

The Effects of a Lipolytic Cream, Exercise and a High Antioxidant Diet on Cellulite

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Abstract

Control and investigational groups(56 total) (age range 20-65) participated in a 6 week randomized single blinded study to assess a slimming system (lipolytic agent suspended in a cream, exercise (3 minute lower body in morning and evening), massage and diet) on body fat and weight and cellulite. Subjects were encouraged to accomplish 180 minutes of other moderate intensity exercise (90 minutes aerobic in bouts of 30-60 minutes and 90 minutes lower leg exercises from a DVD that lasted 30 minutes and was done 3 times per week). They were on a healthy high antioxidants recommendations diet to reduce 300-500 calories per day. Data collection included weight, height, age, girth, and body fat, ultrasound to measure thigh cellulite, a self-perception of skin smoothness and cellulite and a measure of skin compliance on the thigh. The combination of the exercise, diet and cream reduced cellulite by 67% on the thigh. There was also a 29% reduction in subcutaneous fat on the thighs. Overall cardiovascular health increased as seen by a reduction in 11.4+/-17.3/4.5+/-10.8 mmHg in blood pressure and 8.3+/-16.2 beats per minute in heart rate. Overall body weight was reduced by 3.8+/-1.3 kg and the thigh girth was reduced by 5.7+/-1.1cm.

Keywords: exercise, exertion, body fat

1 Introduction

Cellulite is a skin and subcutaneous fat disorder that is almost entirely seen in women[1]. It doesn't matter if a woman is thin or fat, cellulite can still occur on the thighs [2-4]. While being overweight is a predisposing factor to cellulite, recent investigations point to

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cellulite being a form of chronic lymph edema and inflammation in the subcutaneous fat[5]. The overall effect is subcutaneous fat bulging out of the containing collagen fibers into the dermis resulting in an orange peel appearance of the skin[6]. It is most commonly found in the hips, buttocks, and thighs but can also touch other areas, including the abdomen[6]. While only 2% of men are effected, 90% of women over age 20 are affected [7, 8]. Predisposing factors include smoking, a sedentary lifestyle, eating habits, wearing tight cloths, stress and being Caucasian[5].

The cellular manifestations of cellulite include edema, cellular inflammation, liquid infiltration and enhanced adipocyte activity [9-12]. The condition starts usually with hormone related increases in matrix-metalloproteinases (MMPs), which weakens capillary walls and challenges extracellular matrix integrity[13]. As a result, tissue leak from tissues and activate the inflammatory process[13]. This process accelerates skin ageing in women[14].

As a form of lymph edema, numerous treatments have bene shown to be effective for cellulite [1,3,15]. These include lymph massage to the thighs, anti-inflammatory diets and exercise. Each has its own advantages and disadvantages. In the present investigation, 2 groups of subjects participated. One was a control group for measurements only. The other was the investigational group and used a combination of diet, exercise, a lipolytic cream and massage to reduce cellulite on the thighs.

2 Methods

2.1 Subjects

The subjects in the study were all female with cellulite on their thighs. There were 56 total subjects, 30 control and 26 in the exercise group. The general characteristics of the subjects is shown in Table 1. Subjects signed a consent form and all procedures were approved by the Human Review Committee of Solutions IRB.

2.2 Measures

Compliance-Subjects in the control group were provided with instructions at the beginning of the study to not change their lifestyle. This was verified at the end of the study by a questionnaire. Subjects in the exercise group were asked to complete log sheets on a daily basis for compliance for both the diet and exercise programs and log cream use. For the exercise group, a diet compliance scale was as follows each day:

---1 point each day for full compliance and then if they did not accomplish full exercise compliance, it was prorated in 1/4 increments.

---1/3 point for each of the 3 meals they complied with for a total of 1 point each day for full compliance

Diet- The diet consisted of a mixed diet with approximately the same proportions of fat, carbohydrate, and protein. The diet was a dietary recommendation involving a reduction in calories by following a dietary, lifestyle and behavior modification plan with a daily reduction of 300-500 calories per day and an exercise program. The diet encouraged eating high antioxidant foods such as vegetables and fruits and lean proteins.

Body Fat Content- Body fat content was measured by an Impedance Plethysmograph (RJL systems, Clinton TWP, MI).

Girth Measurement- Girth measurements were made by a measuring tape with a tension meter that applied 3 grams of force during the measurements. The same person made all measurements. Measurements included the umbilicus, thighs and hips.

Blood Pressure- Blood pressure was measured by auscultation of the left arm. An automatic blood pressure cuff was used on the wrist (Omron Hem 621, Schaumburg, IL.).

