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ABSTRACT

Objective: While there has been a great deal of research on obstructive sleep apnea and its association with obesity, there is little documentation in the primary literature concerning weight loss and improved physical fitness after medical treatment of obstructive sleep apnea. This study will document the effects of a reduced calorie diet combined with aerobic conditioning and strength training on a subject who has been treated surgically for obstructive sleep apnea.

Methods: The subject participated in a 12-week structured fitness and nutritional program for weight reduction. Pre-program baseline measurements including weight, body mass index (BMI), body fat composition, and waist measurement were established. A pre-program baseline of physical fitness capability was established including a timed 1.5 mile run along with maximum repetitions of specific callisthenic and strength exercises performed with a 2 minute time limit. All physical fitness training activity was recorded, including elapsed times, repetitions, weight levels, and exercise intensity attained. Daily dietary intake, including grams of carbohydrate, protein, and fat, as well as total calories consumed were recorded in a program log. At program completion monitored parameters were analyzed for percent change from baseline.

Results: The dietary calculations revealed an average intake of 1237 total calories per day. This was broken down into 61% carbohydrates, 26% protein, and 13% fat. The subject had a total weight loss of 41 pounds during the 12 week program, corresponding to a 16.5% decrease from a baseline of 248 pounds. BMI was reduced from 37.7 to 31.5, a 16.4% decrease. Body fat percentage was reduced from 36.6% to 28%, a decrease from baseline of 23.5%. Patient's waist size decreased from 42 inches to 36 inches, a decrease

of 14.3% from baseline. The subject decreased his time in the 1.5 mile run from 15:36 to 12:23, a decrease of 20.4% from baseline. The subject improved his 2 minute pushup maximum from 26 to 53, a 104% increase. The number of sit-ups in 2 minutes was increased from 41 to 76, an increase of 85% from baseline.

Conclusion: The subject of the case-study was able to achieve gains in physical fitness as well as weight loss by following a highly structured nutritional plan combined with aerobic conditioning and strength training.

INTRODUCTION

Obstructive sleep apnea (OSA) is a condition in which upper airway collapse causes a reduction or total cessation of respiratory ventilation during sleep. Excessive tissue of the soft palate, large tonsils, and large uvula can all contribute to narrowing of the upper airway. Frequent obstruction of ventilation can lead to a hypoxemic state accompanied by frequent awakenings, preventing the patient from progressing into deeper stages of sleep. Complications arising from OSA can include altered behavior and mood, headaches, pulmonary and systemic hypertension, as well as life-threatening sleep-related arrhythmias and congestive heart failure. When obstructive sleep apnea is accompanied by excessive daytime lethargy, sleepiness, and fatigue, the condition is referred to as obstructive sleep apnea hypopnea syndrome, or OSAHS. There is a high prevalence of OSAHS in the U.S., with an estimated 80% of cases going undiagnosed[1]. Wisconsin Cohort Study data indicates that prevalence of OSAHS is 4% in men and 2% in women[2].

There has been a long-time association between obesity and obstructive sleep apnea. This association may be partly be due to the hormone leptin. Leptin is a protein of 167 amino acids and has a structure similar to cytokines. Leptin is produced mainly in white adipose tissue, and levels of the hormone increase with increasing adipose mass. Among several effects, leptin inhibits the synthesis of hypothalamic neuropeptide Y, which is a potent stimulator of appetite. It appears that obesity may be related to resistance to leptin, resulting in elevated circulating levels of leptin. Recent research also shows a correlation between obstructive sleep apnea and leptin. This research indicates that patients affected by obstructive sleep apnea have higher leptin levels than may be considered normal[3,4].

This discussion suggests an association between obesity, leptin resistance, and obstructive sleep apnea. Despite this demonstration of leptin resistance in obese individuals, subcutaneous injections of leptin in these same patients has led to reduction in fat mass and weight loss[5]. Also, studies have shown that subjects diagnosed with obstructive sleep apnea, when treated with Continuous Positive Airway Pressure (CPAP), displayed significant reduction in leptin levels as well as significant reductions in visceral fat accumulation[6].

Obesity has long been implicated as a risk factor for obstructive sleep apnea and occurs in up to 50% of middle aged individuals[7]. However, this discussion implicates obstructive sleep apnea as a potential contributor to the state of obesity. Not only can appetite stimulation due to decreased leptin sensitivity have an effect on weight control, but the excessive daytime sleepiness, fatigue, and lethargy encountered in OSAHS can also be suggested as a cause of excessive weight gain and reduced fitness levels in affected individuals.

