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The effect of an 8-minute Yoga breathing program on fitness, weight loss and breathing capacity

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Abstract

This was a single blinded randomized study with an intervention group and a control group to examine a modification in lifestyle and an 8-minute exercise session each day to lose weight. Fifty-seven female subjects participated. Subjects underwent girth measurements at the umbilicus, hips, thigh and upper arm; weight, height (for BMI), body fat, heart rate, blood pressure, abdominal strength, leg strength, arm strength, sedentary O2 saturation, treadmill challenged O2 saturation, resting metabolism (which includes fat metabolism), and lung capacity. Measures were repeated at baseline and the end of the 6-week period. During the 6-week period, they followed a healthy recommended diet with high volumes of vegetables and fruit and 8 minutes of exercise each day. In the investigational group, the average weight loss was 4.85 KG over the 6-week period, BMI was reduced 1.79 at the end of the 6 weeks, a significant loss ($p<0.01$). Body fat in this group was reduced by 5.87 percent, the average girth at the showed an average loss in circumference of 5.9 cm over the 6-week period. For the hip, the average loss in circumference was 6.28 cm, for the thigh the average loss in circumference in the investigational group was 5.0 cm, and for the upper arm reduced girth by 2.61 cm. For strength for the investigational group, for the abdominals the increase was 11.3 Kg, for the leg it was 6.0 kg and for the arm it was 4.8 kg. All of these increases were significant ($p<0.01$). The basal metabolic rate, in the investigational group after the 6 weeks increased to 31.1 cc/kg lean body mass. The fat burning doubled in the investigational group. In

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conclusion, subjects slept better, had high oxygen saturation and better strength and excellent weight and fat loss with this program.

Keywords: fat, exercise, diet

1 Introduction

There is a worldwide crisis in increased obesity [1]. Increased body mass is associated with diabetes and cardiovascular disease [2-4]. When added to drinking and cigarette smoking, the increase in health care costs around the world is increasing exponentially from obesity and its related comorbidities [5]. To combat this problem, many exercise and fitness paradigms have been developed to be used by people who are overweight [5-7].

One of the complications of obesity is a disorder called Pickwickian syndrome [8-10]. Described in Dickens "Pickwick Papers", this syndrome is associated with increased body fat on the rib cage and in the abdominal areas [11, 12]. The increased resistance of the chest muscles to chest expansion results in a reduced depth of inspiration and more rapid rate of breathing than is seen in thinner individuals [11, 12]. Because the dead space in the lung can be over 1000 cc of air, the lung becomes poorly ventilated and there is a high percentage of venous AD mixture of venous and arterial blood [13]. This then causes arterial PO2 to lower as well as hemoglobin saturation. Arterial oxygen tension is even more impaired during mild exercise. With exercise, hemoglobin oxygen saturation can plummet causing lactic acid production to increase markedly in muscle and reducing exercise tolerance to literally steps [6, 9, 10].

Diet and exercise can lower BMI but the exercise needs to be such that it can be completed in a reasonable time and at a reasonable intensity [14, 15]. Further, breathing difficulties can be reduced through learning of proper breathing techniques such as yoga breathing [16]. By teaching how to breath deeper, there can be an immediate improvement in oxygen saturation in the arterial blood which can be corrected later with diet[16]. This also allows shifts in metabolism to fats for better health and greater exercise tolerance. This same paper also showed an almost 8-fold increase in the ability to sleep soundly at night, also lowering the chance of heart disease and stroke.

The purpose of this investigation then is to see if in people who are moderately overweight to obese can tolerate mild exercise better and become healthier by teaching them how to breath with yoga breathing, to eat better and then to engage in mild exercise each day.

2 Subjects

Fifty-seven female subjects participated with a BMI range of 22 to 52. They were 22-68 years old. They were free of cardiovascular disease and not taking any medication that would alter metabolism or balance. Subjects had their weight stable for 3 months. All protocols and procedures were submitted and approved by the Solutions IRB and all subjects had all experimental procedures explained to them and signed a statement of informed consent. The demographics of the subjects are shown in Table 1. There was no statistical difference in the groups for the age, height and weight of the subjects. Twenty-six people were in the diet group and thirty one in the control group.

Table 1: demographics of subjects

		age	height	weight	BMI
diet	mean	50.0	163.6	92.5	34.6
	SD	11.7	8.1	21.2	7.7
control	mean	48.3	164.9	86.2	31.8
	SD	11.9	6.7	17.3	6.5

3 Methods

Diet

The diet consisted of healthy foods (i.e. lean proteins, more complex carbohydrates, high fiber, and lower calorie dense foods). This diet was a calorie restriction diet with exchanges and many choices on foods. This was based on a behavioral strategy approach. The subjects were moving towards healthier foods, i.e. fruits, vegetables, lean proteins, and higher fiber). They were provided with a booklet of different types of foods. All foods and drinks were allowed on the diet. Some were unrestricted, e.g. healthy fruits and vegetables, and all other foods were controlled using a portion counting system. Different foods had different portions and subjects needed to examine their foods and track the portions for each meal. Depending on their initial body weight, they were allowed more portions if they were heavier to begin with. Subjects were encouraged to drink 64 ounces of water daily to stay hydrated. They kept a log of what they ate so that they could monitor their progress in eating healthier.

Exercise

The exercise involved a series of 8 minute workouts and breathing exercises conducted as one per day. They used agonist antagonist exercise combinations with breathing to build muscle strength and burn calories (Oxygen 8 Fat loss system, Savvier 2014). The videos targeted the major muscles of the body including the arms, legs, and abdominal muscles.

Breathing Exercise

A video was provided as part of the workout to teach Yoga breathing techniques. These techniques were meant to increase arterial oxygen saturation.

Pittsburg sleep index

The PQSI was used to assess the quality of sleep. It has been validated in numerous studies[17-19]. It has been translated into 54 languages and measures the quality of sleep. Sleep quality is important since poor sleep quality is associated with chronic fatigue.

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, Bannockburn).

Heart Rate

Heart rate was determined by counting the radial pulse over a 15 second period and multiplying by 4.

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 tensionometer that applied 3 grams of force during the measurements. The locations were: girth of the waist at the umbilicus and 2.5 cm above the umbilicus and thighs at half of the distance between the hip and knee. The hips were measured at the greater trochanter and the arms equal distance between the shoulder and elbow. The same person made all of the measurements and all measurements were made by a senior student in the doctor of physical therapy program.

Compliance

Subjects were asked to complete log sheets on a daily basis for compliance for both the diet and exercise programs and assess how well they complied with the suggested diet.

The diet compliance scale as follows:
The subject stated as a daily percentage score if they have eaten with the proper dietary guidelines. For example, if they ate ¾ of their meals in a healthy manner, they would mark 75% for that day.
For the exercise, the compliance scale was:
The subject marked either a “yes” or “no” on the compliance forms if they have completed the workouts done daily.

Arterial PO_2

Arterial PO_2 was calculated from the hemoglobin disassociation curve. A pulse oximeter (Santa Medical, St. Louis, MO) was used to measure fingertip oxygen saturation. Once oxygen saturation was measured, the following equations were used to calculate the arterial PO2 [20].

$y = 7E\text{-}05x^3 - 0.0213x^2 + 2.57x - 13.773$
Where Y is the hemoglobin saturation and x is the partial pressure of arterial oxygen.

Exercise o2 measure
Exercise was accomplished on a treadmill with variable speed and inclination. The treadmill was adjusted to 3 mph at an angle of 3 degrees for the subjects. Subjects walked for 5 minutes and each minute heart rate and O2 saturation was measured on the finger.

Procedures for treadmill test
Subjects entered the laboratory and rested for 15 minutes prior to testing. During this time demographics and weight and body fat content were assessed. The arterial oxygen saturation was measured from the fingertip. The average reading was taken over a 1 minute period. Subjects then walked on the treadmill and O2 saturation and heart rate were measured once per minute for 5 minutes. If saturation dropped below 60% or heart rate above 140 beats per minute, the walking was terminated.