Heart Rate- Heart rate was determined by the radial pulse by the blood pressure cuff mentioned above.

Ultrasound- Subcutaneous fat thickness was assessed with a Mindray M7 Ultrasound. The probe used was a linear probe with 512 elements in the probe which could measure the thickness of skin and subcutaneous fat to a resolution of 0.1 mm. It used at a base frequency of 10 MHz. Measures were made on the upper thigh at 5 locations to determine the average fat thickness.

The standard deviation and mean of these measures were used to calculate the coefficient of variation of the thickness of the fat layer as an index of unevenness of subcutaneous fat and cellulite.

Video- There were 2 videos provided. One video had 3 minute sessions of standing and lying thigh exercises. The second video had 3, 30 minute sessions of lower body strength exercises and 2, 30 minute aerobic workouts.

Exercise program-

For the exercise group, the subjects were asked to perform 180 minutes of cumulated exercise per week. Exercise sessions were mixed in terms of aerobic and anaerobic exercise and participants could select from a variety of activities such as treadmill, jogging, bicycling, stair climb, aerobic dance and similar moderate intensity exercise or could utilized aerobic workouts provided on the video. The exercise could be done at any time during the day and anytime during the week but the recommendation was 30 minutes bouts of exercise. Half of the exercise was the 3, 30 minute video lower body exercise sessions.

Lipolytic cream- Thelipolytic creamisa proprietary formulation that contained 2 compounds, caffeine and aminophylline (Savvier LP, Carlsbad, California).

Subjects had to rub the cream on twice daily and then perform a 3 minute leg exercise video after the application. This was followed by 2 minutes of an upward rolling massage motion of the thighs using a small roller to reduce edema.

Self-assessment and softness scales- A 10 cm analog visual scale was used at the beginning and end of the study to assess self-feeling of the cellulite and skin softness.

Measurement of skin flexibility and softness-

A pressure algometer was used to measure skin flexibility and softness. The algometer tip was placed through a small hole in 3 different plastic sheets at 3 thicknesses such that the tip was pressed into the mid-thigh at 0.46, 1.29, and 1.78 cm. Pressure was then recorded in Neutons.

2.3 Procedures

This was a randomized single blinded study so the individuals doing the measurements did not know, for each subject, which group they were in. For both groups, measures were taken at the start, 2 weeks, 4 weeks and 6 weeks. At each measuring point, we measured subcutaneous fat with ultrasound, height, weight and age. In addition girth was measured at the umbilicus, thigh and hips. Body fat was measured by impedance. By placing pressure on the skin with an algometer, skin compliance and stiffness was

measured. Gluteal fold height was also measured. Finally, a visual analog scale at the beginning and end of the study was used to measure self-assessment of cellulite and skin softness. Heart rate and blood pressure were measured at the beginning and end of the study. For the experimental subjects, they used a suggested high antioxidant diet with a mild caloric restriction and 180 minutes of exercise each week. The exercise was 90 minutes of free exercise and 90 minutes of video leg exercise per week. For the cream, the cream was applied in the morning and evening daily with a short exercise bout (3 minutes) and roller massage.

2.4 Statistical Analysis

Statistical analysis involved the calculation of means and standard deviation and related and unrelated T tests. ANOVA was used to cross compare groups. The level of significance was $p \leq 0.05$.

3 Main Results

The body weight of the subjects in the two groups is shown in Figure 1 throughout the 6 week period. As can be seen here, there was no statistical difference in the control group throughout the 6 weeks (ANOVA $p > 0.05$). However, for the cream group, there was a significant loss in weight from the beginning to the end and for each 2 weeks of the study ($p < 0.01$ ANOVA). Overall body weight was reduced by 3.8 ± 1.3 kg.

The change in girth in the abdominal area is shown in Figure 2. As shown in Figure 2, there was no change in girth in the umbilicus in the control group throughout the 6 week period ($p > 0.05$). However, for the exercise and cream group, the umbilicus girth was significantly reduced over the 6 week period (ANOVA $p < 0.01$).

The change in thigh circumference is shown in Figure 3. There was no change in the circumference in the control group through the study (ANOVA $p > 0.05$). However, for the experimental group, there was a significant loss in girth in the thighs ($p < 0.01$ ANOVA) throughout the study with a total loss of 5.7 ± 1.1 cm at 6 weeks.

The loss in circumference in the hips for the 2 groups of subjects is shown in Figure 4. As shown here, the control group had no change in hip circumference but the crème group had a significant loss in hip circumference over the 6 weeks ($p < 0.01$ ANOVA).

