properties, but above all is able to act at the fibrotic tissue level, due to its lytic properties [19].

The two diets followed the indications of the anti-inflammatory diet with the specific exclusion of: milk and dairy products, processed meat, added sugars, nightshades [20-24].

Both groups were indicated to eat considerable quantity of blue fish, due to the high amount of ω -3 Polyunsaturated Fatty Acids (ω -3 LC-PUFAs), and plants, including vegetables, edible mushrooms, tea, coffee, chocolate, herbs and spices, to exploits the antioxidant and antiinflammatory property of phenolic compounds, polyphenols, terpenes and terpenoids [25].

When implementing the anti-inflammatory approach, in addition to paying attention to the quality of food, in order to obtain results in terms of reducing symptoms, there is need to encourage the consumption of good fats, which have seen to be trophic for the lymphatic system. To do so, it is important to work on modulating the percentages of macronutrients in the diet, which need to be shifted towards the fat component.

BOX 2: Table of Food Choice

Food Product	HFKD	LCAD
Whole grains	-	x
potatoes	-	x
legumes	-	x
Skinless poultry, turkey, chicken, duck, goose...	x	x
Red meat	x	x
pork	-	-
Sausages and processed meat	-	-
Cold cuts	-	-
milk	-	-
Yoghurt (greek/kefir)	-	-
Coconut, almond, oat milk	x	x
Coconut yoghurt	x	x
dairy	-	-
fish	x	x
seafood	x	x
eggs	x	x
avocado	x	x
olives	x	x
Extra virgin olive oil	x	x
seeds	x	x
nuts	x	x
coconut	x	x
Almond and coconut flour	x	x
chocolate 99%	x	x
chocolate 85%	-	x
ghee	x	x

Coconut oil	x	x
Non-starchy vegetables	x	x
starchy vegetables	-	x
nightshades	-	-
fruits	-	x
coffee	x	x
Teas and herbals	x	x
Beer, vine and other spirits	-	-
sugar	-	x
sweeteners	x	x
Herbs and spices	x	x
salt	x	x

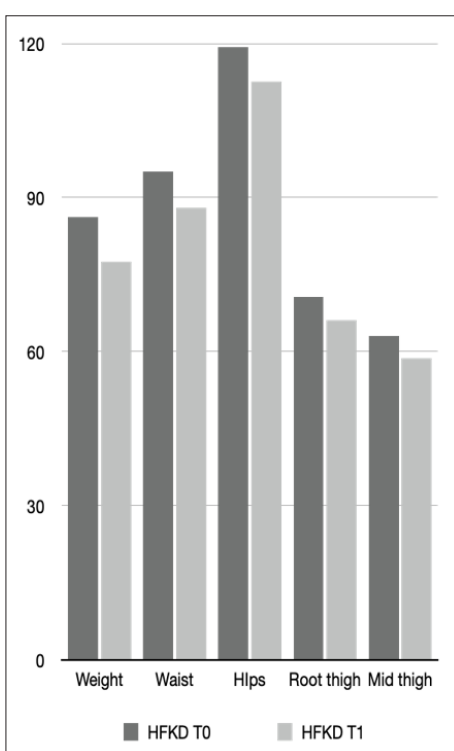
Discussion

Changes in body weight and anthropometric measurements overtime.

HFKD induced a significant weight loss ($86,18 \pm 12,88$ kg vs. $77,59 \pm 11,90$ kg, $p = 0,0217$). There was a significant decrease in waist circumference ($95,12 \pm 8,60$ cm vs. $88,08 \pm 8,43$ cm, $p = 0,0063$). Lower limb measurements also showed a significant reduction after 8 weeks of HFKD, in fact there was a decrease in hip circumference ($119,20 \pm 9,15$ cm vs. $112,5 \pm 9,11$ cm, $p = 0,0144$), a decrease in the thigh circumference at the root ($70,58 \pm 5,38$ cm vs. $66,20 \pm 5,28$ cm, $p = 0,0066$) and at the median point ($63,12 \pm 5,43$ cm vs. $58,66 \pm 4,89$ cm, $p = 0,0045$).