Strength measurement
Strength was measured on a leg, abdominal or arm dynamometer. These are strain gage dynamometers that used 4 strain gages to measure force and then the output was amplified with a BioPac MP100 system. The gain was 5000 and the analog to digital conversion rate was 1000 samples per second.

BMR
Basal metabolic rate was measured on waking at the beginning and end of the study. This was accomplished by having the subjects eat a standard chicken dinner and sleeping overnight in a hotel. At first waking, resting oxygen consumption and RQ were measured on a Cosmed K42b2 metabolic cart (Cosmed

LTD, Milan Italy). From this data, carbohydrate and fat metabolism were calculated.

4 Procedures

The study was a single blinded randomized study where the technicians taking the measurements were blinded as to who was in each group. Subjects underwent girth measurements at the umbilicus, hips, thigh and upper arm; weight, height (for BMI), body fat, heart rate, blood pressure, abdominal strength, leg strength, arm strength, sedentary O2 saturation, treadmill challenged O2 saturation, resting metabolism (which includes fat metabolism), and lung capacity. Measures were repeated at baseline and the end of the 6-week period. At weeks 1, 2 and 4 girth and weight were measured. During the 6-week period, they followed a healthy recommended diet and 8 minutes of exercise each day. In the first and last week, they underwent oxygen saturation testing at rest and on a treadmill. The PSQI was used at the beginning, at 4 weeks and 6 weeks into the study.

5 Statistical Analysis

Statistical analysis involved the calculation of means and standard deviations and T tests to examine the data. For multi week comparisons ANOVA was used. The level of significance was $p \leq 0.05$.

6 Results

The results of the study are shown in Figures 1-18 as described below.

Weight and BMI
The initial starting weights, body fat percentage and BMI of the 2 groups of subjects are listed in Table 1. The average % body fat of the control group was 47.22+/-15.5 and for the diet group was 48.82+/-9.8%. The changes in body weight and BMI are shown in Figures 1 and 2 respectively for the control and investigational group of subjects over the 6 week experimental period.

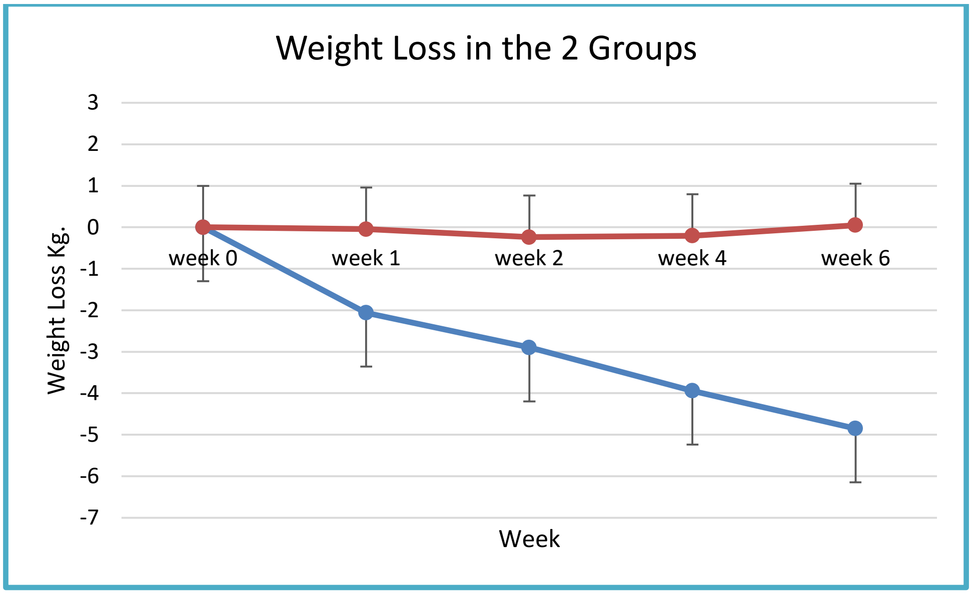


Figure 1: Body weight loss in the 2 groups of subjects as the mean of all subjects in each group over 6 weeks.

For body weight, the control group averaged 86.2+/-17.3 kg. There was no significant difference in weight throughout the 6 week period (ANOVA $p>0.05$). As shown in Figure 1, the investigational group showed considerable weight loss over the 6 week period. The average weight loss was 4.85 KG over the 6 week period (Figure 1 and 3). At 1 week, they lost on the average 2.06 kg and for 2 weeks they lost 2.9 kg.

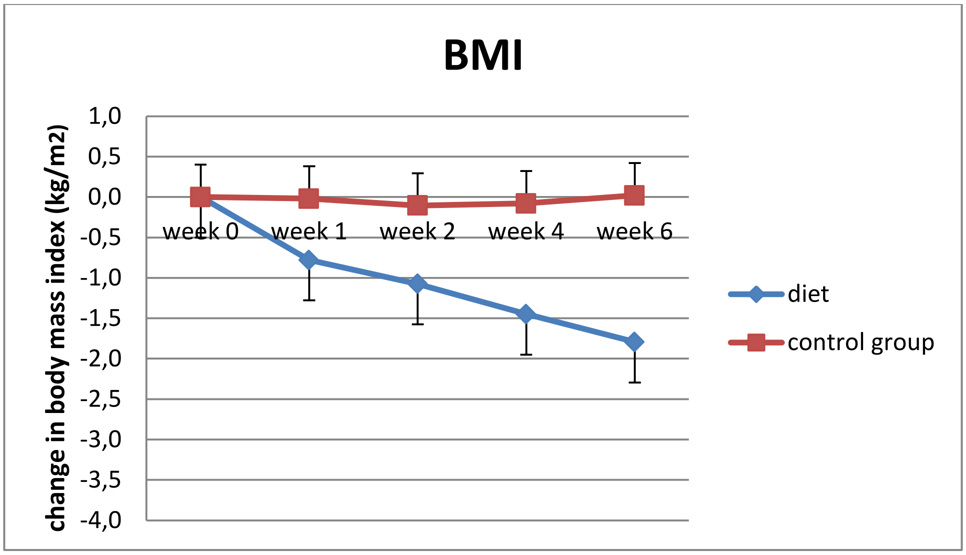


Figure 2: BMI change in the 2 groups of subjects as the mean of all subjects in each group over 6 weeks.

The BMI was also significantly reduced in the investigational group ($p<0.01$) but not in the controls ($p>0.05$).

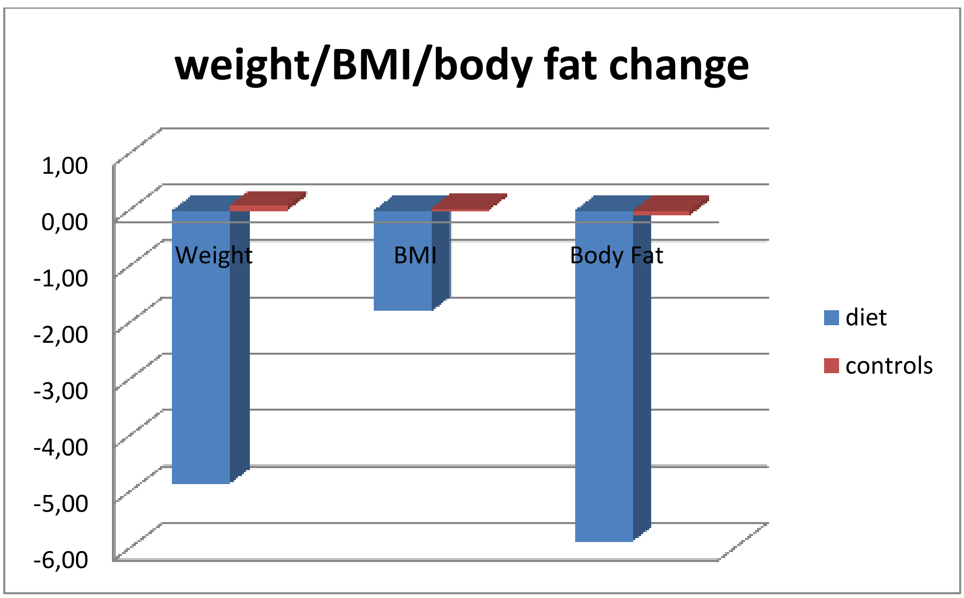


Figure 3: Loss in girth at the umbilicus in the 2 groups of subjects over the 6 week period.