As shown in Figure 5, the gluteal fold height did not change in the 6 week period in the control subjects. But in the crème group, it was increased at each measurement period. This increase was significant ($p < 0.01$ ANOVA) and totaled 3.97 cm.

Figures 6 and 7 show the change in skin compliance in the control and crème groups respectively. The controls and crème groups had no change in skin compliance ($p > 0.05$).

The self-reported compliance is shown in Figure 8. Compliance for exercise, diet and crème use averaged about 50%. The compliance of the control group for not changing lifestyle was 100%.

The mean thickness and coefficient of variation in fat thickness on the middle of the thigh is shown in Figures 9 and 10. There was no difference in the control group. For the crème group, the results of the experiment showed that the combination of the exercise,

diet and cream reduced cellulite by 67% on the thigh. There was also a 29% reduction in subcutaneous fat on the thighs. These were both significant ($p < 0.01$).

As shown in Figure 11, self-assessment of cellulite on a 100 point scale was reduced by 14.1 ± 13.2 , a significant reduction ($p < 0.01$). The reduction in self-assessment of cellulite was a 39.6 % improvement.

Overall cardiovascular health increased as seen by a reduction in $11.4 \pm 17.3 / 4.5 \pm 10.8$ mmHg in blood pressure and 8.3 ± 16.2 beats per minute in heart rate in the crème group. There was no significant change in the control group.

3.1 Discussion of Results

Numerous studies have investigated the causes and possible improvements for cellulite [1, 5, 6, 15]. Current research shows that it occurs almost entirely in women and is linked to b-estrogen receptors in fat, particularly on the back of the thigh[16]. It is a form of lymph edema and involves inflammation of subcutaneous fat. Cellulite has been linked to several gene alleles that make even lean women susceptible to cellulite[8]. The overall effect is subcutaneous fat bulging out of the containing collagen fibers into the dermis resulting in an orange peel appearance of the skin[6]. It is most commonly found in the hips, buttocks, and thighs but can also touch other areas, including the abdomen[6]. The fat can be liberated by a number of lipolytic agents. These include caffeine, which is commonly found in cellulite creams, and aminophylline[17]. Both penetrate the skin easily and liberate fat from the subcutaneous fat layer. Aminophylline has been shown to be effective in spot girth loss[17]. It is a known vasodilator which will cause a small reduction in heart rate but has no adverse effects on other body systems such as pulmonary function[18]. It is considered safe for use in the body[19]. Exercise has been shown to improve cellulite [20]. Further, since the cause of cellulite is inflammation, higher levels of local or systemic antioxidants are needed to reduce or remove the inflammation. Finally, massage also helps to reduce edema in the thighs and buttocks while also smoothing the skin and increasing skin circulation and elasticity.

In the present investigation, all of these techniques were used. A lipolytic cream consisting of aminophylline and caffeine was rubbed into the skin. Next subjects exercised their legs to help increase the lipolytic activity. A light massage was used through a roller at a set pressure. Finally subjects underwent a healthy diet that was high in antioxidants and engaged in 180 minutes of exercise a week to help with weight loss.

The results of the experiments showed significant loss in fat in all areas measured but exceptional fat loss in the thighs where the cream, massage, and exercise were targeted. Further, there was an overall weight loss and an improvement in blood pressure and heart rate in the exercise group; there was no change in the control group. The results of the experiment showed that the combination of the exercise, diet and cream reduced cellulite by 67% on the thigh. There was also a 29% reduction in subcutaneous fat on the thighs. Overall cardiovascular health increased as seen by a reduction in $11.4 \pm 17.3 / 4.5 \pm 10.8$ mmHg in blood pressure and 8.3 ± 16.2 beats per minute in heart rate. Overall body weight was reduced by 3.8 ± 1.3 kg and the thigh girth was reduced by 5.7 ± 1.1 cm.

The exercise conducted in the lower body twice each day, increased the height of the gluteal fold significantly adding to cosmesis. In all then, the system increased cardiovascular health, causing a significant weight loss and spot loss of cellulite and smoothing of the skin. Subjects reported a significant improvement in their feeling of smoothness and beauty in their legs as well as firmness. By using 3 pressures applied to

the skin on the thigh, the compliance of the skin was measured. It can be expected that firmness will increase on the thigh due to loss in fat and increase in muscle mass and tone due to exercise. Here the pressure algometer showed no statistical change. However, the subjects self-reported improvement in firmness of muscle and softness of the skin. The conclusion is that the increase in firmness in muscle was offset by an increase in skin elasticity as self-reported by the subjects.

