

A Dissertation On

**“EFFECT OF BHASTRIKA PRANAYAMA ON ABDOMINAL OBESITY IN
MEN & WOMEN – A RANDOMIZED CONTROLLED TRIAL”**

Submitted by

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The Institutional Ethical Committee of Government Yoga & Naturopathy Medical College and Hospital, Chennai reviewed and discussed the application for approval of “EFFECT OF BHASTRIKA PRANAYAMA ON ABDOMINAL OBESITY IN MEN & WOMEN – A RANDOMIZED CONTROLLED TRIAL”, project work submitted by Dr. A. Jancy Rani, 3rd year M.D.Yoga, Post graduate, Government Yoga and Naturopathy Medical College and Hospital, Chennai.

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LIST OF ABBREVIATIONS USED

SFT	Skin Fold Thickness
W/H Ratio	Waist Hip Ratio
BMI	Body Mass Index
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
PR	Pulse Rate
HR	Heart Rate
RR	Respiratory Rate
BP	Blood Pressure
CG	Control Group
SG	Study Group
FFA	Free Fatty Acids
IL	Inter Leukin
TNF	Tumor Necrosis Factor
DM-2	Diabetes Mellitus-2
CAD	Coronary Artery Disease
ER	Endoplasmic Reticulum

ABSTRACT

Background:

Obesity is a state of excess adipose tissue mass abdominal obesity or central obesity occurs when excessive abdominal fat around the stomach and abdomen there is a strong correlation between central obesity and cardiovascular disease. Obesity is associated with the development of some of the most prevalent diseases of modern society such as Type-II Diabetes Mellitus, hypertension, coronary artery disease, certain forms of cancer, arthritis, renal failure and gall bladder disease, and is associated with high morbidity and mortality.

Generalized obesity measured by Body Mass Index (BMI) is one of the major causes of ill health in the society. However, abdominal obesity, which is closely associated with intra-abdominal fat and measured either by waist circumference or waist-to-hip ratio, predicts subsequent coronary artery disease.

Aim:

This study was planned to evaluate the effect of Bhastrika pranayama on abdominal obesity.

Methods: Sixty [male or female] patients with Abdominal Obesity of age group between 18-45 years will participate in the study. After obtaining informed consent, they will be subjected to be measured for their Height, Weight, BMI, Hip and Waist Circumference and Waist-Hip ratio and Abdominal skin fold thickness.

After obtaining informed consent, the selected patients would be subjected to Yoga Therapy for 10 minutes/twice a day for 60 days, under the supervision of Department of Yoga and Naturopathy, Government Yoga and Naturopathy Medical College, Arumbakkam, Chennai 106.

Results:

Based on the analysis of the results obtained, we can conclude the differences were found in weight, BMI, Skin fold thickness between study group and control group.

Keywords: Bhastrika Pranayama, BMI, Waist hip Ratio, Skin Fold Thickness, Body Mass Index, Abdominal Obesity

Interpretation and conclusion: Two months combined practice of Bhastrika Pranayama in obese individuals showed minimal changes in Waist Hip Ratio and BMI.

TABLE OF CONTENTS

Sl. No.	INDEX	PAGE NO.
1	INTRODUCTON	1
2	AIMS AND OBJECTIVES	7
3	REVIEW OF LITERATURE	8
4	MATERIALS AND METHODS	64
5	RESULTS	79
6	DISCUSSION	83
7	CONCLUSION	85
8	LIMITATIONS	87
9	BIBLIOGRAPHY	88
10	ANNEXURES	102

LIST OF TABLES

TABLE NO.	TOPIC	PAGE NO.
1	WHO Classification of BMI	31
2	Demographic details of the subjects	65
3	List of Primary and Secondary outcome variables	71
4a	Criteria for waist circumference in adults	73
4b	Criteria for waist/hip ratio in adults	73
5	Comparison of variables recorded at the beginning of the yoga program	79
6	Comparison of variables recorded at the end of the yoga program in between the groups	80
7	Comparison of variables after the yoga program in between the yoga and control groups	81

LIST OF FIGURES

FIG. NO.	CONTENTS	PAGE NO.
1	Types of fat	12
2	Panniculus in standing patient	13
3	Types of obesity	15
4	Pathophysiology of Obesity	18
5	Formation of atherosclerotic lesions	19
6	Fat metabolism pathway	22
7	Complication of Obesity	33
8	Benefits of exercise	39
9	Participant practicing Bhastrika Pranayama (individual practice)	49
10	Participant practicing Bhastrika Pranayama (Group Practice)	49
11	Group practice of Bhastrika Pranayama with the principal investigator	50
12	Written consent form	66
13	Calculation of Body Mass Index	67
14	Illustration of Data Points	69
15	Trail Profile	70
16	Picture showing the measurement of Waist-Hip Circumference	74
17	Measurement of Skin-fold Thickness using a Caliper	75

1.0 INTRODUCTION

Obesity condition usually translates into excessive body weight. On the one hand obesity can develop even in the absence of excessive body weight, whereas on the other hand a person (eg, a body builder) can develop remarkable overweight without excessive body fatness.

Interestingly, the word “obesity” (from the Latin **obesitas**) used today in a purely descriptive way, in its etymology, points to the most common behavioral condition leading to obesity, ie overeating. In fact, **obesitas** is the condition of the **obesus** (ie, plump), word that, in turn, is composed of **ob** (ie, over) and **esus**, i.e., the past participle of **edere** (ie, to eat).

Obesity can be classified in several different ways: for example, by BMI intervals and related aggregate risk of mortality, by anatomic phenotypes or by etiologic criteria. According to the World Health Organization (WHO), obesity is classified as class I for a BMI between 30 and 34.9 kg/m², class II for a BMI between 35 and 39.9 kg/m², and class III for a BMI ≥ 40 kg/m²¹. In turn, class I obesity is associated with (hence, labeled as) a “moderate risk”, class II with a “high risk”, and class III with a “very high risk” of mortality². The most common anatomical characterization refers to a prevalently visceral or a prevalently subcutaneous deposition of fat. The ratio of waist circumference to hip

circumference (WHR) has served the purpose of defining the degree of central (i.e., **visceral**) vs. peripheral (i.e., **subcutaneous**) obesity.

Obesity recognized excess accumulation of fats (Resulting in increased weight). Obesity is most commonly caused by a combination of excessive food intake, lack of physical activity, and genetic susceptibility. The prevalence of obesity worldwide is rising caused primarily by genes, endocrine disorders, medications. One important category of obesity not captured by BMI is so-called “abdominal obesity”-the extra fat found around the middle that is an important factor in health, even independent of BMI.

Abdominal obesity is known that visceral adiposity is a major risk factor for metabolic complications of obesity, while subcutaneous fat seems to be much more benign, and in some cases even protective against the development of metabolic complications. Waist–hip ratio was suggested as an additional measure of body fat distribution^{1,26}. In women, BMI was associated with increased risk of systemic diseases; however, waist–hip ratio appeared to be a stronger independent risk factor than BMI.² The simplest and most often used measure of abdominal obesity is waist size. Guidelines generally define abdominal obesity in women as a waist size 35 inches or higher, and in men as a waist size of 40 inches or higher. There are a number of ways to measure body fat. Globally, there are 1.5 billion adults who are either overweight or obese, a number expected to increase to 3 billion by 2030. Obesity in India has reached epidemic proportions in the 21st century, with morbid obesity affecting 5% of the country's population. India is following a trend of other developing countries that are steadily becoming more obese. Obesity is a major

risk factor for cardiovascular disease metabolic disorders³. In addition to inadequate eating habits, a sedentary lifestyle is the main cause of obesity⁴. The point prevalence is higher in women (15%) than in men (11%)⁵. Management of obesity can include lifestyle changes, medications, or surgery. The main treatment for obesity consists of dieting and Yoga. Yoga has an important role to play in the treatment of Obesity. Yoga techniques affect body, internal organs, endocrine glands, brain, mind and other factors concerning Body-Mind complex. Various Yoga techniques can be practiced effectively to reduce the weight and achieve normal healthy condition of Body and Mind. Yoga is a means of balancing and harmonizing the body, mind and emotions. From the physical body, yoga moves on to the mental and emotional levels. Yoga is simply a means of maintaining health and well-being in an increasingly stressful society⁶.

Studies have shown that BMI is a reasonable measure of adiposity given that body weight and stature are simple, inexpensive, safe, and practical measurements to acquire⁷⁻¹². Several population studies suggest that overall BMI increases with age up to the fifth or sixth decade after which BMI declines¹³. The results of the study on “How Useful Is Body Mass Index for Comparison of Body Fatness across Age, Sex, and Ethnic Groups?” demonstrate a strong influence of age and sex, but not of ethnicity, on the relation between BMI and body fatness. These findings should be considered when interpreting BMI results in population studies and when designing clinical trials in which body fatness is a main study variable¹⁴.

Management of obesity can include lifestyle changes, medications, or surgery. The main treatment for obesity consists of dieting and Yoga. Yoga has an important role to play in the treatment of Obesity. Yoga techniques affect body, internal organs, endocrine glands, brain, mind and other factors concerning Body-Mind complex. Various Yoga techniques can be practiced effectively to reduce the weight and achieve normal healthy condition of Body and Mind. Yoga is a means of balancing and harmonizing the body, mind and emotions. From the physical body, yoga moves on to the mental and emotional levels. Yoga is simply a means of maintaining health and well-being in an increasingly stressful society.

The National Centre for Complementary and Alternative Medicine (NCCAM) refers to yoga as a —mind-body medicine, with its use being recommended as a non-pharmacological tool for managing various non-communicable diseases. Yoga which includes various postures (Asanas), breathing techniques (Pranayama), and meditation¹⁸ has been shown to have therapeutic benefits for individuals with a wide range of health conditions.

Generalized obesity measured by body mass index (BMI) is one of the major causes of ill health in the society. However, abdominal obesity, which is closely associated with intraabdominal fat and measured either by waist circumference or waist-to-hip ratio, predicts subsequent coronary artery disease¹⁵.