Table 1: Anthropometric Measurements 1st Group HFKD

Parameters	T 0 values	T 1 values	P	Δ
	Media ± SD	Media ± SD		
Weight (kg)	86.18 ± 12.88	77.59 ± 11.90	0.021776	8.59
Waist (cm)	95.12 ± 8.60	88.08 ± 8.43	0.006308	7.04
Hip (cm)	119.20 ± 9.15	112.5 ± 9.11	0.014402	6.7
Root thigh (cm)	70.58 ± 5.38	66.20 ± 5.28	0.006694	4.38
Mid thigh (cm)	63.12 ± 5.43	58.66 ± 4.89	0.004539	4.46

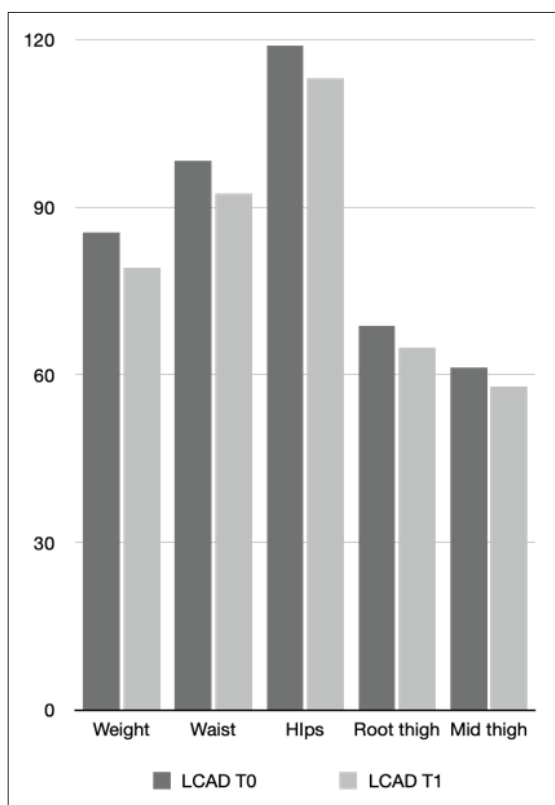


Graphic 1: Anthropometric measurements 1st group's results HFKD

The LCAD also induced a significant decrease in weight loss ($85,43 \pm 9,15$ kg vs. $79,15 \pm 8,67$ kg, $p = 0,0185$) and other anthropometric parameters: waist ($98,33 \pm 9,04$ cm vs. $92,45 \pm 9,04$ cm, $p = 0,0345$); hip circumference ($119 \pm 6,35$ cm vs. $113,04 \pm 6,05$ cm, $p = 0,0017$); thigh circumference at both the root ($68,79 \pm 5,41$ cm vs. $64,91 \pm 4,68$ cm, $p = 0,0109$) and median ($61,29 \pm 5,5$ cm vs. $57,91 \pm 4,52$ cm, $p = 0,0253$).

Table 2: Anthropometric Measurements 2nd Group LCAD

Parameters	T 0 values	T 1 values	P	Δ
	Media ± SD	Media ± SD		
Weight (kg)	85.43 ± 9.15	79.15 ± 8.67	0.018560928	6.28
Waist (cm)	98.33 ± 9.04	92.45 ± 9.04	0.034588412	5.88
Hip (cm)	119 ± 6.35	113.04 ± 6.05	0.001744492	5.96
Root thigh (cm)	68.79 ± 5.41	64.91 ± 4.68	0.010982076	3.88
Mid thigh (cm)	61.29 ± 5.5	57.91 ± 4.52	0.025337168	3.38



Graphic 2: Anthropometric measurements 2nd group's results LCAD

Improvements in Symptoms

Significant results were also recorded in the statistical analysis of the data collected using a validated questionnaire for lipedema symptoms.