In summary, the exercise, diet with lipolytic cream and massage provided a significant improvement in cellulite smoothness, reduction in subcutaneous fat and thigh girth loss.

4 Tables and Figures

Table 1: General characteristics of subjects

controls	age (years)	height(cm)	weight(kg)	BMI(%)
mean	40.6	166.3	93.8	33.8
sd	13.6	8.4	17.5	5.6
diet	age (years)	height(cm)	weight(kg)	BMI(%)
mean	39.3	165.7	94.3	34.6
sd	6.5	8.7	19.5	8.0

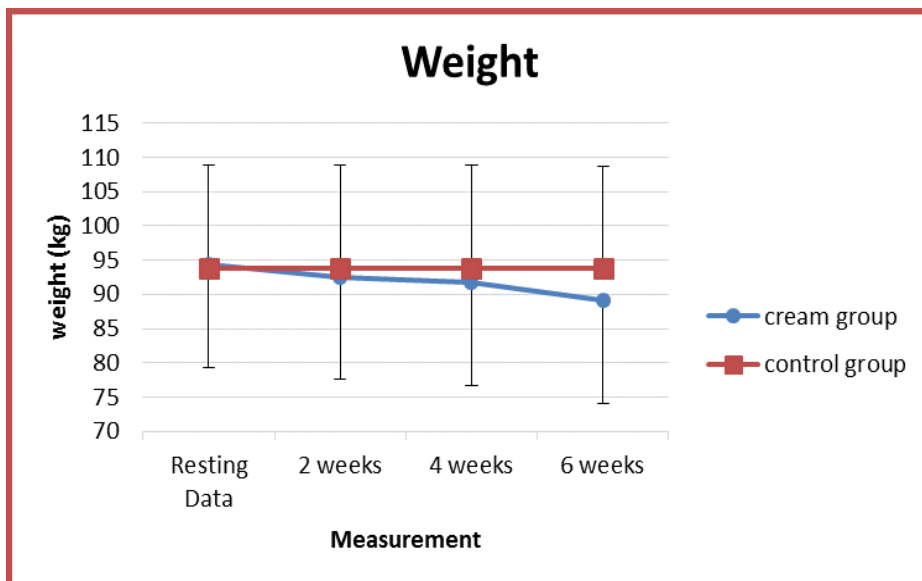


Figure 1: Weight loss in the 2 groups of subjects throughout the study. Each point is the mean of all subjects in the group +/- the standard deviation.

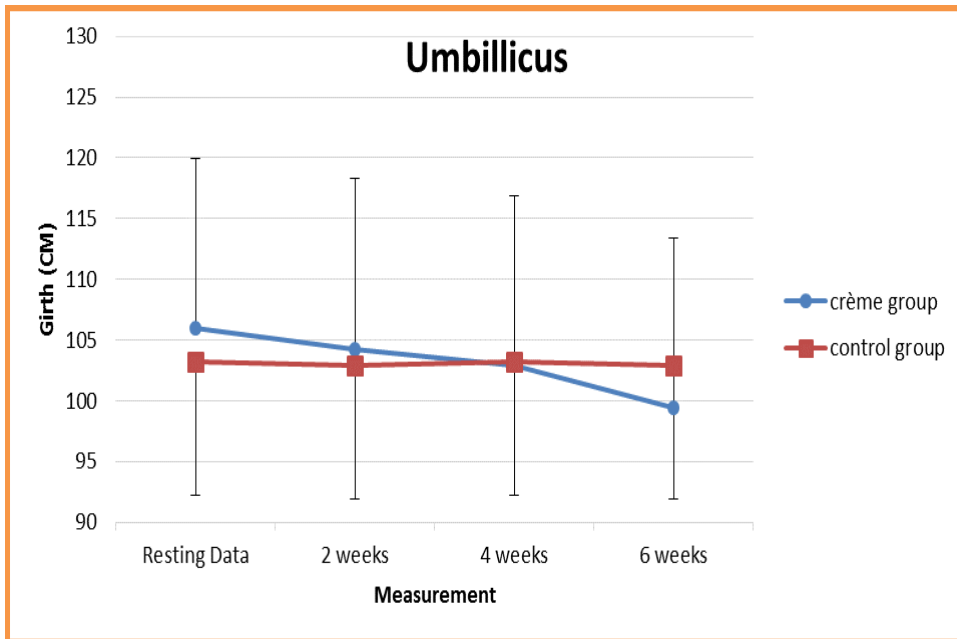


Figure 2: umbilicus girth throughout the 6 week period. Each point is the mean of all subjects in the group +/- the standard deviation.