Treatment strategies for obstructive sleep apnea include lifestyle change and weight loss, CPAP, oral appliances that move the tongue and mandible forward, and surgical procedures such as uvulopalatopharyngoplasty (UPPP) to increase upper airway diameter. While weight gain and obesity are highly associated with obstructive sleep apnea, a review of the literature has yielded little information on the effectiveness of weight loss and fitness programs after successful treatment for obstructive sleep apnea.

The purpose of this case study was to investigate the effects of a 12 week treatment program in a 42 year old man after undergoing surgical treatment for obstructive sleep

apnea. The program combined aerobic conditioning and strength training with a strict nutritional plan.

METHODS

Subject

The subject was a 42 year old Caucasian male with a diagnosis of obstructive sleep apnea facilitated by polysomnography in 2 sleep study sessions. A 3 month trial of CPAP was unsuccessful in this subject, so he underwent Uvulopalatopharyngioplasty (UPPP) for surgical correction of obstructive sleep apnea. He has no other past medical history, but has a positive family history of obstructive sleep apnea, with his mother also being affected.

The subject has a long history of athletic involvement as well as exceptional fitness through frequent aerobic conditioning activities combined high intensity resistance training. He was formerly recognized as one of the top high school basketball players in the state of Texas. In his early to late twenties he received consistent ratings of "Outstanding" on Physical Readiness Tests while in the military. The subject slowly gained weight after leaving the military, getting married and having a family. Weight gain was also exacerbated by the progression of obstructive sleep apnea symptoms.

Design

The study was a single case study design. The program was designed so that scheduled activities as well as monitoring of results could be achieved using methods readily available to most people. This included membership to a professional gym for the weight training portion of the program for the 12 week period and the purchase of an impedance body fat analyzer and scale.

Establishment of Baseline Variables

Prior to initiation of the physical fitness and nutritional program, the following were recorded to establish a baseline so that progress can be effectively monitored:

Physical Parameters

- Height
- Total body weight (TBW)*
- Body Mass Index (BMI) calculated*
- Body fat % (BF%) as measured on subjects body impedance analysis scale*
- Waist measurement

* These parameters were recorded or calculated weekly during the program.

Fitness and Strength Parameters

- timed 1.5 mile run*
- maximum repetitions of sit-ups and pushups in 2 minutes

*These parameters were repeated every 4 weeks to document improvement.

Fitness Program

The design of the weight training and conditioning portion of this case study closely followed the program set forth in the book **Body for Life** by Bill Phillips. This fitness program consisted of a weekly 6 day routine for the duration of the study. The specific weekly schedule was as follows:

Monday – Upper body weight training

Tuesday – Aerobic conditioning

Wednesday – Lower body weight training

Thursday – Aerobic conditioning

Friday – Upper body weight training

Saturday – Aerobic conditioning

The next week was similar, but involved lower body weight training on Monday and Friday, and upper body weight training performed on Wednesday. Aerobic conditioning sessions consisted mostly of running, but other exercises including basketball and hiking were substituted as needed.

Nutritional Program

The nutritional portion of the case study was derived from multiple sources. These sources included, but were not limited to:

- **The South Beach Diet** by Arthur Agaston, M.D.
- **8 Weeks to Optimal Health** by Andrew Weil, M.D.
- **My Big Fat Greek Diet** by Nick Yphantides, M.D.
- **Body for Life** by Bill Phillips
- **Sly Moves** by Sylvester Stallone

Briefly, the diet involved 3 daily balanced meals, with a healthy snack in between each meal. Time between meals and snacks was approximately three hours. Specific menu items were recorded, with calories and calorie distribution between carbohydrates, protein, and fat. Meal menus were repeated often, allowing easier maintenance of nutritional content and distribution. Diet included an optional “day off” once a week. Many nutritional programs offer this option as a way to maximize strict adherence to the diet for at least 6 days per week.

Case Study Data Analysis

Of primary interest in this case study were changes observed in body mass index (BMI), total body weight (TBW), and body fat percentage (BF%). Baseline levels of these parameters were established prior to program onset. Repeat measurements occurred weekly until program completion after 12 weeks. At completion of program, percent change from baseline calculations were performed for BMI, TBW, and BF%. Percent change from baseline was also calculated for waist measurement.