Looking at the loss in body fat, the subjects lost 5.87 % of fat in the investigational group which equates to 7.51kg during the study in the investigational group. Since this exceeds the weight that was lost by 2.66 Kg, the difference is obviously a gain in muscle mass as shown in the strength diagrams described below.

Girth

Umbilicus

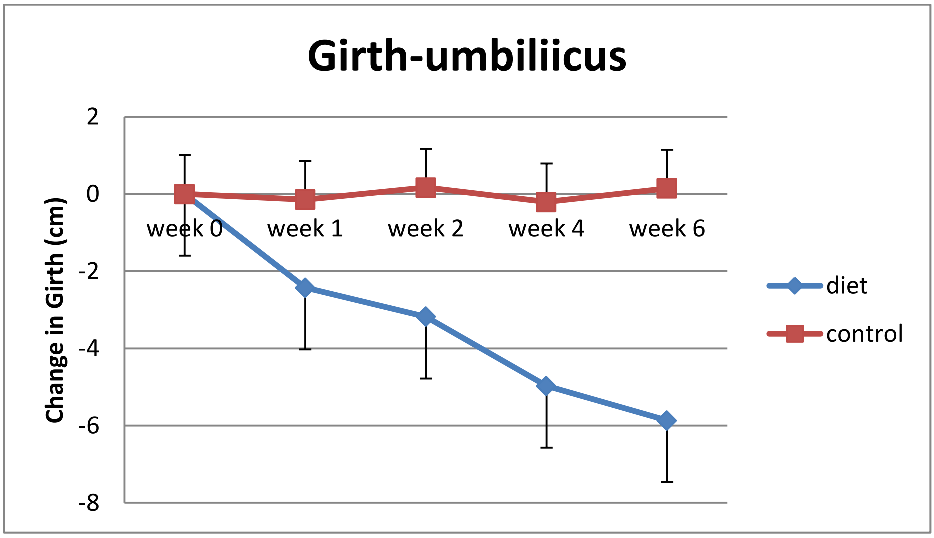


Figure 4- Loss in girth at the umbilicus in the 2 groups of subjects over the 6 week period.

The girth at the umbilicus (Figure 4) was also significantly reduced in the investigational vs. the control group of subjects ($p<0.01$). The average loss in circumference in the investigational group was 5.9 cm over the 6-week period (Figure 5). In the first week, the loss in girth was 2.43 cm or about 1 inches around the waist. This equates to a loss of 1 jean size. By the second week, the reduction in circumference was 3.18 cm.

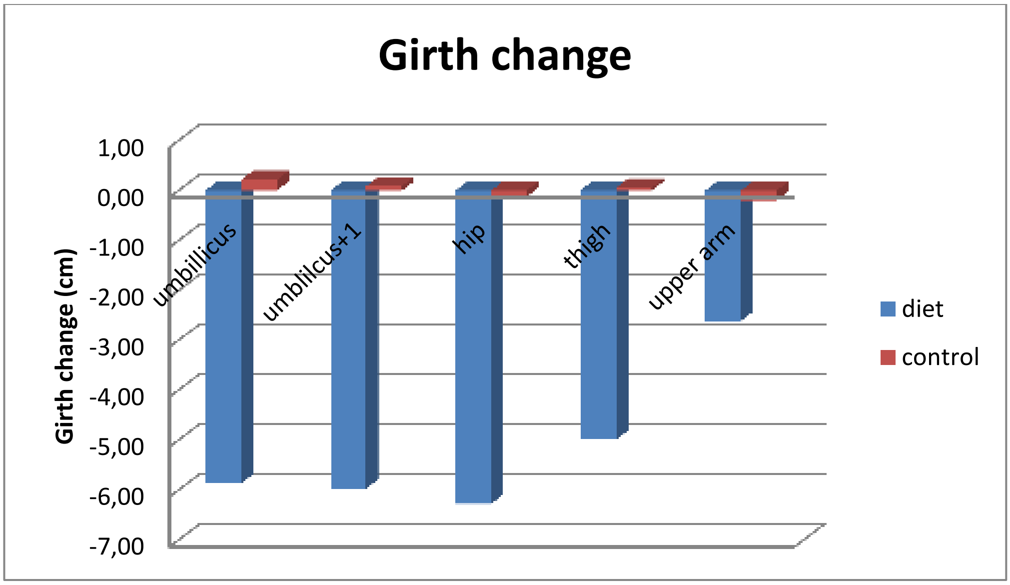


Figure 5: the loss in girth at the umbilicus, thighs, hips and upper arm throughout the study. The graph represent the 2 groups of subjects as the mean of all subjects in each group over 6 weeks.

The loss in girth was significant even after the first week of the study (Figure 4). The change in girth at the umbilicus, hips, thighs and arm in the control groups from the beginning to the end of the study was not significant but for the investigational groups it was ($p<0.01$) (Figure 5,6,7 and 8).

Hip

The girth at the hip (Figure 6) was also significantly reduced in the investigational vs. the control group of subjects ($p<0.01$). There was no statistical difference in the circumference of the control group from the beginning to the end of the study but there was a significant loss ($p<0.01$) in the investigational group, the average loss in circumference was 6.28 cm over the 6 week period.

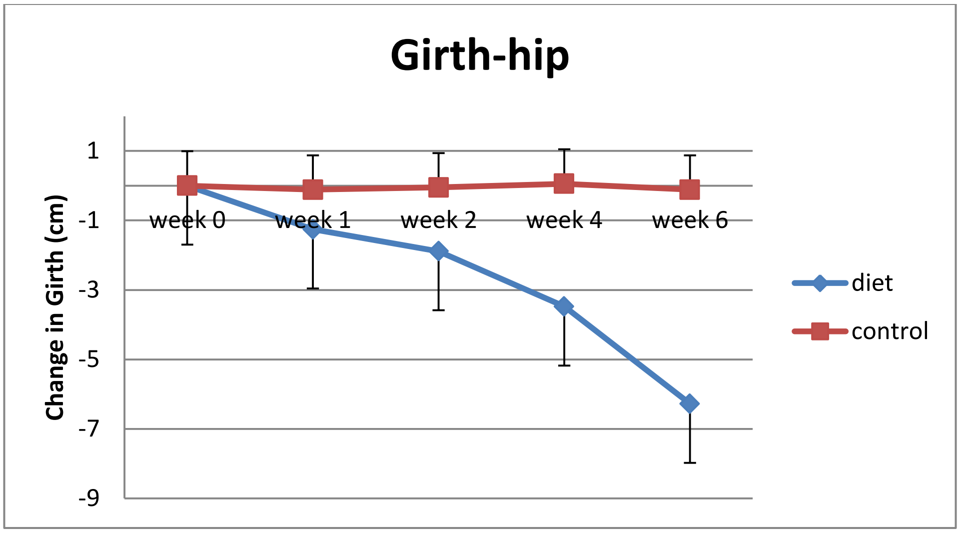


Figure 6: Loss in girth at the hip in the 2 groups of subjects over the 6 week period.

The loss in girth was significant even after the first week of the study.

Thigh

The girth at the thigh (Figure 7) was also significantly reduced in the investigational vs. the control group of subjects ($p<0.01$).

The average loss in circumference in the investigational group was 5.0 cm over the 6 week period.