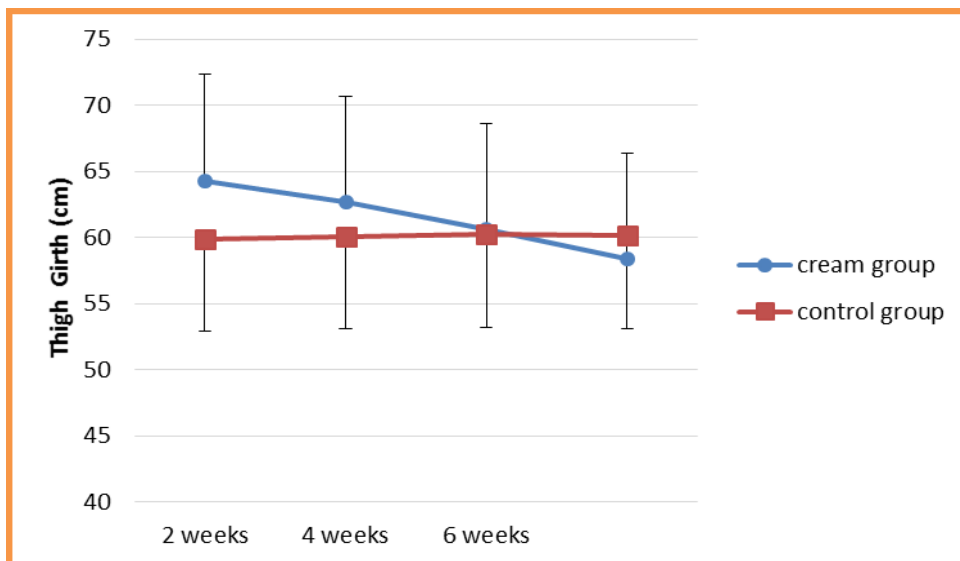


Figure 3: thigh circumference in the 2 groups of subjects throughout the study. Each point is the mean of all subjects in the group +/- the standard deviation.

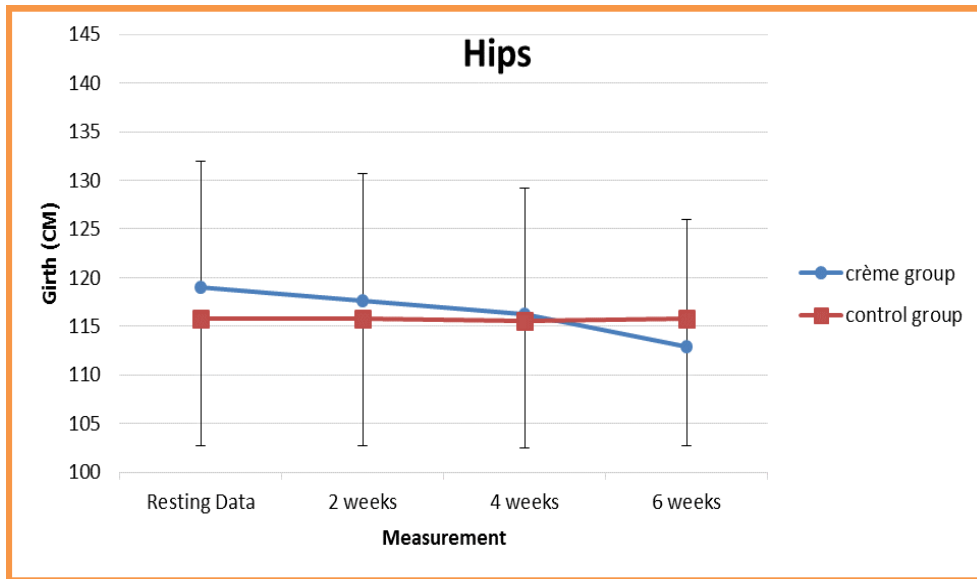


Figure 4: Change in girth in the hips in the control and crème groups over the 6 weeks. Each point is the mean of all subjects in the group +/- the standard deviation.