HFKD most significant result were observed in the reduction of symptoms including: the sensation of pain in the affected areas ($5,33 \pm 3,07$ vs. $2,71 \pm 2,17$, $p = 0,00001$), sensitivity to touch or pressure ($7,67 \pm 3,05$ vs. $4,04 \pm 2,72$, $p = 0,00001$), the presence of hematomas/ecchymosis ($7,08 \pm 3,17$ vs. $4,79 \pm 2,90$, $p = 0,00001$), the sensation of internal tension in the legs ($5,75 \pm 3,9$ vs. $2,75 \pm 2,65$, $p = 0,00006$), the sensation of heaviness ($7,71 \pm 2,94$ vs. $4 \pm 2,75$, $p = 0,00001$), the sensation of tiredness or fatigue in the legs ($7,12 \pm 3,30$ vs. $3,88 \pm 2,83$, $p = 0,00001$), the swelling ($7,12 \pm 3,12$ vs. $3,42 \pm 2,70$, $p = 0,00001$), in the improvement of the quality of life ($6,5 \pm 3,36$ vs. $3,17 \pm 2,69$, $p = 0,00001$) and about the dissatisfaction with the appearance of the legs ($9,12 \pm 1,84$ vs. $6,29 \pm 2,88$, $p = 0,00005$). Other very good results involved the sensation of heat or burning in the affected areas ($3 \pm 3,2$ vs. $1,29 \pm 1,94$, $p = 0,00115$) and in the presence of muscle cramps ($3,67 \pm 3,26$ vs. $2 \pm 2,43$, $p = 0,00251$). Less, but significant results were recorded in the fields that collected lower values in the questionnaire, the itching or tingling ($4,12 \pm 3,60$ vs. $2,12 \pm 2,50$, $p = 0,00108$), the limitation of walking ($2,29 \pm 3,53$ vs. $1,42 \pm 2,46$, $p = 0,03156$) and the cold sensation in the affected areas ($2,17 \pm 3,48$ vs. $1,33 \pm 2,72$, $p = 0,02969$). No statistically significant results were recorded for the reduction in the presence of skin irritation as it is a parameter present above all in the 4th stage of the disease which was not included in the study.

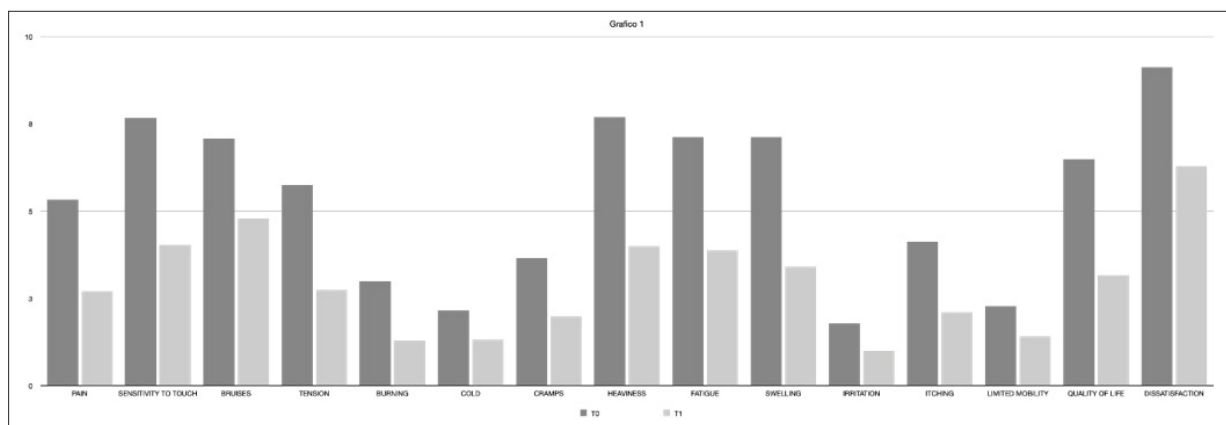
A significant regression of symptoms was also shown in the sample of people who followed the LCAD diet for 8 weeks but not as impressive as HFKD.