Obesity is associated with the development of some of the most prevalent diseases of modern society, such as Type-II Diabetes Mellitus, hypertension, coronary artery

disease, certain forms of cancer, arthritis, renal failure and gall bladder disease, and is associated with high morbidity and mortality¹⁶.

In a study conducted on the “Effect of Bhastrika pranayama on waist and hip circumference” in the study group, the waist circumference and hip circumference decreased significantly as compared to that of control group. This shows that Bhastrika pranayama has reducing impact on waist circumference and hip circumference in overweight individuals¹⁷.

In a study conducted on “Yoga in Women With Abdominal Obesity— a Randomized Controlled Trial”, an intensive yoga intervention lasting 8 weeks including women with abdominal obesity reduced participants’ waist circumference, waist-hip ratio, body weight, BMI, and percentage of body fat and increased the percentage of muscle mass. Yoga improved participants’ mental and physical wellbeing and self esteem, and reduced their perceived stress¹⁸.

In a study conducted on “Effect of Bhastrika on selected body composition variables” the results showed significant effect on body fat % and no change was found in control group¹⁹.

In a study conducted on “Effect of yogic asana on body mass index” Yoga group showed a significant improvement after 8 weeks of yogic posture in body mass index²⁰. A study conducted on the “Effect of Yoga and various Asanas on Obesity, Hypertension & Dyslipidemia” showed significant decrease in the parameters of obesity viz. BMI and WHR, significant improvement in hypertension both systolic and diastolic blood

pressure and significant improvement in various lipid profile parameters viz. decrease in total cholesterol, LDL, triglycerides, VLDL and increase in HDL in study group as compared to control group²¹. The study on “Effect of Yoga on Heart Rate, Blood Pressure, Body Mass Index” showed that there was a significant reduction in blood pressure, heart rate, and BMI in the total cohort with yoga. SBP, HR and BMI value shows statistically highly significant ($p < 0.05$)²².

The study on “Effects of Yogic practices on Body Mass Index and Body Fat among Obese Women”, BMI ($p < 0.05$) and percentage of body fat ($p < 0.05$) were significantly decreased in yoga group than the control group. Regular yogic practices resulted beneficial health improvement in obese women by decreasing BMI and percentage of body fat²³. The “Effect of Pranayama on Body Mass Index in Young Medical Students” concluded that Short term pranayama have reducing impact on BMI and also have positive and useful effect on weight reduction in young adults²⁴. Study on “Effect of Bhastrika Pranayama on Body Mass Index and Abdominal Skin fold Thickness” Showed that body mass index and abdominal skin fold thickness is decreased in the subjects from study group as compared to that of control group at the end of 8 weeks²⁵. Although the above mentioned studies reveal the efficacy of various pranayamas on Abdominal Obesity, this study implies the effect of Bhastrika Pranayama on Abdominal Obesity.

2.0 AIMS AND OBJECTIVES

2.1 Aim

The aim of this study was to assess the effect of Bastrika pranayama changes in the Abdominal obesity in men and women.

2.2 Objectives of the study

The objectives of the present study are:

- To record the BMI, Skin Fold Thickness (SFT) and Waist-Hip ratio before and after intervention
- To record the Resting Cardio-respiratory parameters before and after intervention

3.0 REVIEW OF LITERATURE

3.1 Obesity

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have a negative effect on health. Obesity is a leading preventable cause of death worldwide, with increasing rates among adults and children.

3.2 Causes of Obesity

The balance between calorie intake and energy expenditure determines a person's weight. If a person eats more calories than he or she burns (metabolizes), the person gains weight (the body will store the excess energy as fat). If a person eats fewer calories than he or she metabolizes, he or she will lose weight. Therefore the most common causes of obesity are overeating and physical inactivity. Ultimately, body weight is the result of genetics, metabolism, environment, behavior, and culture.

3.2.1 Genetics

A person is more likely to develop obesity if one or both parents are obese. Genetics also affect hormones involved in fat regulation. For example, one genetic cause of obesity is leptin deficiency. Leptin is a hormone produced in fat cells and also in the placenta. Leptin controls weight by signaling the brain to eat less when body fat stores are too high. If, for some reason, the body cannot produce enough leptin or leptin cannot signal

the brain to eat less, this control is lost, and obesity occurs. The role of leptin replacement as a treatment for obesity is currently being explored.

3.2.2 Overeating

Overeating leads to weight gain, especially if the diet is high in fat. Foods high in fat or sugar (for example, fast food, fried food, and sweets) have high energy density (foods that have a lot of calories in a small amount of food). Epidemiologic studies have shown that diets high in fat contribute to weight gain.

A diet high in simple carbohydrates The role of carbohydrates in weight gain is not clear. Carbohydrates increase blood glucose levels, which in turn stimulate insulin release by the pancreas, and insulin promotes the growth of fat tissue and can cause weight gain. Some scientists believe that simple carbohydrates (sugars, fructose, desserts, soft drinks, beer, wine, etc.) contribute to weight gain because they are more rapidly absorbed into the bloodstream than complex carbohydrates (pasta, brown rice, grains, vegetables, raw fruits, etc.) and thus cause a more pronounced insulin release after meals than complex carbohydrates. This higher insulin release, some scientists believe, contributes to weight gain.

Frequency of eating The relationship between frequency of eating (how often you eat) and weight is somewhat controversial. There are many reports of overweight people eating less often than people with normal weight. Scientists have observed that people who eat small meals four or five times daily, have lower cholesterol levels and lower

and/or more stable blood sugar levels than people who eat less frequently (two or three large meals daily). One possible explanation is that small frequent meals produce stable insulin levels, whereas large meals cause large spikes of insulin after meals.

The primary sources of these extra carbohydrates are sweetened beverages, which now account for almost ²⁷ percent of daily food energy in young adults in America²⁸ and potato chips.²⁹ Consumption of sweetened drinks such as soft drinks, fruit drinks, iced tea, and energy and vitamin water drinks is believed to be contributing to the rising rates of obesity^{30,31} and to an increased risk of metabolic syndrome and type 2 diabetes.³⁰ Vitamin D deficiency is related to diseases associated with obesity.³²

3.2.3. Physical inactivity

Sedentary people burn fewer calories than people who are active. The National Health and Nutrition Examination Survey (NHANES) showed that physical inactivity was strongly correlated with weight gain in both sexes.

3.2.4 Medications

Medications associated with weight gain include certain antidepressants (medications used in treating depression), anticonvulsants (medications used in controlling seizures such as carbamazepine [Tegretol, Tegretol XR, Equetro, Carbatrol] and Valproate [Depacon, Depakene]), some diabetes medications (medications used in lowering blood sugar such as insulin, sulfonylureas, and thiazolidinediones), certain hormones such as oral contraceptives, and most corticosteroids such as prednisone.

Weight gain may also be seen with some high blood pressure medications and antihistamines. The reason for the weight gain with the medications differs for each medication. If this is a concern for you, you should discuss your medications with your physician rather than discontinuing the medication, as this could have serious effects.

3.2.5 Psychological factors

For some people, emotions influence eating habits. Many people eat excessively in response to emotions such as boredom, sadness, stress, or anger. While most overweight people have no more psychological disturbances than normal weight people, about 30% of the people who seek treatment for serious weight problems have difficulties with binge eating.

Diseases such as hypothyroidism, insulin resistance, polycystic ovary syndrome, and Cushing's syndrome are also contributors to obesity.

3.2.6 Social issues

A link between social issues and obesity has been established. Lack of money to purchase healthy foods or lack of safe places to walk or exercise can increase the risk of obesity.

3.3 Types of Obesity

Fat is known to have two main purposes, says Susan Fried, Director of Boston Obesity and Nutrition research Centre at Boston University.

Fat stores excess calories in a safe way to mobilize the fat stores and fat releases the hormones that control metabolism.

There are various types of fat as follows Brown, White, Subcutaneous, Visceral and belly fat.

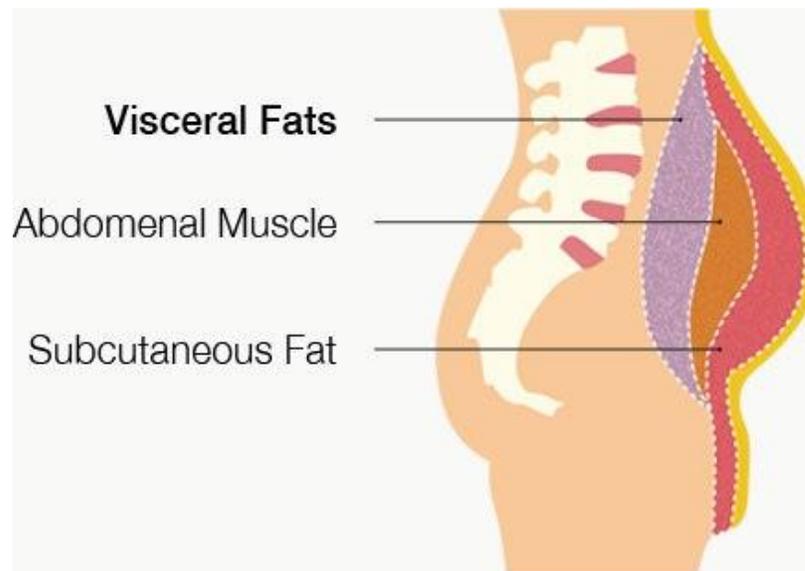


Figure 1 Types of fat

3.3.1 Subcutaneous Fat

That pinchable fat is soft belly fat, also known as subcutaneous adipose fat located just below the skin and intramuscular fat tissue that is deployed within the skeletal muscle, acts as insulation and a source of energy for your body.

In the lower abdominal area, panniculus adiposus is the fatty layer of the subcutaneous tissues, superficial to a deeper vestigial layer of muscle, the panniculus carnosus.³³

Panniculus, sometimes referred to incorrectly as FUPA (Fat Upper Pelvic Area) or pannus, is a medical term describing a dense layer of fatty tissue growth, consisting of subcutaneous fat in the lower abdominal area.