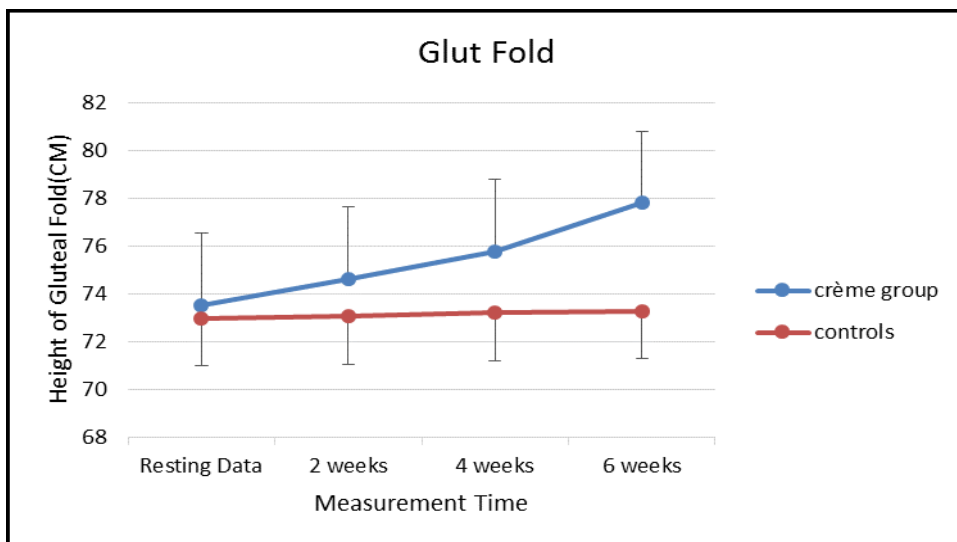


Figure 5: Change in height of the gluteal fold in the control and crème groups over the 6 weeks. Each point is the mean of all subjects in the group +/- the standard deviation.

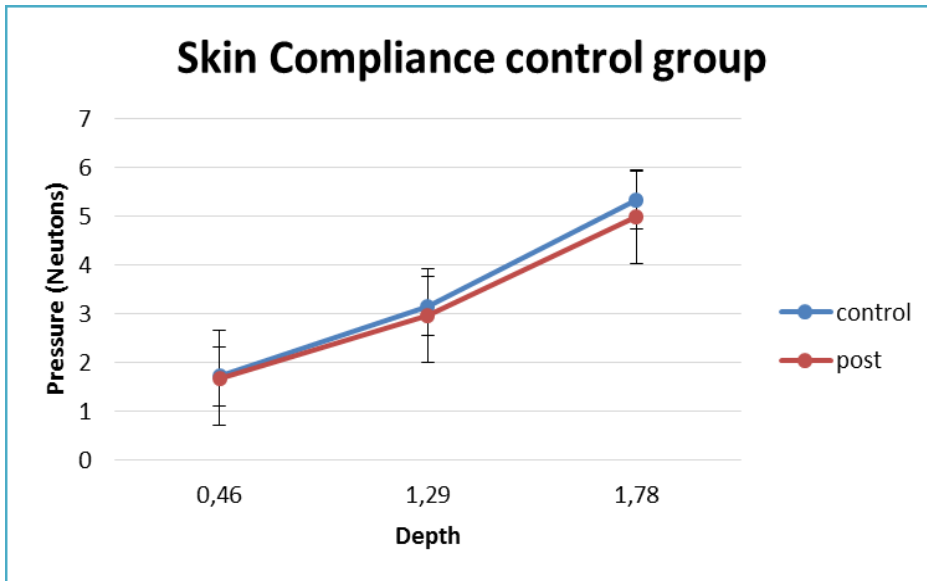


Figure 6: Change in skin compliance before and after the 6 week period in the control subjects. Each point is the mean of all subjects in the group +/- the standard deviation.