Baseline fitness parameters were also established prior to program onset. Measurements were repeated every 4 weeks during the 12 week program to monitor improvement. These parameters were based on Physical Readiness Tests performed by military personnel. Parameters included a timed 1.5 mile run, maximum number of pushups performed in 2 minutes, and maximum number of sit-ups performed in 2 minutes.

Nutritional parameters were analyzed by calculating the mean daily Calorie intake, mean daily carbohydrate intake, mean daily protein intake, and mean daily fat intake.

RESULTS

The subject had a total weight loss of 41 pounds during the 12 week period, corresponding to a 16.5% decrease from a baseline of 248 pounds. BMI was reduced from 37.7 to 31.5, a 16.4% decrease. Body fat percentage was reduced from 36.6% to 28%, a decrease from baseline of 23.5%. See Table 1 for all total body weight, body fat %, and BMI measurements during the program.

Week	Weight	Body Fat%	BMI
Baseline	248	36.6	37.7
1	244	36.2	37.1
2	241	35.9	36.6
3	236	35.6	35.9
4	233	35.4	35.4
5	230	35.2	35.0
6	226	34.5	34.4
7	222	33.8	33.8
8	217	33.2	33.0
9	212	31.5	32.7
10	214	30.1	32.3
11	210	29.3	31.9
12	207	28.7	31.5

Table 1 – Program changes in weight, body fat%, and BMI

Subject decreased his time in the 1.5 mile run from 15:36 to 12:23, a decrease of 20.4% from baseline. The subject improved his 2 minute pushup maximum from 26 to 53, a 104% increase. The number of sit-ups in 2 minutes was increased from 41 to 76, an increase of 85% from baseline. See Table 2 for 1.5 mile run times, pushups in 2 minutes, and sit-ups in 2 minutes.

Week	1.5 mile run	Pushups in 2 min.	Sit-ups in 2 min.
Baseline	15:36	26	41
4	14:47	35	54
8	13:53	42	64
12	12:33	53	76

Table 2 – Program changes in 1.5 mile run, pushups/2 min., and situps/2 min.

Patient's waist size decreased from 42 inches to 36 inches, a decrease of 14.3% from baseline. The dietary calculations revealed an average intake of 1237 total calories/day. This was broken down into 61% carbohydrates, 26% protein, and 13% fat.

DISCUSSION

Patients afflicted by obstructive sleep apnea are continuously subjected to low energy levels, extreme fatigue, and disrupted sleep. These factors can combine to reduce the activity level of patients, leading to increased weight gain, creating a vicious positive feedback cycle of worsening obstructive sleep apnea. This study helps show that healthy improvements are achievable in patients successfully treated for obstructive sleep apnea.

Factors contributing to the success of this program included the subject's ability to strictly adhere to the format of the program. Keeping the program simple created a good environment for compliance. Another option of using highly advanced laboratory measurements of fitness, such as exercise stress test VO2 measurements, as well as physiology lab methods of body fat measurement, while providing valuable data to the study, would have made program compliance much more difficult. This study was designed in a way that any other person wishing to undertake such a program would be able to monitor their progress in a similar fashion.

The subject was able to demonstrate both aerobic and strength improvements by participating in the combined aerobic and strength training regimen. Weight reduction was achieved by combining scheduled exercise sessions with a reduced calorie nutritional diet.

The subject showed improvement in all monitored variables. It is important to note that the improvement in physical fitness and body size criteria set forth in this study should not be attributed to surgical correction of obstructive sleep apnea alone. The

subject in this study participated in a highly structured physical fitness program combined with numerous nutritional adjustments. It is easy to imagine that anyone who followed a similar program, not just former obstructive sleep apnea patients, could achieve similar improvement in their physical status as well. But it also should be pointed out that a subject who still suffers the debilitating effects of obstructive sleep apnea most likely would be unsuccessful in such a program secondary to extreme fatigue and disrupted sleep patterns.

As mentioned previously, most of the primary literature deals with the epidemiology, pathophysiology, complications, treatments, and outcomes of patients diagnosed with obstructive sleep apnea. However, there appears to be many opportunities for continued research in the physical fitness of obstructive sleep apnea patients. Observing health indicators in patients diagnosed with obstructive sleep apnea, and monitoring such factors over time, while undergoing various treatment modalities, may provide some interesting results.

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