Figure 2 Panniculus in standing patient

Panniculi can form after rapid weight loss, as seen with strict exercise plans - in this case, the abdominal fat is successfully reduced, but excess skin is left behind which hangs loosely over the area. It can be a result of obesity and can be mistaken for a tumor or hernia. Abdominal panniculus can be removed during abdominal panniculectomy, a type of abdominoplasty. A panniculus can also be the result of loose tissues after pregnancy or massive weight loss.³⁴

3.3.2 Visceral Fat

Visceral fat is also called hard belly fat or central obesity, is located deep in your abdominal cavity around the vital organs (liver, heart, kidneys). Intra-abdominal or

visceral fat has been associated with the deleterious effects on human health. Visceral obesity is the most dangerous fat than subcutaneous fat. The main negative effect of the lower sensitivity to insulin, a hormone that helps glucose to enter the body's cells i.e diabetes type 2 diabetes^{35,36}, inflammatory diseases³⁷. More obvious physiological abnormalities of visceral obesity which include – high triglycerides, high blood pressure, high blood sugar and low HDL (good cholesterol) under a single term – metabolic syndrome. Visceral obesity increases risk for cardiovascular disease. Among the deposits of fat, visceral fat is the most active, and mobilize substances secreted in the greatest quantities, releases a lot of fatty acids (products of degradation of fats) in the bloodstream.

3.3.3 Inactivity Obesity

Lack of physical activity can cause overweight in this type of obesity, trunk parts of the body quickly gain fat and become unhealthy.

3.3.4 Android Obesity or Food Obesity

In this type of obesity the body's extra fat gets distributed over the abdominal region of the body of the obese individual and the person's body's shape seems to be apple shaped. If the body mass index for any person is 30 or more, then he or she has android obesity disease. If you overindulge in unhealthy foods you suffer from food obesity, excessive sugar intake can also cause food obesity, which lead to accumulation of fat around the middle part of the body.

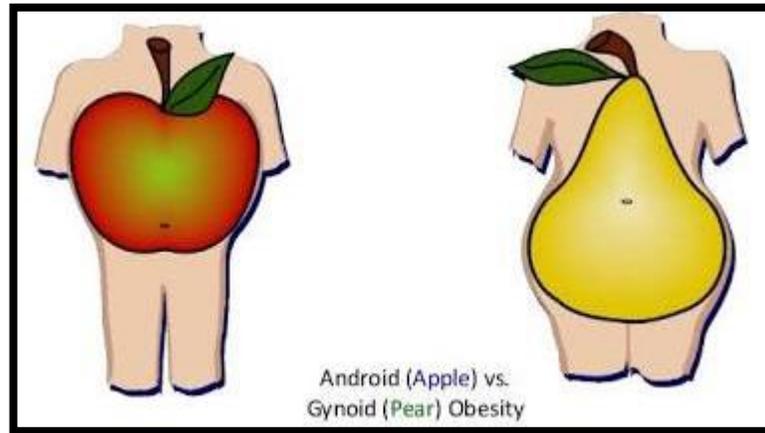


Figure 3 Types of obesity

3.3.5 A Gynoid (or Pear Shaped)

This body type is typically defined as a rounder lower half of the body, with more fat deposited in the hips, buttocks and thighs. Anxiety or depression can often lead to overeating and accumulation of fat in the body, since the body must constantly survive in fight or flight mode. To treat this type of obesity, you must control your anxiety.

3.3.6. Venous Obesity

Its cause is genetic in nature, rather than habitual in nature. If anyone in your family suffers from venous circulation, you run the risk of the same condition. This type of obesity is particularly common in pregnancy. Exercise is the best solution for this problem.

3.3.7 Atherogenic obesity

People whose fat tends to accumulate in the stomach area often suffer from atherogenic obesity. This is a particularly dangerous condition since it can affect your other organs and lead to breathing problems. It is extremely important to avoid drinking alcohol if you have atherogenic obesity.

3.3.8 Gluten Obesity

No stranger to many health problems that gluten can actually cause obesity. This type of weight gain is most common in women. It is often spotted during the periods of hormonal change like puberty, pregnancy and menopause. The accumulation of muscle mass through activities like lifting weights is the most effective treatment for this condition to combat gluten obesity. In all cases it comes down to the same basic concepts: decreasing your calorie-intake, increasing your physical activity, avoiding alcohol and smoking.

3.4 Obesity Prevalence

Globally, there are 1.5 billion adults who are either overweight or obese, a number expected to increase to 3 billion by 2030. Obesity in India has reached epidemic proportions in the 21st century, with morbid obesity affecting 5% of the country's population. India is following a trend of other developing countries that are steadily becoming more obese. Obesity is a major risk factor for cardiovascular disease and metabolic disorders. In addition to inadequate eating habits, a sedentary lifestyle is the main cause of obesity. The point prevalence is higher in women (15%) than in men (11%).³⁸

3.5 Obesity Pathophysiology

3.5.1 Role of Lipotoxicity and Inflammation on Obesity

White adipose tissue (WAT) releases pre-fatty acids and adipokines, which are lipotoxic and inflammatory and result in diverse effects, outlined in the left-hand columns. Their correlation to the metabolic syndrome is shown on the right-hand column, whereas all the effects culminate in atherosclerosis are in the bottom of the figure.

The excessive fatty acids from lipolysis, which is stimulated by the enhanced sympathetic state existing in obesity. The release of these excessive free fatty acids then incites lipotoxicity, as lipids and their metabolites create oxidant stress to the endoplasmic reticulum and mitochondria. This affects adipose as well as non-adipose tissue, accounting for its patho-physiology in many organs, such as liver and pancreas, and in the metabolic syndrome.^{39,40} The free fatty acids released from excessively stored triacylglycerol deposits also inhibit lipogenesis, preventing adequate clearance of serum triacylglycerol levels that contribute to hypertriglyceridemia.

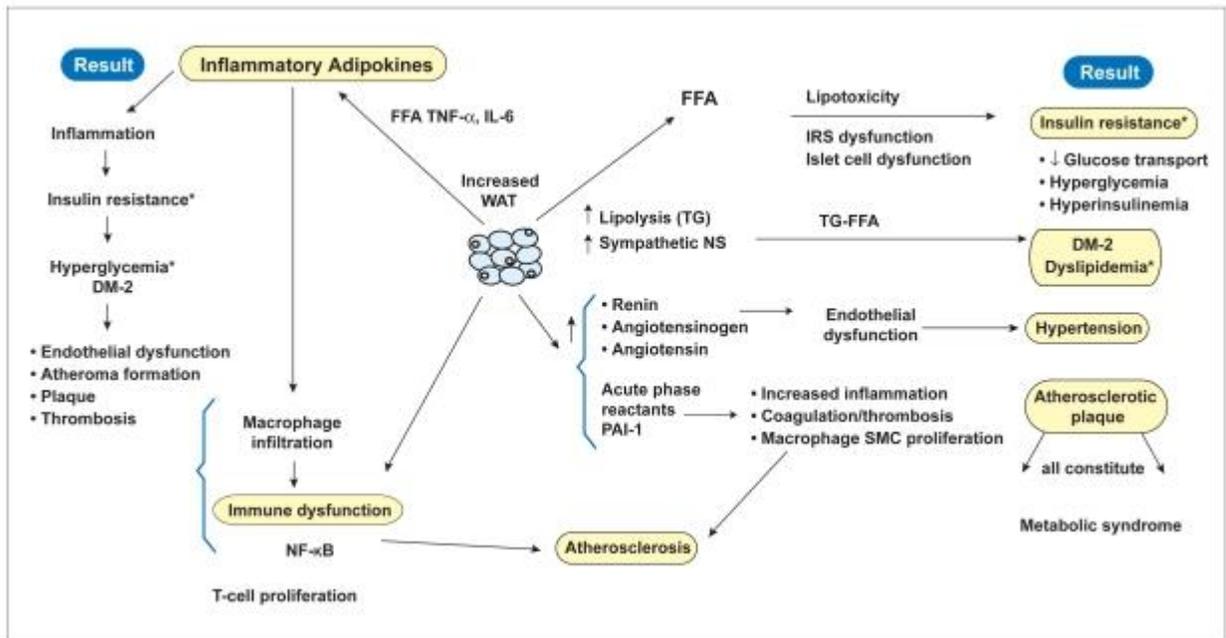


Figure 4 Pathophysiology of Obesity

Release of free fatty acids by endothelial lipoprotein lipase from increased serum triglycerides within elevated β lipoproteins causes lipotoxicity that results in insulin-receptor dysfunction. The consequent insulin-resistant state creates hyperglycemia with compensated hepatic gluconeogenesis. The latter increases hepatic glucose production, further accentuating the hyperglycemia caused by insulin resistance. Free fatty acids also decrease utilization of insulin-stimulated muscle glucose, contributing, further to hyperglycemia.^{41,42} Lipotoxicity from excessive free fatty acids also decreases secretion of pancreatic β -cell insulin, which eventually results in β -cell exhaustion.⁴³

3.5.2 Role of inflammation and immune dysfunction in obesity

The immune dysfunction (left column) and inflammation (center column with arrows) are correlated with atherosclerotic lesions (right column).