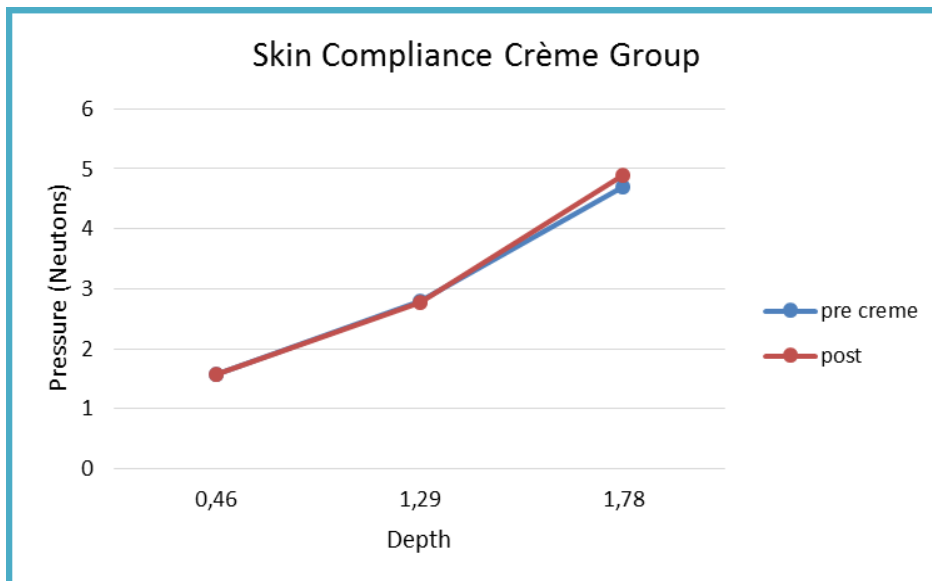


Figure 7: Change in skin compliance before and after the 6 week period in the crème subjects. Each point is the mean of all subjects in the group +/- the standard deviation.

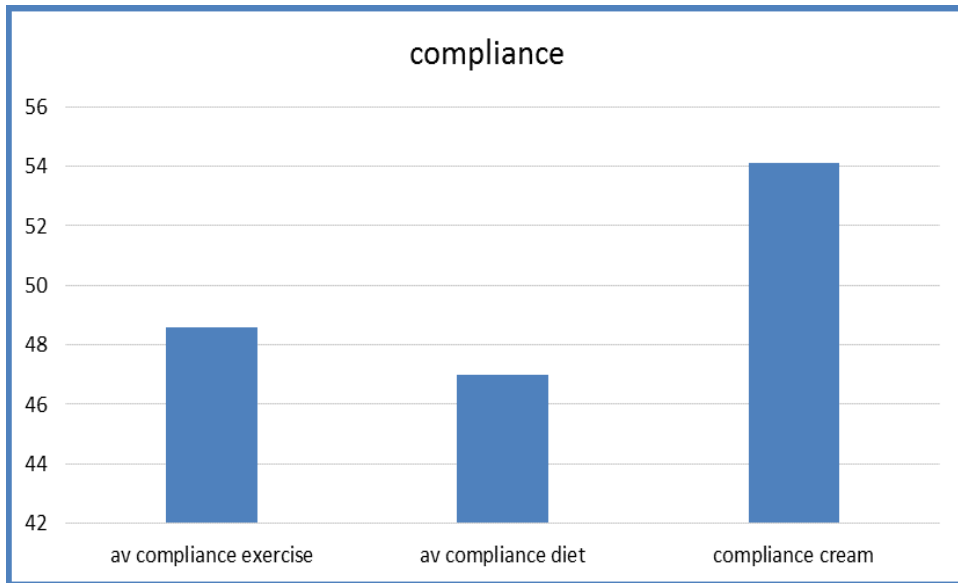


Figure 8: The reported compliance for the exercise, diet and cream in the crème group. The data is the average of all 6 weeks in this group.

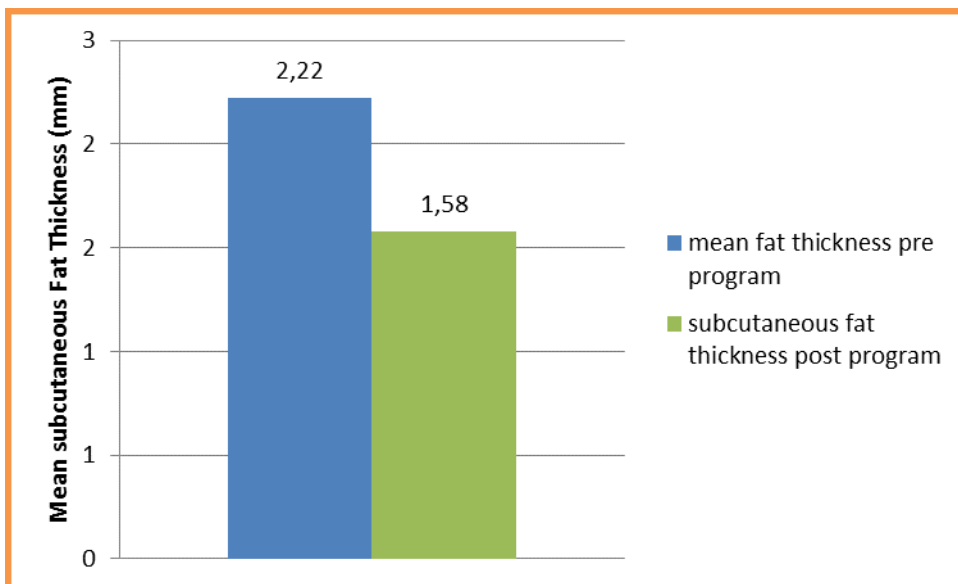


Figure 9: This figure shows the pre-program and post program subcutaneous fat thickness on the thigh. The data is the mean of all crème subjects.