There was a significative decrease in some parameters such as the sensation of pain in the affected areas ($5 \pm 3,16$ vs. $3,08 \pm 2,33$, $p= 0.00001$), a decrease in sensitivity to touch or pressure ($6,88 \pm 3,02$ vs. $4,67 \pm 2,51$, $p= 0.00001$), a regression of the sensation of internal tension ($6,62 \pm 3,03$ vs. $3,58 \pm 2,79$, $p= 0.00001$), and in the sensation of heat or burning ($4,92 \pm 3,64$ vs. $2,29 \pm 2,75$, $p= 0,00002$); a decrease in the sensation of heaviness ($7,67 \pm 3,03$ vs. $4,71 \pm 2,88$, $p= 0.00001$), tiredness ($7,04 \pm 3,15$ vs. $4,38 \pm 2,49$, $p= 0.00001$), and swelling ($8,17 \pm 2,07$ vs. $4,96 \pm 2,54$, $p= 0.00001$) and finally an improvement in quality-of-life conditioning ($6,33 \pm 3,72$ vs. $4,21 \pm 2,93$, $p= 0.00001$) and lower limb dissatisfaction ($8,83 \pm 1,92$ vs. $6,71 \pm 2,01$, $P= 0.00001$). Good results were observed in the decrease of hematomas/ecchymosis ($6,5 \pm 3,51$ vs. $4,5 \pm 3,18$, $p= 0.00033$), and in the occurrence of muscle cramps ($2,42 \pm 2,84$ vs. $1,04 \pm 2,03$, $p= 0.0016$), and tingling ($2,42 \pm 3,24$ vs. $1,5 \pm 2,57$ $p= 0,00152$). Less significative results were observed in the limitation of walking ($2,42 \pm 3,59$ vs. $1,33 \pm 2,44$ $p= 0,01233$). No statistically significant results were recorded for the reduction in the presence of skin irritation as it is a parameter present above all in the 4th stage of the disease which was not included in the study.

Table 3: Questionnaire Data 1st Group HFKD

Symptoms	Valori iniziali	Dopo 8 settimane	p	Δ
	Media ± DS	Media± DS		
Are the affected areas painful?	5.33 ± 3.07	2.71 ± 2.17	0.00001	2.62
Are the affected areas sensitive to touch or pressure?	7.67 ± 3.05	4.04 ± 2.72	0.00001	3.63
Do you bruise easily?	7.08 ± 3.17	4.79 ± 2.90	0.00001	2.29
Do you feel tension in your legs?	5.75 ± 3.93	2.75 ± 2.65	0.00006	3
Do you feel excessive warmth in your legs?	3 ± 3.2	1.29 ± 1.94	0.00115	1.71
Do your legs feel cold?	2.17 ± 3.48	1.33 ± 2.72	0.02969	0.84
Do you have muscle cramps?	3.67 ± 3.26	2 ± 2.43	0.00251	1.67
Do your legs feel heavy?	7.71 ± 2.94	4 ± 2.75	0.00001	3.71
Do your legs feel tired?	7.12 ± 3.30	3.88 ± 2.83	0.00001	3.24
Do you sometimes have swelling?	7.12 ± 3.12	3.42 ± 2.70	0.00001	3.7
Is there skin involvement?	1.79 ± 3.52	1 ± 2.26	NS	0.79
Is there itching?	4.12 ± 3.60	2.12 ± 2.50	0.00108	2
Do you have difficulty walking?	2.29 ± 3.53	1.42 ± 2.46	0.03156	0.87
How much does the condition affect your quality of life?	6.5 ± 3.36	3.17 ± 2.69	0.00001	3.33
How dissatisfied are you about the appearance of your legs?	9.12 ± 1.84	6.29 ± 2.88	0.00005	2.83

Table 3: Comparison of results obtained from filling in the lipedema symptoms questionnaire of 24 patients before starting an LCAD diet and after 8 weeks