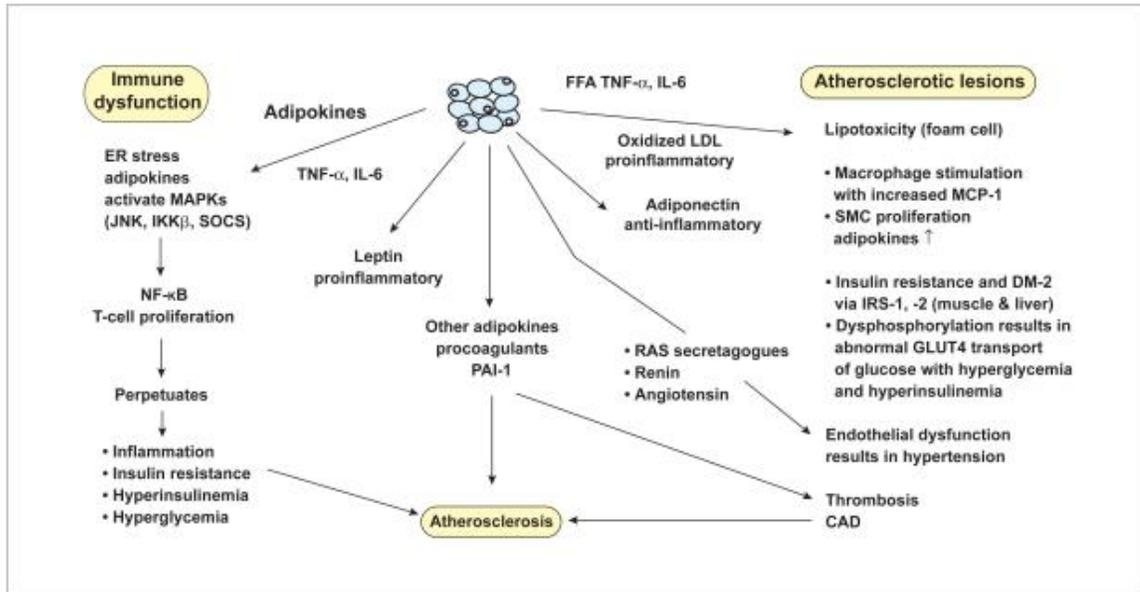


Figure 5: Formation of atherosclerotic lesions

Abdominal obesity, due to intra-abdominal adiposity, changes the secretion of adipokines. This occurs both through altered secretion of adipocyte-derived biologically active substances (adipokines), including free fatty acids, adiponectin, interleukin-6, tumour necrosis factor alpha, and plasminogen activator inhibitor-1.

3.5.2.1 Adiponectin

Key properties of adiponectin is to promote anti-atherogenic effect, reduce risk of developing diabetes, reduce differentiation of macrophages into foam cells, reduce

atherogenic vascular remodelling, reduce hepatic glucose output, increase insulin sensitivity. In abdominal obesity secretion of adiponectin reduces and due to it insulin sensitivity decreases i.e. risk of diabetes increases, differentiation of macrophages into foam cells getting increases, atherogenic vascular remodelling increases hepatic glucose output increases.^{44,45}

3.5.2.2 IL-6: Interleukin-6

Key properties of IL-6 is to promote inflammation, promote pro-atherogenic effect, promote diabetes, increase Vascular inflammation, increase Hepatic C-reactive protein production, reduce Insulin signaling. In abdominal obesity secretion of IL-6 increases and due to it Insulin signalling reduces i.e., risk of diabetes increases, risk of inflammation increases.⁴⁶⁻⁴⁸

3.5.2.3 TNFa: tumour necrosis factor alpha

Properties of TNFa are Pro-atherogenic/pro-diabetic effect ie. decrease in Insulin signaling, increase in secretion of other pro-inflammatory mediators. In abdominal obesity secretion of TNFa increases and due to that Insulin signaling reduces ie. risk of diabetes increases and risk of inflammation increases.^{46,47,48}

3.5.2.4 C-reactive protein

Properties of C-reactive protein is to promote inflammation, promote pro-atherogenic effect, promote chronic low-grade inflammation predict adverse cardiovascular

outcomes. In abdominal obesity secretion of C-reactive protein increases and due to that risk of inflammation increases.^{46,47,49}

3.5.2.5 PAI-1 (plasminogenactivator inhibitor-1)

Its Properties are to promote Pro-atherogenic effect and pro-coagulant effect, increase Atherothrombotic risk. In abdominal obesity secretion of PAI-1 increases the risk of Atherosclerosis.^{46,47}

3.6 Physiology of Fat Metabolism: Overview and Synthesis

3.6.1 Pathways of the Fat System

Lipolysis: hydrolysis of triacylglycerol to glycerol and free fatty acids

β -Oxidation: mitochondrial oxidation of fatty acids -----ENERGY!

Ketogenesis: synthesis of ketone bodies

Lipogenesis: fatty acid synthesis

Esterification: attachment of fatty acids to glycerol to form triglycerides

Cholesterolgenesis: synthesis of cholesterol

Steroidogenesis: synthesis of steroid hormones from cholesterol

3.6.2 Interactions of Fat Metabolism Pathways

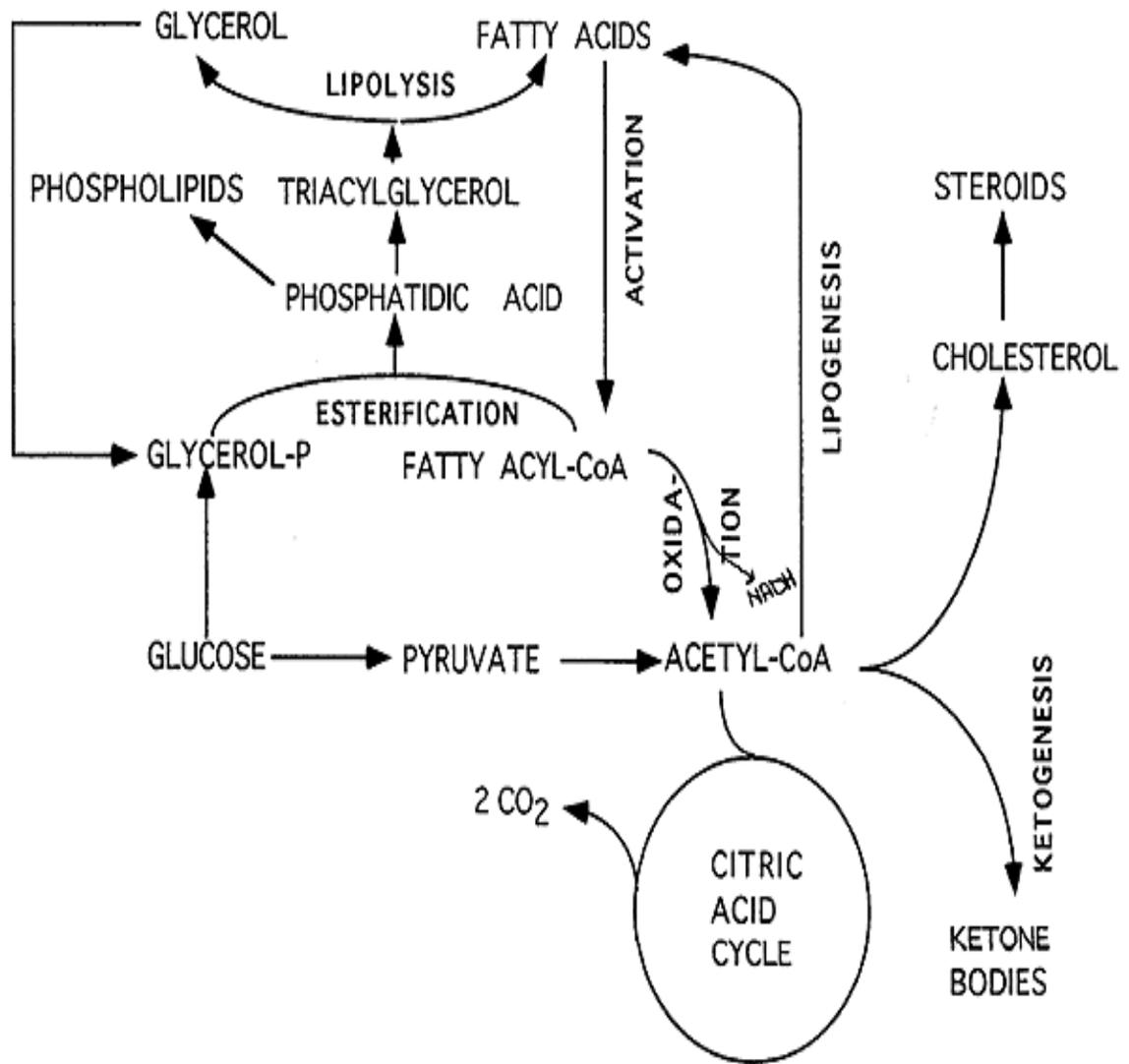
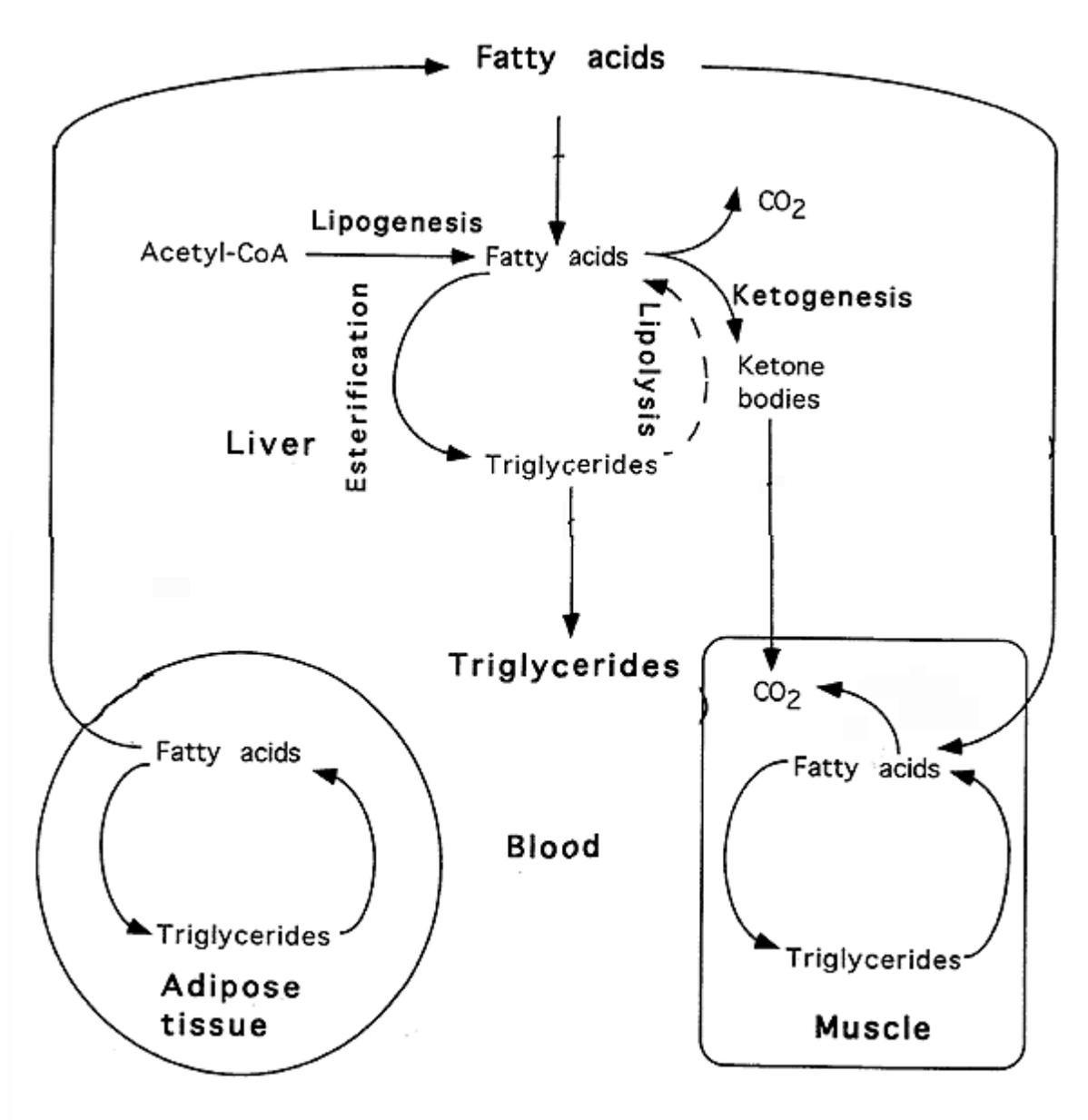