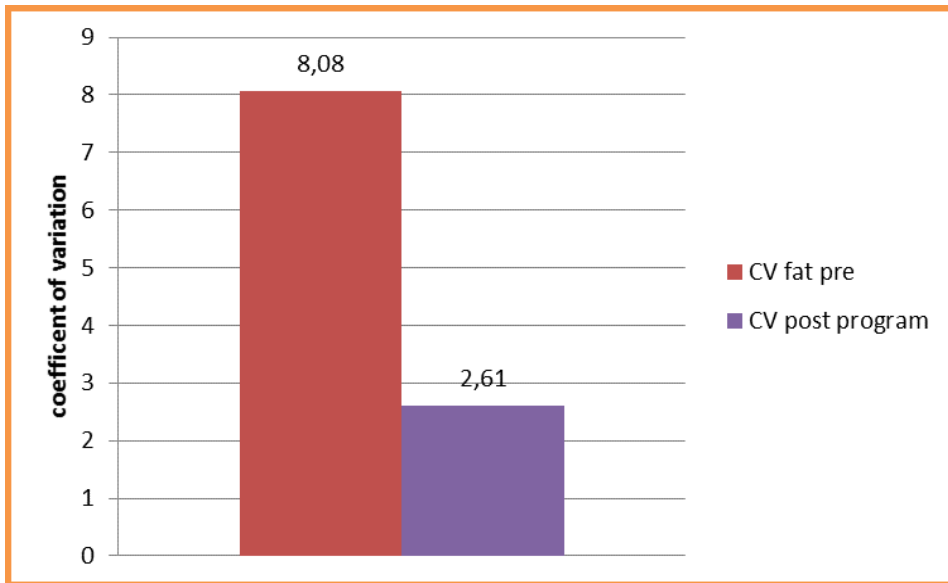


Figure 10: This figure shows the pre-program and post program coefficient of variation in fat thickness on the thigh (CV). The data is the mean of all subjects in the crème group.

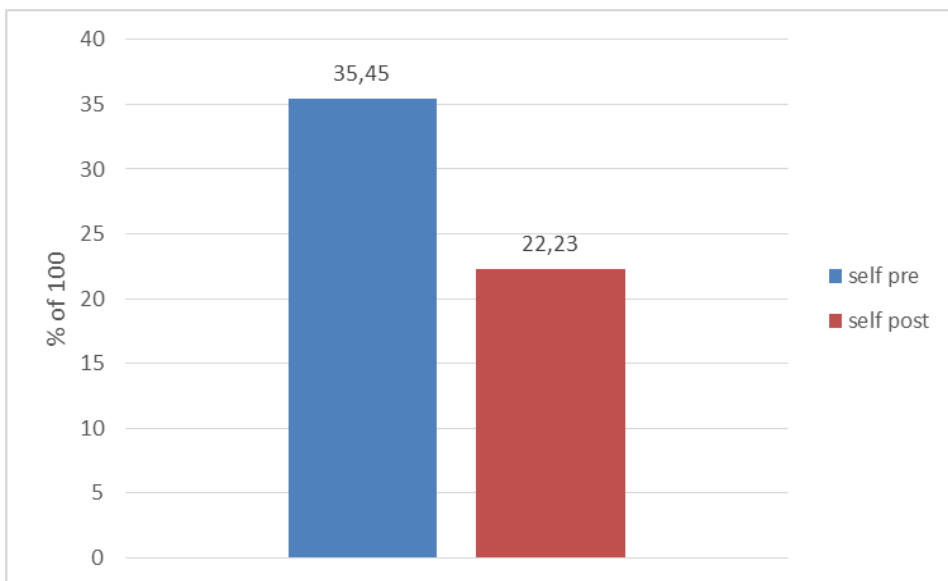


Figure 11: This figure shows the pre-program and post program self-assessment of cellulite. The data is the mean of all subjects in the crème group.

5 Conclusion

The system described and investigated here was very effective in reducing body weight, subcutaneous fat and cellulite. The combination of the exercise, diet and cream reduced cellulite by 67% on the thigh. There was also a 29% reduction in subcutaneous fat on the

thighs. Overall cardiovascular health increased as seen by a reduction in 11.4+/-17.3/4.5+/-10.8 mmHg in blood pressure and 8.3+/-16.2 beats per minute in heart rate. Overall body weight was reduced by 3.8+/-1.3 kg and the thigh girth was reduced by 5.7+/-1.1cm.

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