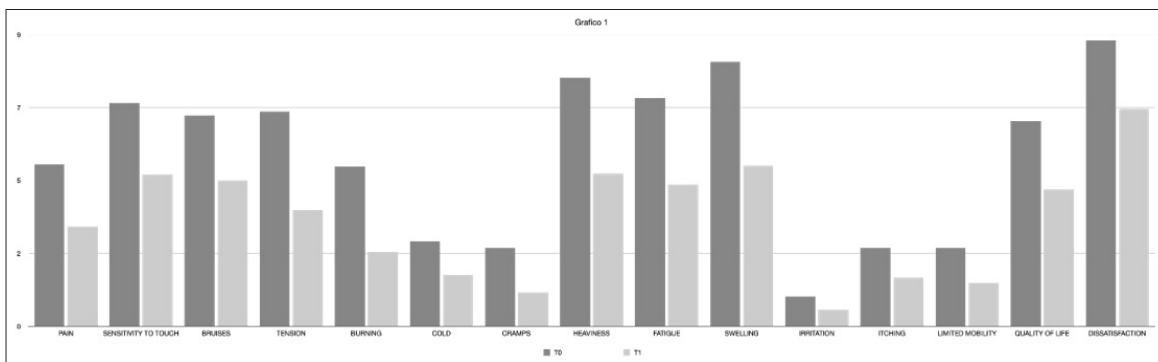


Graphic 3: Questionnaire 1st group's results HFKD

Table 4: Questionnaire Data 2nd Group LCAD

Sintomatologia	Dopo 8 settimane	Dopo 8 settimane	p	Δ
	Media± DS	Media± DS		
Are the affected areas painful?	5 ± 3.16	3.08 ± 2.33	0.00001	1.92
Are the affected areas sensitive to touch or pressure?	6.88 ± 3.02	4.67 ± 2.51	0.00001	2.21
Do you bruise easily?	6.5 ± 3.51	4.5 ± 3.18	0.00033	2
Do you feel tension in your legs?	6.62 ± 3.03	3.58 ± 2.79	0.00001	3.04
Do you feel excessive warmth in your legs?	4.92 ± 3.64	2.29 ± 2.75	0.00002	2.63
Do your legs feel cold?	2.62 ± 3.84	1.58 ± 2.66	0.01041	1.04
Do you have muscle cramps?	2.42 ± 2.84	1.04 ± 2.03	0.0016	1.38
Do your legs feel heavy?	7.67 ± 3.03	4.71 ± 2.88	0.00001	2.96
Do your legs feel tired?	7.04 ± 3.15	4.38 ± 2.49	0.00001	2.66
Do you sometimes have swelling?	8.17 ± 2.07	4.96 ± 2.54	0.00001	3.21
Is there skin involvement?	0.92 ± 2.18	0.5 ± 1.38	NS	0.42
Is there itching?	2.42 ± 3.24	1.5 ± 2.57	0.00152	0.92
Do you have difficulty walking?	2.42 ± 3.59	1.33 ± 2.44	0.01233	1.09
How much does the condition affect your quality of life?	6.33 ± 3.72	4.21 ± 2.93	0.00001	2.12
How dissatisfied are you about the appearance of your legs?	8.83 ± 1.92	6.71 ± 2.01	0.00001	2.12

Table 4: Comparison of results obtained from filling in the lipedema symptoms questionnaire of 24 patients before starting an LCAD diet and after 8 weeks



Graphic 4: 2nd group's questionnaire results LCAD

Conclusions

HFKD led to significant fat loss in the lower limbs, the area most affected by the development of lipedema, and a greater improvement in the key symptoms afflicting Lippias comparing with LCAD. The higher improvement in symptoms is presumably due to the well documented anti-inflammatory power of ketone bodies. Further studies have to be done but the high fat ketogenic diet should be considered the nutritional treatment of choice for lipedema and, together with other conservative therapies, it could be considered a valid tool for the treatment of this pathology.

Acknowledgments

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