Figure 6: Fat metabolism pathway

3.6.3 Fat Metabolism in Specific Tissues



Liver: oxidizes fats, produces ketones, exports triglycerides

Muscle: uses fats and ketones as an energy source

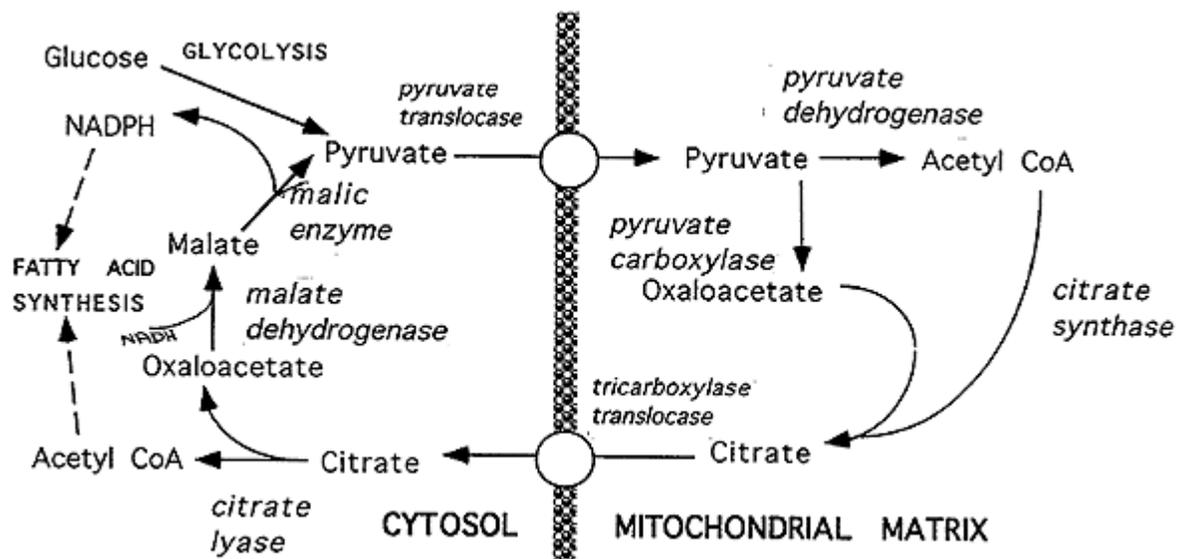
Adipose Tissue: stores fats as triacylglycerol and releases fatty acids as needed for energy

Mature RBC's (no mitochondria) / **Brain** (lack of enzymes): do not use fats for energy

3.6.4 Fatty Acid Synthesis (Lipogenesis)

Export of Acetyl CoA for Fatty Acid Biosynthesis

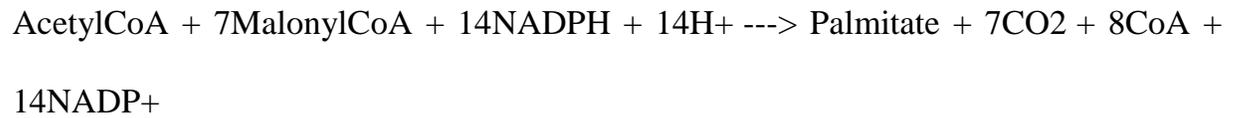
$\text{AcetylCoA}_{\text{mit}} + 2\text{ATP} + \text{NADH} + \text{NADP}^+ \rightarrow \text{AcetylCoA}_{\text{cyt}} + 2\text{ADP} + 2\text{P}_i + \text{NAD}^+ + \text{NADPH}$



AcetylCoA Carboxylase: $\text{Acetyl CoA} + \text{HCO}_3^- + \text{ATP} \rightarrow \text{Malonyl CoA}$

Committed Step, Highly Regulated

Fatty Acid Synthase:



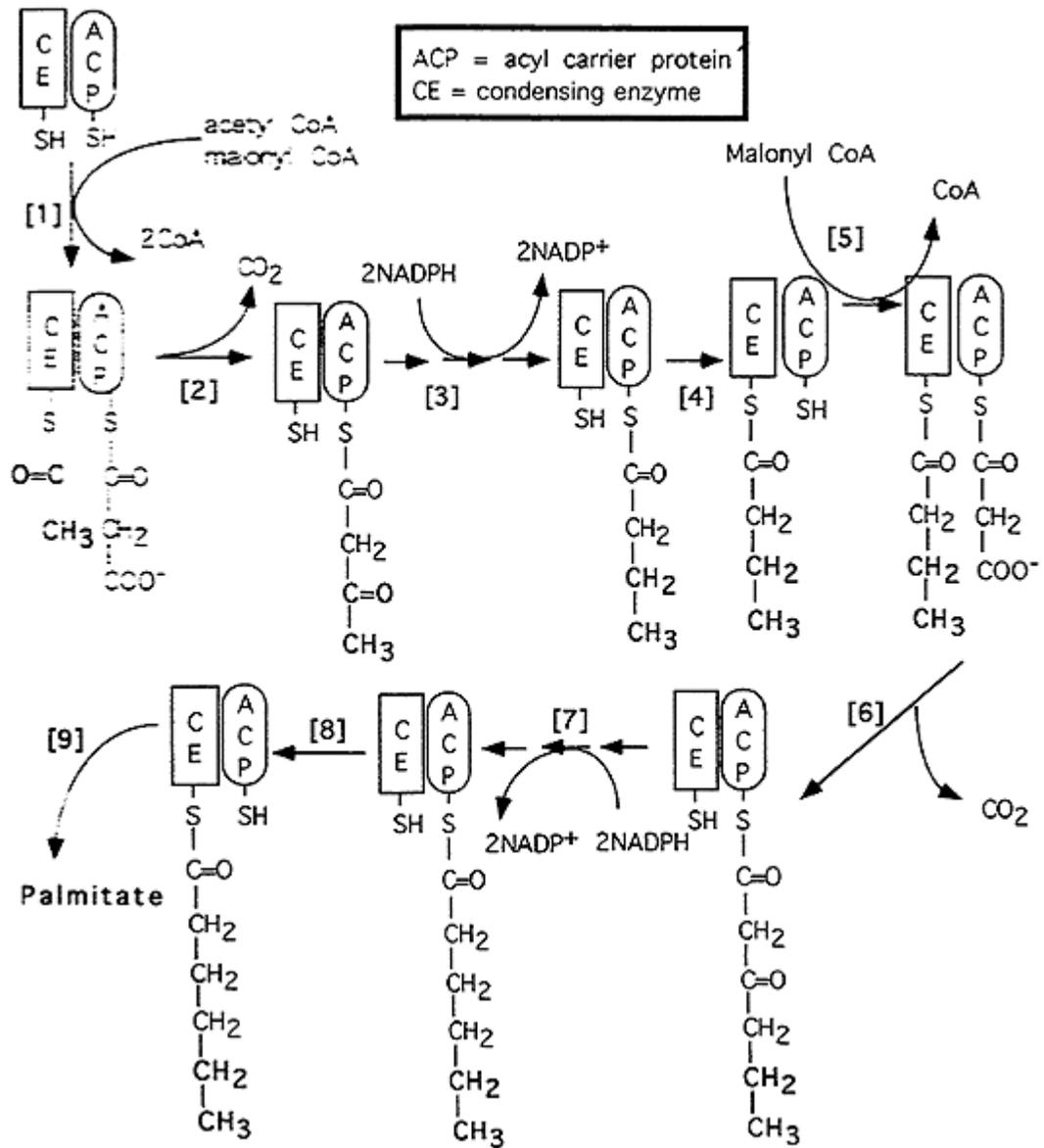
Dimeric Enzyme: each monomer has 7 enzyme activities

Primary Product: palmitic acid

Purpose: process the fatty acid chain through 7 cycles to produce the 16-C product; 4 C's are introduced in the first cycle from Acetyl CoA and Malonyl CoA; subsequent cycles 2 C units are derived from Malonyl CoA following the release of CO₂