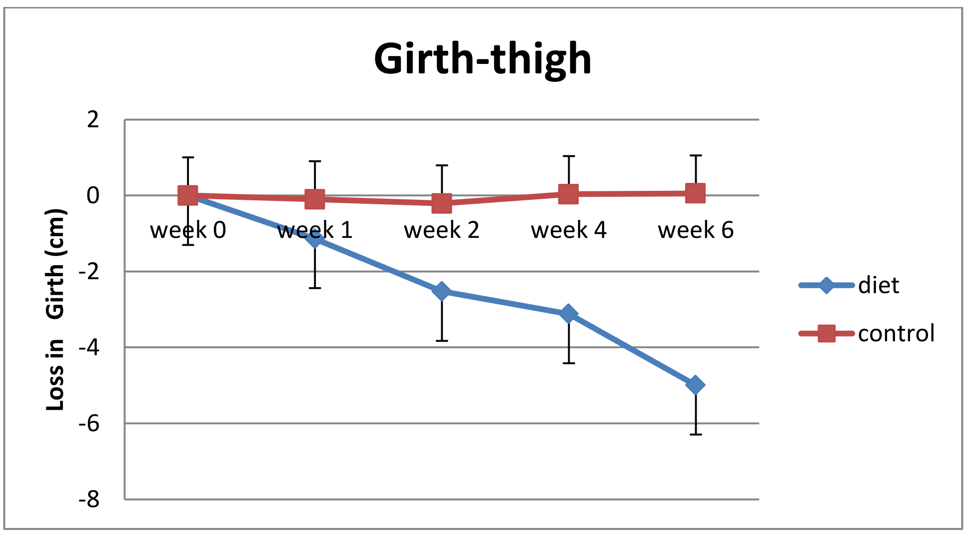


Figure 7: Loss in girth at the thigh in the 2 groups of subjects over the 6 week period.

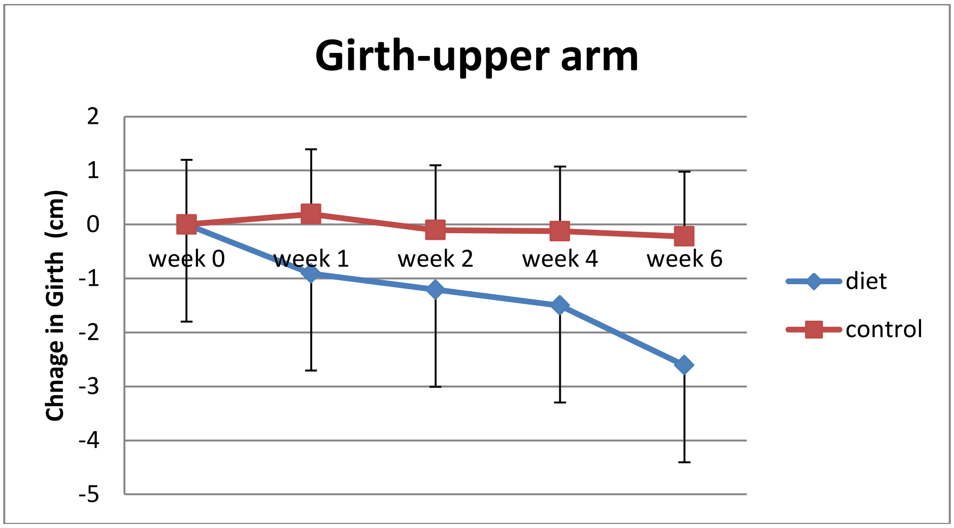


Figure 8: Loss in girth at the arm in the 2 groups of subjects over the 6 week period.

As shown in Figure 8, the control group showed no loss in girth in the upper arm throughout the study while the investigational group reduced girth by 2.61 cm (see figure 8). This loss was significant ($p<0.01$).

Strength

The change in strength in the arm, abdominals and quadriceps are shown in Figure 9.

There was no statistical change in either of the 3 in the control group ($p>0.05$). For the investigational group, for the abdominals, the increase was 11.28 Kg, for the quadriceps it was 6.1 kg and for the arm it was 4.8 kg. All of these increases were significant ($p<0.01$).

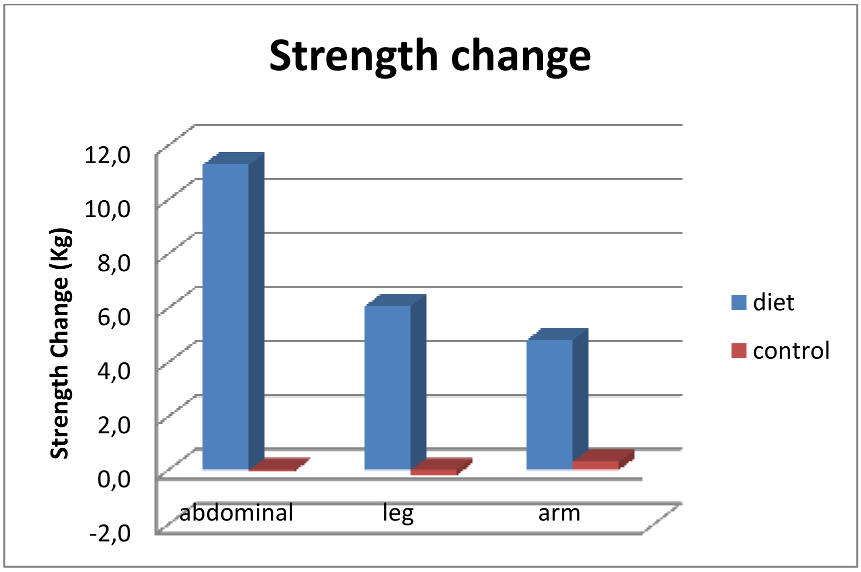


Figure 9: the arm, abdominal and leg strength in the 2 groups of subjects during the 5 measurement periods from the beginning to the end of the study. All data is shown as the average for the entire group +/- the SD.

BMR and fuel use at rest

The average basal metabolic rate and use of fats was not different comparing the data at the beginning and end of the study for the control group ($p>0.05$). For the control group, the basal metabolic rate was 1371 calories per day or 30.1 cc/kg lean body mass with the fuel use at rest consisting of 40.3 % fats. For the diet group, the basal metabolic rate was 1341 calories per day or 28.3 cc/kg lean body mass with the fuel use at rest consisting of 35.4% fats (Figure 10, 11). The data showed a significant correlation between body fat and fat fuel use of -0.51 ($p<0.01$). In other words, the greater the body fat, the more the carbohydrates burned in the BMR. The basal metabolic rate in the investigational group post diet was 1557 calories per day or 31.1 cc/kg lean body mass ($p<0.01$).

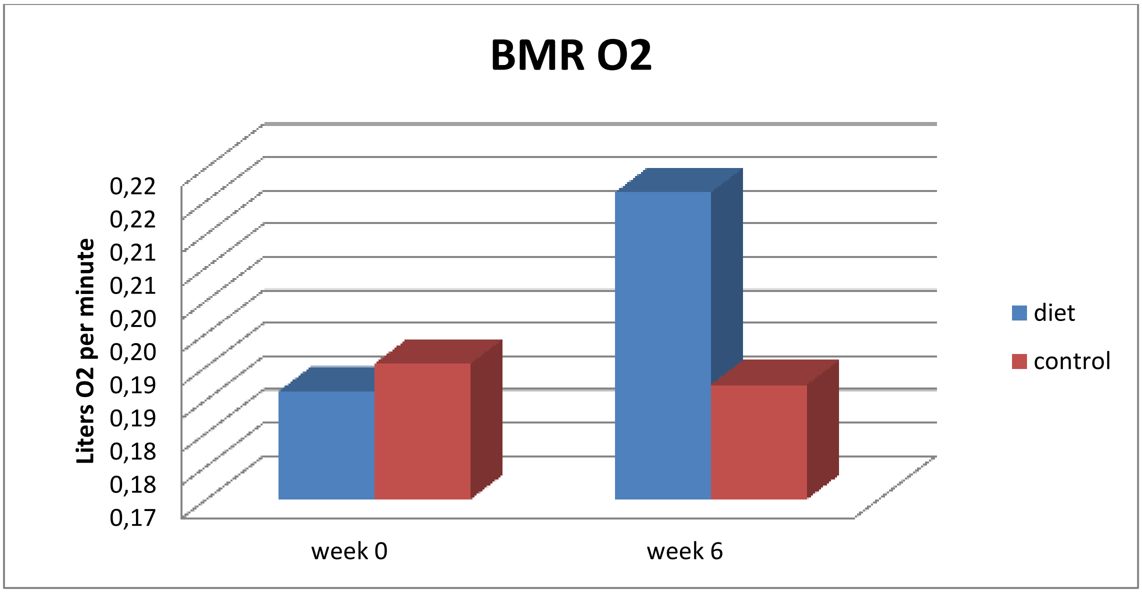
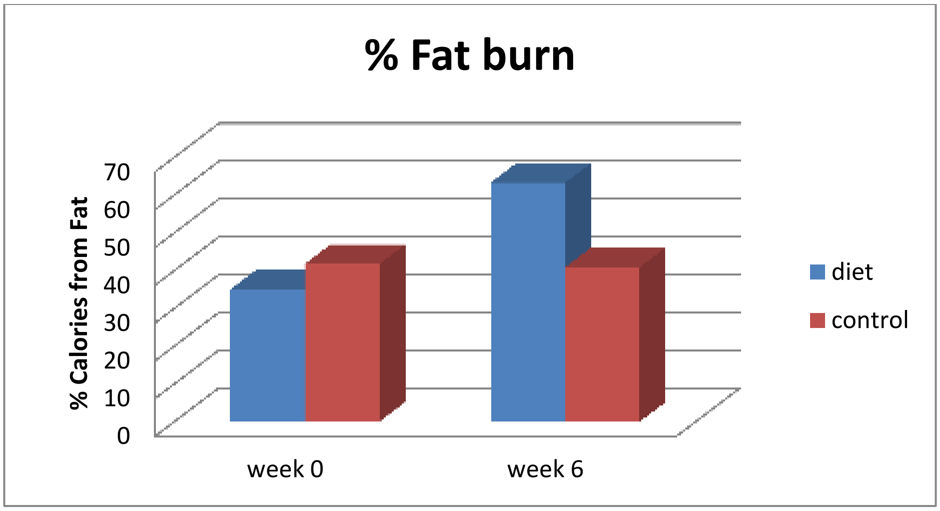


Figure 10: The basal metabolic rate at the beginning and end of the study in the control and investigational groups.

Fuel use also changed toward more burning of fat and less carbohydrates in the investigational group (Figure 11). This change was significant and amounted to an almost double (1.8 times) increase in fat burning ($p<0.01$) when calculated on a percentage basis. When calculated based on fat calories burned it was an increase in fat burning by double (2.1 times). The correlation between fat burned during resting and walking and blood oxygen saturation was significant ($p<0.01$)



Panel A

Figure 11: The fuel use at basal rate at the beginning and end of the study in the control and investigational groups (panel A) and the relationship between fat burning and 02 saturation in the diet group (panel B). The correlation was 0.83 and significant at $p<0.01$.

The correlation between the subject's oxygen saturation and their fat burning at rest was significant. In other words, the higher their blood oxygen saturation, the greater was their use of fat as a fuel. This was seen in both the pre and post diet and exercise condition in the subjects. But the correlation was higher post diet and exercise since the subject group was now more homogeneous in terms of their diet and exercise level as shown in Figure 11B. The correlation was 0.83 and significant at $p<0.01$.

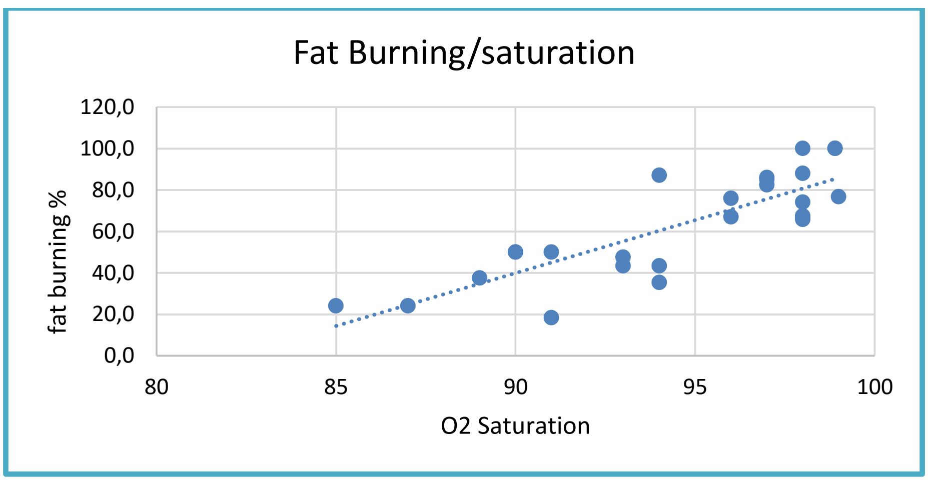


Figure 11B

Hemoglobin saturation at rest and walking

Before diet control data

As shown in Figure 12, saturation was reduced with BMI especially above a BMI of 30. The largest changes occurred for a BMI above 35. For example, at a BMI of 40, the hemoglobin saturation was reduced by about 5% with the subject resting.

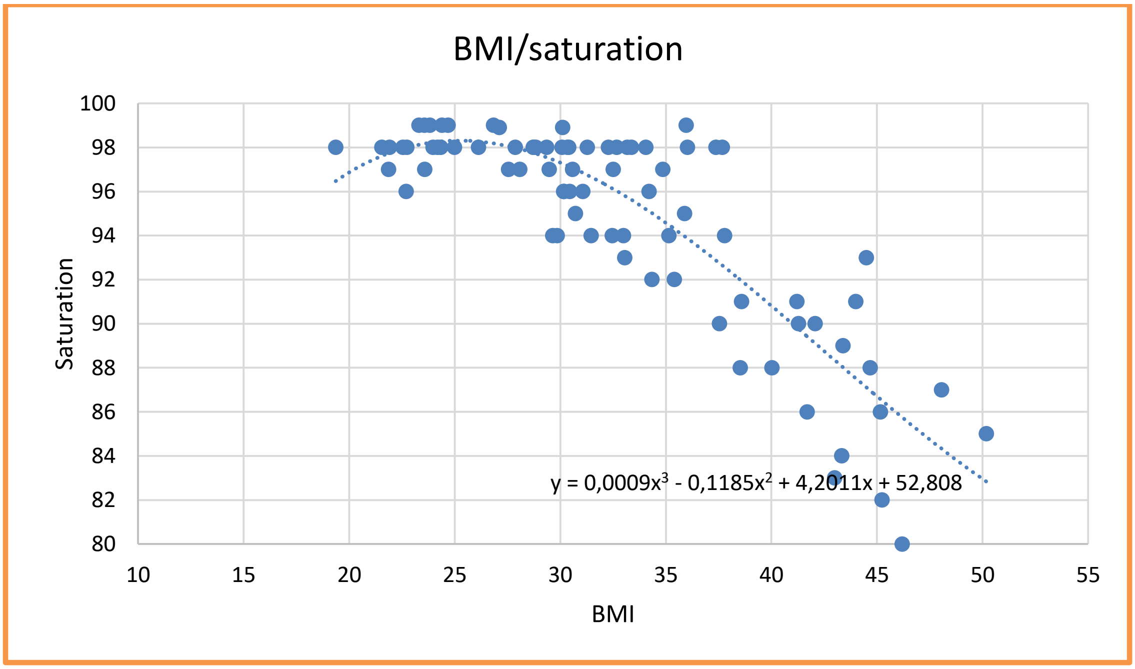


Figure 12: The relationship between oxygen saturation in the finger and BMI with the subject quietly sitting in 81 subjects. The equation of the curve was y=93.87 +.141x-.0058x^2

Data from subjects here is added to a paper by Petrofsky et al 2015.