ACP = Acyl Carrier Protein

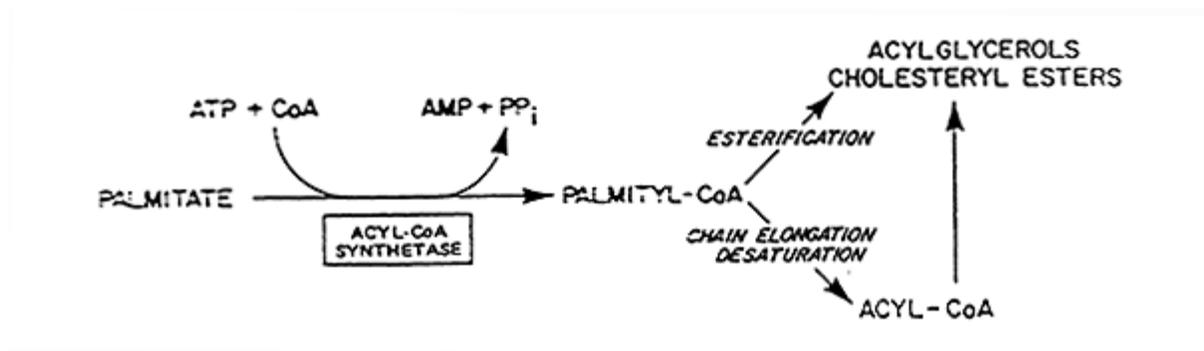
CE = Condensing Enzyme



- ACP on one monomer is in close proximity to CE on the other monomer. The initial steps result in attachment of an acetyl group from acetyl CoA on CE and the malonyl group from malonyl CoA on ACP.
- The acetyl group on CE condenses with the malonyl residue on ACP with the release of CO₂.

- The ACP bound intermediate undergoes reduction by NADPH, dehydration, second reduction (NADPH).
- The 4 C fatty acid is transferred to the CE preparing the ACP for attachment of a second malonyl CoA.
- Malonyl CoA donates a malonyl group to ACP (as previously described).
- The 4 C group from CE condenses with the second malonyl residue with release of CO₂.
- Reduction (NADPH), dehydration, second reduction (NADPH).
- The cycle is completed with the transfer of the growing hydrocarbon chain to CE.
- The process continues for 5 more cycles ([4] through [7]) with successive two C additions. Once a palmitoyl group is formed on ACP it is cleaved by thioesterase releasing palmitic acid (palmitate).

3.6.5 Acyl-CoA Synthetase



Elongation: microsomal process (ER), requires malonylCoA and two NADPH, process is similar to that occurring with fatty acid synthase.

Unsaturation: microsomal process, reduction with NADPH or NADH, molecular oxygen is required.

3.6.6 Regulation of Lipogenesis

<u>Enzyme</u>		<u>Regulatory agent</u>	<u>Effect</u>
Acetyl CoA carboxylase	Short-term	Insulin	Stimulation
		Glucagon	Inhibition
	Long-term	High-carbohydrate, low-fat diet	↑ enzyme synthesis
		High-fat diet	↓ enzyme synthesis
		Fasting	↓ enzyme synthesis
Fatty acid synthase		High-carbohydrate, low-fat diet	↑ enzyme synthesis
		High-fat diet	↓ enzyme synthesis
		Fasting	↓ enzyme synthesis

3.6.6.1 Conditions Favoring Lipogenesis

increased glucokinase activity in liver - *increases metabolism of glucose as a fatty acid precursor*

decreased fatty acid availability - *reduces inhibition of lipogenesis*

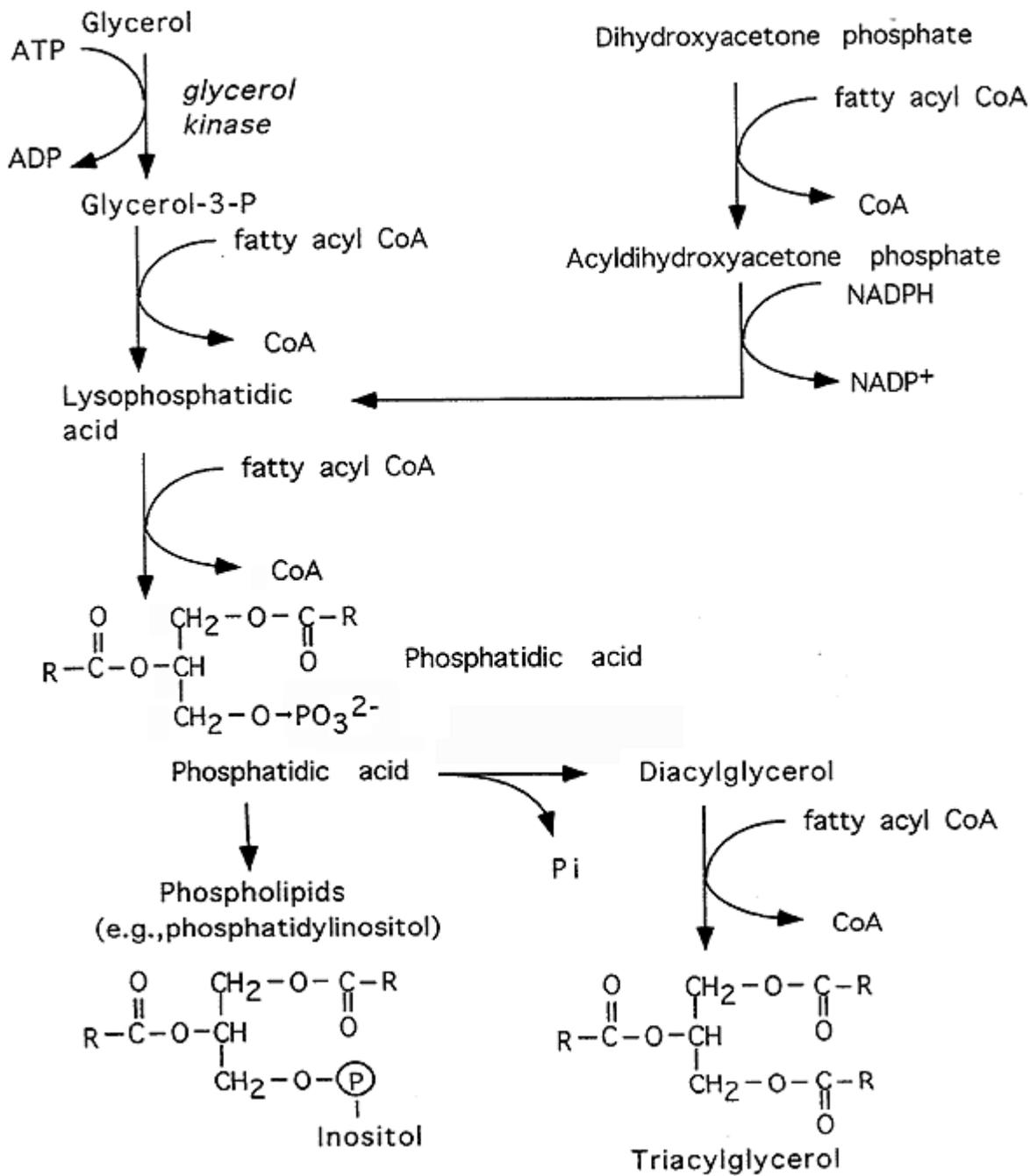
activation of acetyl CoA carboxylase - *increases production of malonyl CoA*

increased flux through pentose shunt - *produces NADPH for fat synthesis*

hypercaloric high carbohydrate or high protein, low-fat diet - *provides precursors for fat synthesis*

3.6.7 Esterification

Formation of Phosphatidic Acid from Glycerol or Dihydroxyacetone Phosphate and its Conversion to Triacylglycerol or Phospholipids.



3.7 Pathogenesis of Obesity

Obesity has been implicated as one of the major risk factors for hypertension (HTN), heart failure (HF), and coronary heart disease (CHD). The adipocyte acts as an endocrine organ, and plays a substantial role in the pathogenesis and complications of obesity.⁵²⁻⁵⁴ Increased levels of leptin (an adipocyte-derived hormone) which reduces food intake and reduces energy metabolism by increasing insulin resistance, increases CV disease by increasing vascular injury. C-reactive protein (CRP) may play a vital role in the development of leptin resistance, which is important because endogenous hyperleptinemia does not reduce appetite or increase energy expenditure.^{50,51}

3.7.1 Body Mass Index (BMI)

3.7.1.1 Height

Using standard measuring tape, height in meters or centimetres or inches of each patient would be measured.

3.7.1.2 Weight

Using standard measuring weighing machine KRUPS, ESSAE, EEROKA LTD to measure the weight in kilogram or pounds of each patient.

The body mass index (BMI) is a value derived from the mass (weight) and height of an individual. The BMI is defined as the body mass divided by the square of the body height, and is universally expressed in units of kg/m^2 , resulting from mass

in kilograms and height in metres. The most commonly used definitions, established by the World Health Organization(WHO) in 1997 and published in 2000, provide the values listed in the below Table 1⁵⁵⁻⁵⁷.

Table 1 WHO Classification of BMI

BMI	Classification
< 18.5	Underweight
18.5–24.9	normal weight
25.0–29.9	Overweight
30.0–34.9	class I obesity
35.0–39.9	class II obesity
≥ 40.0	class III obesity

3.8. Clinical Features

3.8.1 Obesity Sign

Signs of overweight and obesity include a high body mass index (BMI) and an unhealthy body fat distribution that can be estimated by measuring your waist circumference.