There was a significant correlation between hemoglobin saturation and the subjects BMI of -.81. This was significant $p<0.001$.
Figure 13 shows the relationship between calculated saturation and BMI after 5 minutes of walking. Saturation was reduced further with exercise.

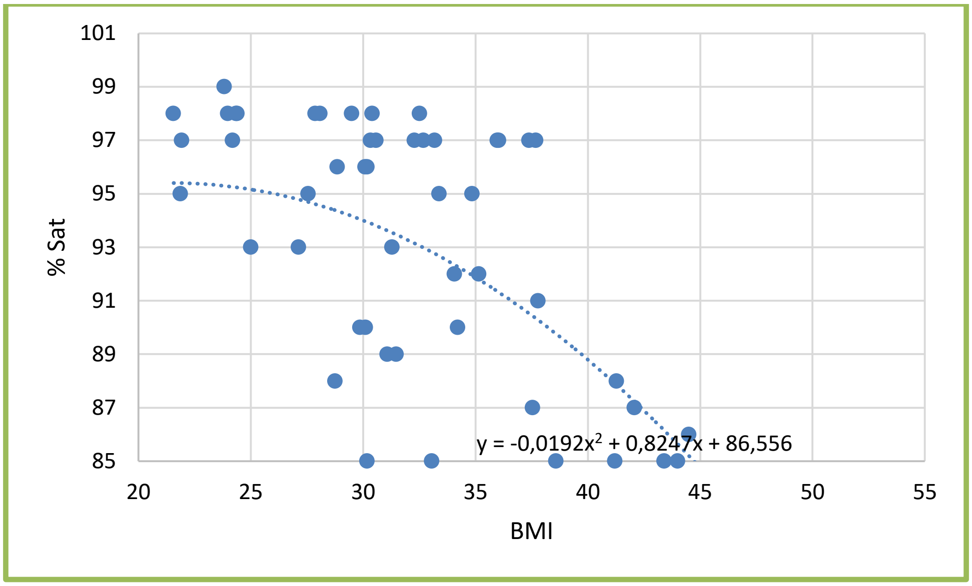


Figure13: The relationship between Hemoglobin saturation in the finger and BMI with the subject walking for 5 minutes.

This was similar to the data during walking. As shown in Figure 14, saturation dropped throughout walking.

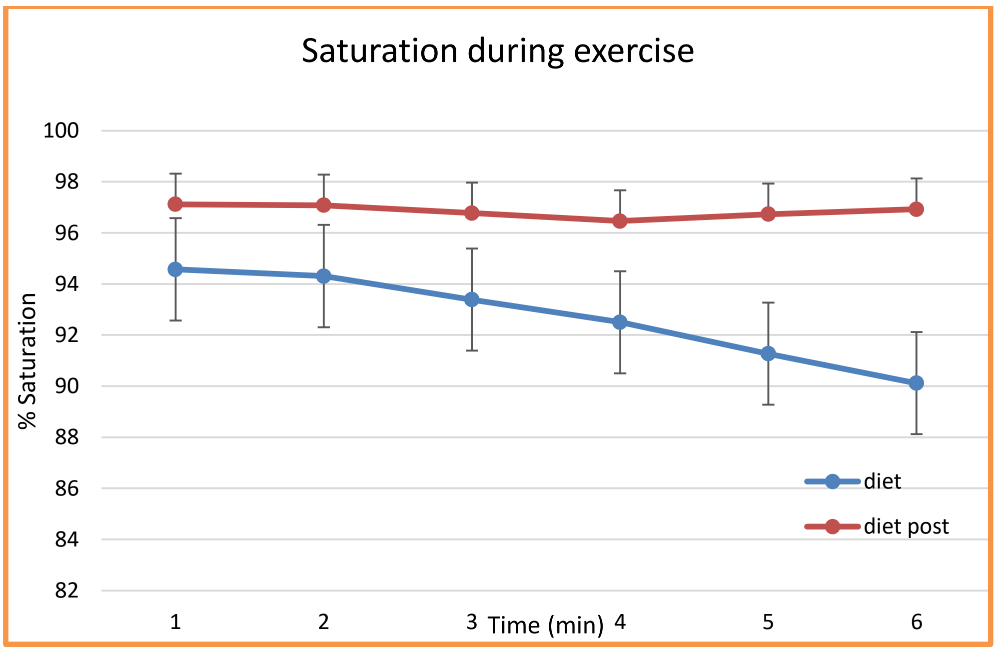


Figure 14: The arterial PO2 in the finger with the subject walking at 3 miles per hour. Data is shown throughout walking in the diet group before and after the 6 week period.

Ventilation before and after the 6 week period

FEV1 and ventilator capacity were measured before and after the 6 week period. The results are shown in Figures 15 and 16. The FEV1 and Ventilation was not statistically different between the beginning and end of the study in the control group ($p>0.05$). For the investigational group, FEV1 averaged 78.8 % of air expired in 1 second at the beginning of the study and 6 weeks later it increased to 84.5% of air expired in 1 second. This increase was significant ($p<0.05$). Ventilation averaged 2.25 liters in the investigational group and significantly increased ($p<0.01$) to 2.46 liters by the end of the study (Figure 16).

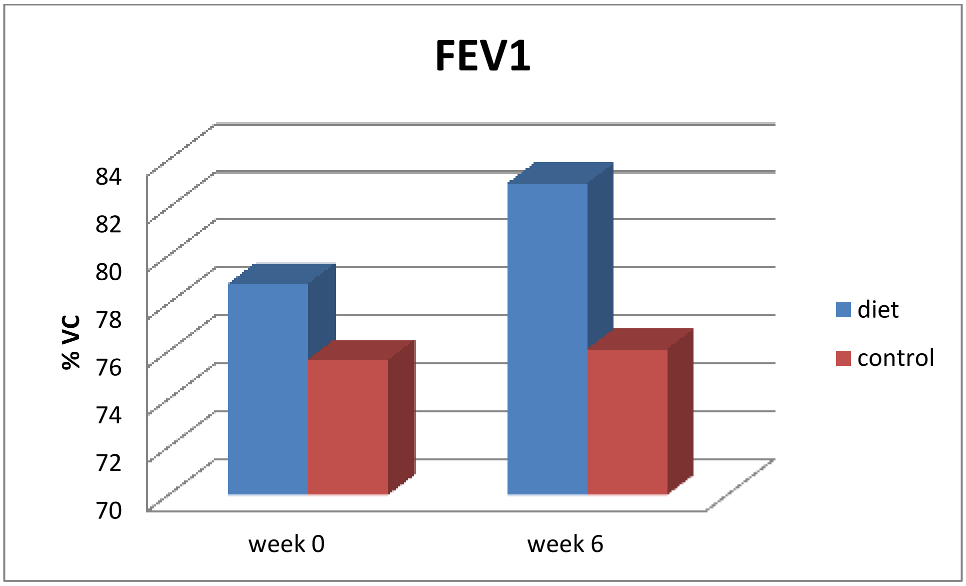


Figure 15: The FEV1 at the beginning and end of the study in the control and investigational groups.

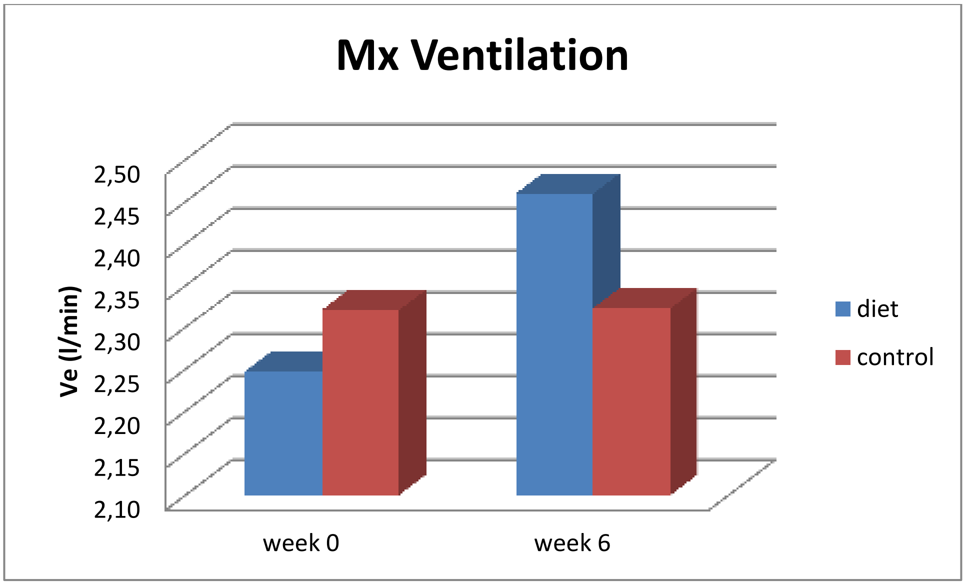


Figure 16: The Maximum Ventilation at the beginning and end of the study in the control and investigational groups.

At Home Lung Fitness Tester

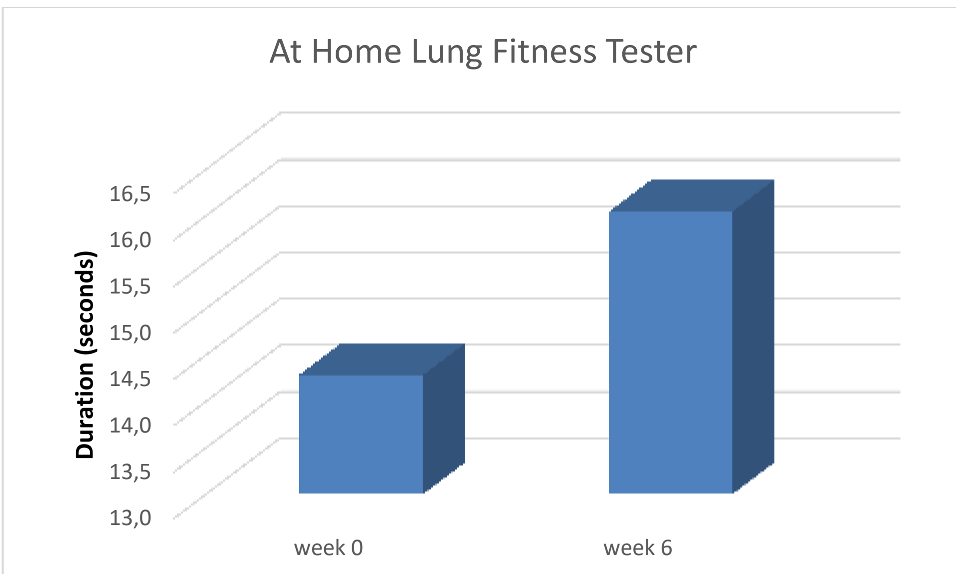


Figure 17: In the investigational group, the time required for the at home lung fitness tester measured at the start and end of the study.

As shown in Figure 17, the length of time, in the diet group, that the Fitness Tester spun was 14.2 seconds at the beginning of the weight loss period. At the end it was 16.1 seconds ($p<0.01$).

Compliance for diet and exercise

The compliance for diet and exercise averaged 68.5 % for the investigational group.

PSQI

The result of the determination of the Pittsburg sleep index is shown in Figure 18 for the 2 groups of subjects.

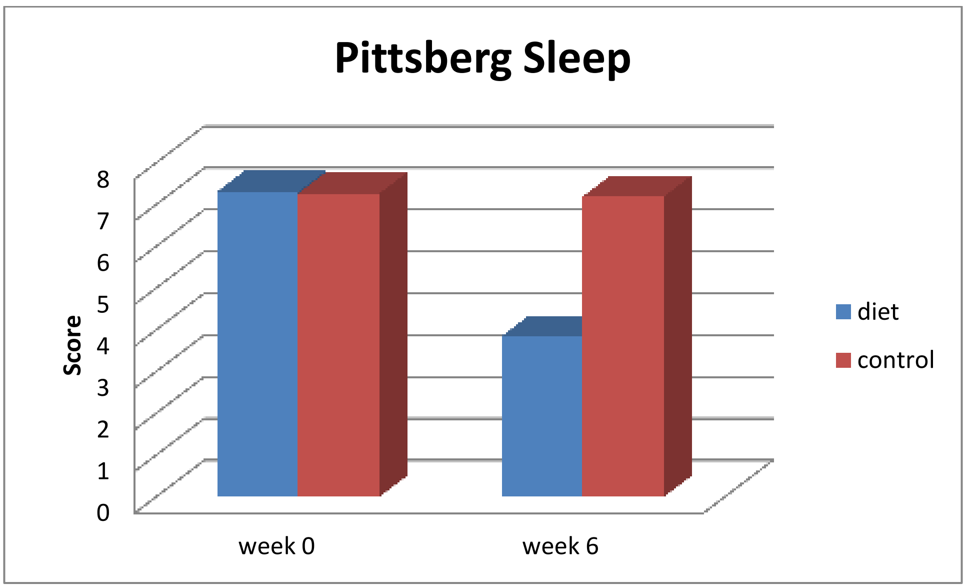


Figure 18: The Pittsburg sleep index in the control and investigation group at the beginning and end of the study. Data is for all of the subjects in each group +/- the SD.

For the control group, there was no significant change in the Pittsburg sleep quality index from the beginning to the end of the study ($p>0.05$). For the diet group, the index was significantly reduced by 47%, an almost 2-fold increase in the ability to sleep. Generally, less than 5 is good sleep quality. At the end of the diet and exercise, the investigational group was good sleep quality and before the study and for the controls, sleep quality was poor.

Heart Rate and Blood Pressure

The heart rate and blood pressure in the controls and investigational groups started at 135/83 and 78 beats per minute and 135/87 and 78 beats per minute respectively at the start of the study period. At the end it was 124/81 and 78 beats per minute in the controls and 130/84 and 80 beats per minute in the investigational group.

7 Discussion

Weight gain for the world population is a reality of the millennium [5]. In all countries in the world, there is a reported increase in obesity. Associated with obesity is an increase in heart disease and associated diseases such as diabetes[5]. While a simple solution would be weight loss and an increase in overall fitness, the solution is never that simple. Programs that promote a change in both lifestyle and diet have been shown to be most effective. A complicating issue is oxygen carriage in the blood [12, 15, 16]. If oxygen saturation drops, then breathing is hard and people fatigue readily and do not want to accomplish exercise [12, 15, 16]. This also alters sleep patterns making people get less sleep and be tired during the next day.

In the present investigation, we combined a lifestyle changing diet and exercise program with yoga breathing to increase oxygen saturation in the blood and allow people to exercise more efficiently and with less fatigue. In the investigational group, the average weight loss was 4.85 KG over the 6 week period, BMI was reduced 1.79 at the end of the 6 weeks, a significant loss ($p<0.01$). Body fat in this group was reduced by 5.87 percent, the average girth at the showed an average loss in circumference of 5.9 cm over the 6 week period. For the hip, the average loss in circumference was 6.28 cm, for the thigh the average loss in circumference in the investigational group was 5.0 cm, and for the upper arm reduced girth by 2.61 cm. For strength for the investigational group, for the abdominals the increase was 11.3 Kg, for the leg it was 6.0 kg and for the arm it was 4.8 kg. All of these increases were significant ($p<0.01$).