3.8.2 Obesity Symptoms

1. Gastroesophageal reflux disease (GERD)
2. High blood pressure
3. High cholesterol
4. Heart disease and blood lipid abnormalities.
5. Joint disease (e.g., osteoarthritis) type 2 diabetes.
6. Snoring
7. Breathing disorders (e.g., sleep apnea, chronic obstructive pulmonary disease)
8. Increased sweating
9. Inability to cope with sudden physical activity
10. Feeling very tired every day
11. Low confidence and self-esteem
12. Feeling isolated

3.8.3 Obesity Complication

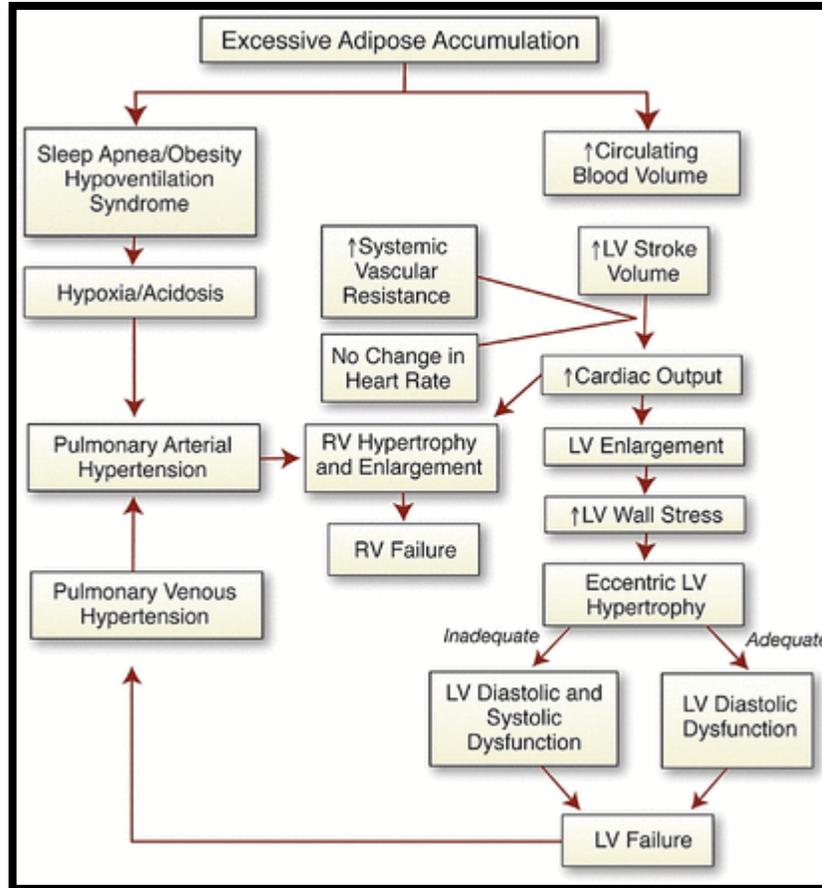


Figure 7: Complication of obesity

Obesity increases total blood volume and cardiac output, and cardiac workload is greater in obesity. Typically, obese patients have a higher cardiac output but a lower level of total peripheral resistance at any given level of arterial pressure^{58,59}. Most of the increase in cardiac output with obesity is caused by stroke volume, although because of increased sympathetic activation, heart rate is typically mildly increased as well.⁶⁰ Obese patients are more likely to be hypertensive than lean patients, and weight gain is typically

associated with increases in arterial pressure^{59,60} due to increased filling pressure and volume, overweight and obese individuals often develop left ventricular (LV) chamber dilation.^{58,60,61} Independent of arterial pressure and age, obesity increases the risk of left ventricular hypertrophy (LVH), as well as other structural abnormalities, obesity also leads to left atrial (LA) enlargement, both from increased circulating blood volume as well as abnormal LV diastolic filling.^{58,62} These abnormalities not only increase the risk of HF, but LA enlargement may increase the risk of atrial fibrillation (AF). In addition to increasing LV structural abnormalities and the propensity for more frequent and complex ventricular arrhythmias⁶⁰, obesity also has adverse effects on diastolic and systolic function^{58,62}.

3.9 Stress and Obesity

3.9.1 Research Study: Stress Cause Excess Abdominal Fat in Lean Woman

Women who are vulnerable to the effects of stress are more likely to have excess abdominal fat, and have higher levels of the stress hormone cortisol, a study conducted at Yale suggests.

While past studies have examined cortisol response in overweight women, this is the first study to show that lean women with abdominal fat have exaggerated responses to cortisol. Abdominal fat is related to worse health, including greater risk of heart disease and diabetes.

“We also found that women with greater abdominal fat had more negative moods and higher levels of life stress,” said Elissa S. Epel, Ph.D., lead investigator on the study she conducted while at Yale's psychology department. “Greater exposure to life stress or psychological vulnerability to stress may explain their enhanced cortisol reactivity. In turn, their cortisol exposure may have led them to accumulate greater abdominal fat.”

Published in the September/October issue of *Psychosomatic Medicine*, the study looked at pre-menopausal, non-overweight women, and overweight women who stored fat either centrally-at the waist vs. peripherally-at the hips, and examined their stress responses over three consecutive days.⁶³

Cortisol affects fat distribution by causing fat to be stored centrally-around the organs. Cortisol exposure can increase visceral fat-the fat surrounding the organs-in animals. People with diseases associated with extreme exposure to cortisol, such as severe recurrent depression and Cushing's disease also have excessive amounts of visceral fat.

“Everyone is exposed to stress, but some people may secrete more cortisol than others, and may secrete cortisol each time they face the same stressor,” Epel adds. “We predicted that reacting to the same stressors consistently by secreting cortisol would be related to greater visceral fat.”⁶⁴

After the first exposure to stress, women with greater abdominal fat felt more threatened by the study's stressful tasks, performed more poorly on them, and secreted more cortisol. They also reported more life stress. By the third exposure to stress, the lean

women with abdominal fat still consistently secreted more cortisol in response to stressful lab tasks, compared to women with peripheral fat.^{63,65}

“It is possible that greater exposure to stressful conditions or psychological vulnerability to stress has led them to overreact to stressors in their daily lives, so they have had greater lifetime exposure to cortisol,” Epel said. “Cortisol, in turn may have caused them to accumulate abdominal fat. Genetics, however, also play a role in shaping reactivity to stress, as well as body shape.”⁶³

Lifestyle and age may also influence levels of abdominal fat. Smoking, alcohol and lack of exercise all contribute to greater abdominal fat. Postmenopausal women tend to carry fat at their abdomen, due to changes in sex hormones. Epel said a healthy lifestyle, including getting enough sleep, exercise and relaxation, may reduce cortisol levels.

“These relationships likely apply to men as well,” Epel said. “However, excess weight on men is almost always stored at the abdomen. On the contrary, in pre-menopausal women, excess weight is more often stored at the hips. Therefore, for women, it is possible that stress may influence body shape more than for men, leading to abdominal fat instead of lower body fat accumulation.”⁶⁴

3.10 Conventional Management

3.10.1 Dieting

Diets to promote weight loss are generally divided into four categories: low-fat, low-carbohydrate, low-calorie, and very low calorie.⁶⁶ A meta-analysis of six randomized controlled trials found no difference between three of the main diet types (low calorie, low carbohydrate, and low fat), with a 2–4 kilograms (4.4–8.8 lb) weight loss in all studies.⁶⁶ At two years these three methods resulted in similar weight loss irrespective of the macronutrients emphasized.⁶⁷ High protein diets do not appear to make any difference.⁶⁸ A diet high in simple sugars such as those in soft drinks increases weight.⁶⁹ Very low calorie diets provide 200–800 kcal/day, maintaining protein intake but limiting calories from both fat and carbohydrates. They subject the body to starvation and produce an average weekly weight loss of 1.5–2.5 kilograms (3.3–5.5 lb). These diets are not recommended for general use as they are associated with adverse side effects such as loss of lean muscle mass, increased risks of gout, and electrolyte imbalances. People attempting these diets must be monitored closely by a physician to prevent complications.⁶⁶

3.10.2 Physical Exercise

Muscles consume energy derived from both fat and glycogen. Due to the large size of leg muscles, walking, running, and cycling are the most effective means of exercise to reduce body fat.⁷⁰ Exercise affects macronutrient balance. During moderate exercise, equivalent to a brisk walk, there is a shift to greater use of fat as a fuel.^{71,72} To maintain

health, the American Heart Association recommends a minimum of 30 minutes of moderate exercise at least 5 days a week.

Perform 20-30 minutes of moderate exercise five to seven days a week, preferably daily. Types of exercise include stationary bicycling, walking or jogging on a treadmill, stair climbing machines, jogging, and swimming.⁷¹ Exercise can be broken up into smaller 10-minute sessions.

Start slowly and progress gradually to avoid injury, excessive soreness, or fatigue. Over time, build up to 30-60 minutes of moderate to vigorous exercise every day.