For the control group, the basal metabolic rate was 1371 calories per day or 30.1 cc/kg lean body mass with the fuel use at rest consisting of 40.3 % fats. For the diet group, the basal metabolic rate was 1341 calories per day or 28.3 cc /kg lean body mass with the fuel use at rest consisting of 35.4% fats (Figure 10, 11). The basal metabolic rate, in the investigational group after the 6 weeks was 1557 calories per day ($p<0.01$). However, when correcting for the loss in weight and increase in lean body mass in this group, the basal metabolic rate increased to 31.1 cc/kg lean body mass. The fat burning almost doubled in the investigational group as the percentage of fat burned at 6 weeks increased to 63.3% (1.8 times higher). However, since BMR also increased, the calories of fat burned increased by 2.1 times (474 fat calories at the start and vs. 985 fat calories at 6 weeks).

For the exercise group, the average arterial blood gas saturation was 94.31%, decreasing by 4.18% after 5 minutes of walking. After the 6 week period, the resting saturation increased by 2.81% and there was no significant decrease with exercise. FEV1 averaged 78.8 % of air expired in 1 second at the beginning of the study and 6 weeks later it increased to 84.5% of air expired in 1 second. Ventilation averaged 2.25 liters in the investigational group and significantly increased ($p<0.01$) to 2.46 liters by the end of the study. In conclusion, subjects slept better, had high oxygen saturation and better strength and excellent weight and fat loss with this program.

This is in line with other studies. The number of calories burned per day in each group was not different from that predicted by the Mifflin St Jeor Equation[21]:

$$P = \left(\frac{10.0m}{1\ \mathrm{kg}} + \frac{6.25h}{1\ \mathrm{cm}} - \frac{5.0a}{1\ \mathrm{year}} + s \right) \frac{\mathrm{kcal}}{\mathrm{day}},$$

where *s* is +5 for males and −161 for females.

The number of cc of oxygen per minute per kilogram body weight is also in agreement with other studies for subjects at waking[22]. The program caused an increase in both lean body mass and BMR, with an associated increase in fat burning.

Thus a combination of selecting foods based on better nutrition, a light exercise program and breathing exercises has been shown here to cause weight loss and increase strength of key muscles. The most important finding is reversing the effects of Pickwickian syndrome[10]. As cited in the introduction, low arterial po2 that lowers even further during exercise is a major health complication of obesity [9-11]. Low arterial $P0_2$ is a predisposing factor to diabetes, stroke and heart disease [10, 12, 17]. Hypoxia alters metabolism in adipose tissue and increases whole body inflammation, a leading cause of diabetes and cardiovascular disease [23, 24]. Much of the data on whole body inflammation generated by hypoxic fat tissue has come to light in the last 10 years[25]. It is now considered the leading factor in causing diabetes and cardiovascular disease[25]. Higher weight and BMI correlate to higher carbohydrate and lower fat metabolism. Here all of these complications were significantly reversed in just 6 weeks. This program also caused an almost doubling increase in the ability to sleep soundly at night, also lowering the chance of heart disease and stroke. If subjects' stayed on the program longer, based upon the improvement trend shown in the data, it is reasonable to believe that these complications would be reversed even further. In addition, this program increased BMR and increased fat burning at rest, promoting weight loss and health even further.

References

[1] Corey, K.E. and L.M. Kaplan, Obesity and liver disease: the epidemic of the twenty-first century. Clin Liver Dis, 2014. 18(1): p. 1-18.
[2] Reuter, C.P., et al., Prevalence of obesity and cardiovascular risk among children and adolescents in the municipality of Santa Cruz do Sul, Rio Grande do Sul. Sao Paulo Med J, 2013. 131(5): p. 323-30.
[3] Raza, Q., et al., Obesity and Cardiovascular Disease Risk Factors among the Indigenous and Immigrant Pakistani Population: A Systematic Review. Obes Facts, 2013. 6(6): p. 523-35.
[4] Yi, K.H., et al., Prevalence of insulin resistance and cardiometabolic risk in Korean children and adolescents: A population-based study. Diabetes Res Clin Pract, 2013.
[5] Aung, K., et al., Risk of Developing Diabetes and Cardiovascular Disease in Metabolically Unhealthy Normal-Weight and Metabolically Healthy Obese Individuals. J Clin Endocrinol Metab, 2013.
[6] Lee, H.O., et al., The association between measurement sites of visceral adipose tissue and cardiovascular risk factors after caloric restriction in obese Korean women. Nutr Res Pract, 2013. 7(1): p. 43-8.
[7] Chou, W.T., et al., Impact of weight change since age 20 and cardiovascular disease mortality risk: the Ohsaki Cohort Study. Circulation journal : official journal of the Japanese Circulation Society, 2013. 77(3): p. 679-86.
[8] Lugaresi, E., et al., [Polygraphic data on motor phenomena in the restless legs syndrome]. Riv Neurol, 1965. 35(6): p. 550-61.
[9] Lavie, P., On sleepy humans and sleepy rats. J Sleep Res, 2008. 17(4): p. 363-4.
[10] Lavie, P., Who was the first to use the term Pickwickian in connection with sleepy patients? History of sleep apnoea syndrome. Sleep Med Rev, 2008. 12(1): p. 5-17.
[11] Mokhlesi, B., Obesity hypoventilation syndrome: a state-of-the-art review. Respir Care, 2010. 55(10): p. 1347-62; discussion 1363-5.
[12] Mokhlesi, B., M.H. Kryger, and R.R. Grunstein, Assessment and management of patients with obesity hypoventilation syndrome. Proc Am Thorac Soc, 2008. 5(2): p. 218-25.
[13] Strinic, T. and D. Eterovic, Oral contraceptives improve lung mechanics. Fertil Steril, 2003. 79(5): p. 1070-3.
[14] Faria, A.G., et al., Effect of exercise test on pulmonary function of obese adolescents. J Pediatr (Rio J), 2013.
[15] da Silva, R.P., et al., Improvement of exercise capacity and peripheral metaboreflex after bariatric surgery. Obes Surg, 2013. 23(11): p. 1835-41.
[16] Mason, H., et al., Cardiovascular and respiratory effect of yogic slow breathing in the yoga beginner: what is the best approach? Evidence-based complementary and alternative medicine : eCAM, 2013. 2013: p. 743504.

[17] Buysse, D.J., Diagnosis and assessment of sleep and circadian rhythm disorders. J Psychiatr Pract, 2005. 11(2): p. 102-15.
[18] Buysse, D.J., et al., Circadian patterns of sleep, sleepiness, and performance in older and younger adults. Sleep, 2005. 28(11): p. 1365-76.
[19] Hasler, G., et al., Excessive daytime sleepiness in young adults: a 20-year prospective community study. J Clin Psychiatry, 2005. 66(4): p. 521-9.
[20] Leow, M.K., Configuration of the hemoglobin oxygen dissociation curve demystified: a basic mathematical proof for medical and biological sciences undergraduates. Adv Physiol Educ, 2007. 31(2): p. 198-201.
[21] Mifflin, M.D., et al., A new predictive equation for resting energy expenditure in healthy individuals. Am J Clin Nutr, 1990. 51(2): p. 241-7.
[22] Harris, J.A. and F.G. Benedict, A Biometric Study of Human Basal Metabolism. Proc Natl Acad Sci U S A, 1918. 4(12): p. 370-3.
[23] Trayhurn, P., Hypoxia and adipose tissue function and dysfunction in obesity. Physiol Rev, 2013. 93(1): p. 1-21.
[24] Ye, J., Emerging role of adipose tissue hypoxia in obesity and insulin resistance. Int J Obes (Lond), 2009. 33(1): p. 54-66.
[25] Trayhurn, P. and I.S. Wood, Adipokines: inflammation and the pleiotropic role of white adipose tissue. Br J Nutr, 2004. 92(3): p. 347-55.