People are never too old to start exercising. Even frail, elderly individuals (70-90 years of age) can improve their strength and balance.⁷⁰

High fat diet leads to obesity, which enhances the systemic inflammation (TNF- α) and causes fibrosis leading to cardiac dysfunction. Exercise decreases high fat diet induced obesity, upregulates anti-inflammatory IL-10, which reduces inflammation, mitigates fibrosis, and ameliorates cardiac dysfunction.⁷¹

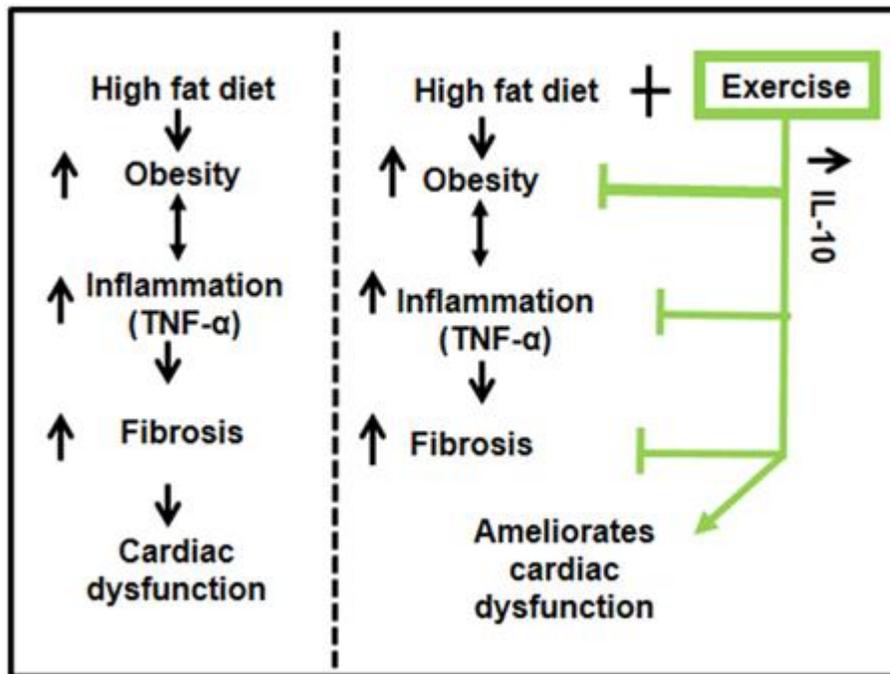


Figure 8 Benefits of exercise

3.11 Pharmacotherapy

Generic name and year of approval	Trade name	Dosage	DEA schedule
Pancreatic lipase inhibitor approved by FDA for long-term use			
Orlistat, 1999	Xenical	120 mg tid before meals	Not scheduled
Orlistat, 2007	Alli (OTC)	60 mg tid before meals	Not scheduled
Serotonin-2C receptor agonist approved by FDA for long-term use			
Lorcaserin, 2012	Belviq	10 mg twice daily	Schedule IV
Combination of phentermine-topiramate approved by FDA for long-term use			
Phentermine-topiramate, 2012	Qsymia	3.75 mg/23 mg, 7.5 mg/46 mg 11.25 mg/69 mg, 15 mg/92 mg	IV, (phentermine)
Noradrenergic drugs approved for short-term use			
Diethylpropion, 1959		25 mg tid 75 mg every morning	IV
Phentermine, 1959		15-30 mg/day	IV
Benzphetamine, 1960		25-50 mg tid	III
Phendimetrazine, 1959		17.5 mg-70 mg tid 105 mg daily	III

The above Drug for obesity were approved by the U.S. Food and Drug Administration (FDA) that produce weight loss. [Reprinted from "Update on obesity pharmacotherapy", by Bray GA, Ryan DH, 2014, Ann N Y Acad Sci, 1311, pp.1-13. Copyright 2014 by John Wiley & Sons, Inc. Reprinted with permission].^{73,74}

3.11.1 Non-surgical liposuction

In this techniques using laser energy, radiofrequency, ultrasound or cold (cryolipolysis) to reduce fat.⁷⁵ Devices are applied directly to the skin of the treatment area and do not employ injections (as in injection lipolysis) or incisions (as in laser assisted liposuction). Although fat loss is more subtle with non-surgical lipolysis techniques compared to surgical liposuction, non-surgical lipolysis techniques have several advantages including reduced risk, reduced cost, and reduced healing time.⁷⁶ Laser,⁷⁷ radiofrequency,⁷⁸ and ultrasound⁷⁹ techniques provide additional advantages of tissue tightening.⁸⁰

3.11.2 Surgical Approach

3.11.2.1 Bariatric surgery

It is the weight loss surgery includes a variety of procedures performed on people who have obesity. Weight loss is achieved by reducing the size of the stomach with a gastric band or through removal of a portion of the stomach or by resecting and re-routing the small intestine to a small stomach pouch (gastric bypass surgery). Long-term studies show the procedures cause significant long-term loss of weight, recovery from diabetes,

improvement in cardiovascular risk factors, and a mortality reduction from 40% to 23%.¹ The U.S. National Institutes of Health recommends bariatric surgery for obese people with a body mass index (BMI) of at least 40, and for people with BMI of at least 35 and serious coexisting medical conditions such as diabetes.⁸¹

3.11.2.2 Liposuction

Liposuction, or simply lipo, is a type of cosmetic surgery that removes fat from the human body in an attempt to change its shape.⁸² The procedure may be performed under general, regional, or local anesthesia. It then involves using a cannula and negative pressure to suck out fat.⁸⁴ Weight loss from liposuction appears to be of a short term nature with little long term effect.⁸³ After a few months fat typically returns and redistributes.⁸³ Liposuction does not help obesity related metabolic disorders like insulin resistance.⁸⁴

It is believed to work best on people with a normal weight and good skin elasticity⁸⁵. In the United States it is the most commonly done cosmetic surgery.^{85,86} Serious complications include deep vein thrombosis, organ perforation, bleeding, and infection.⁸⁷ Death occurs in about one per ten thousand cases.

3.12 Obesity and Bastrika Pranayama

3.12.1 Yoga and Health

Yoga is one of the six systems of Indian Vedic philosophy (Darshan). Maharishi Patanjali, rightly known as the “Father of Yoga”, compiled and refined various aspects of yoga systematically in his “Yoga Sutras” (aphorisms), wherein he advocated the eight-fold path known as “Ashtanga Yoga” for an all-around development of human personality. These include Yama [moral codes], Niyama [self-purification and study], Asana [posture], Pranayama [breathcontrol], Pratyahara [sense control], Dharana [concentration], Dhyana [meditation], and Samadhi [super contemplation]. These are formulated on the basis of multifarious psychological understanding of human personality.

Other aspects of yoga philosophies are broadly classified into four streams namely Work, Worship, Philosophy, and Psychic control. “Karma Yoga,” the path of work, promotes pleasure in labor without indulging in thoughts of success or failure. A free mind allows the task to be done in a skillful manner. “Bhakti Yoga,” the path of worship, is a systematic method of engaging the mind in the practice of divine love. This attitude of love softens our emotions and tranquilizes our mind. “Gyana Yoga,” the path of philosophy, is a systematic way of enlightening the mind about the realities of life by contemplation. This will strip off the garb of Avidya (ignorance) from our mind as it goes to its natural state of rest.

“Raja Yoga,” the path of psychic control, is a systematic process of culturing the mind. It is based on the eight-fold path set by Patanjali.

La forge (1997) revealed that Mind-body practice with existing health promotion and cardiac rehabilitation services can improve the self-efficacy and long-term adherence to healthy behaviors. It can as well improve the personal stress management skills. There are also numerous primary and secondary preventive indications for cardiovascular disease (CVD) where the mind-body exercise plays a primary or complementary role.⁸⁸

Ives JC et.al. (2000)suggested that mind-body exercise methods are now used widely in the health, fitness, and rehabilitation fields. Yoga helps to reduce stress, decrease hypertension, and also exerts cardiorespiratory benefits.⁸⁹

Yank et.al. (2007) reviewed papers to find out the effects of yoga intervention especially on the common risk factors of chronic diseases like overweight, hypertension, high glucose level and high cholesterol. A systematic search yielded 32 articles published between 1980 and april 2007 which revealed that the yoga interventions are generally effective in reducing body weight, blood pressure, glucose level and high cholesterol. ⁹⁰

Kiecolt G et.al. (2010) observed that the stress factors like serum interleukin (IL)-6 levels and C-reactive protein (CRP) are higher in the novices than the yoga experts. It is found that IL-6 promotes CRP Production. The yoga experts produced less lipopolysaccharide-stimulated IL-6 in response to the stressor than novices.⁹¹

Smith et.al. (2011) concluded that yoga when practiced in a more integrated form, i.e., with an ethical and spiritual component provides additional benefits over yoga than when practiced as an exercise regimen.⁹²

Innes KE et.al. (2007) study suggests that chronic stress and related psychosocial factors also play an important role in the development and progression in the pathogenesis of cardio vascular diseases. Integrated psychological and physiological components of health, yoga and other traditional mind-body therapies may offer particular promise in both the primary and secondary prevention of CVD.⁹³

Yoga and meditation has also been commonly used for muscle relaxation. (Ghoncheh, S, & Smith, J C, 2004).Yoga can be performed by most people, including young people and cardiac patients (Ades, P A. et.al., 2003),(Tran, M. et.al., 2001), (Raub, J, 2002) (Dash, M, & Telles, S, 2001).Yoga builds up a core stability during and after pregnancy (Berk, B, 2001) and it increases the creativity and reduces stress, (Khasky, A D, Smith, J C, 1999)as well as to improve muscle power, dexterity, visual perception, (Raghuraj, P, & Telles, S, 1997)and reaction time (Madanmohan et.al.,1993) while strength, endurance, and muscle reaction times which have been quantified previously, but little has been done to quantify the muscle use during yoga practice (Narayan, R. et.al., 1990), (Dostalek, C. et.al., 1979)

3.12.2 Yoga and Obesity

Seo et al. 2012 show that an 8-week of yoga training improves body composition and total cholesterol levels in obese adolescent boys, suggesting that yoga training may be effective in controlling some metabolic syndrome factors in obese adolescent boys.⁹⁴

Telles S et al. 2010 found that short term intensive yogic practice with modified diet pattern for 6-days can decrease the BMI, free fat mass, waist: hip ratio, serum leptin and also promote better postural stability and hand grip strength.⁹⁵

Collins C et al. 1988 Yoga training may help obese adolescents to achieve the recommended levels of physical activity, and it may be an alternative exercise training programs because it has limited harmfulness, and requires virtually no equipment.⁹⁶

Lee JA et al. 2012 a study showed that yoga can improves adiponectin level, serum lipids, and metabolic syndrome risk factors in obese postmenopausal women and effective in preventing cardiovascular disease caused by obesity in obese postmenopausal Korean women.⁹⁷

Vijay T et al. 2012 conducted study on effect of certain yogic postures and breathing techniques suggested that there is significant decrease in the parameters of obesity mainly the Body Mass Index and Waist Hip Ratio.⁹⁸

Dhananjai S et al. 2011 a study indicates usefulness of yoga practices in reducing obesity and reduces risk factors associated with obesity and suggested the useful in management of obesity without any side effects.⁹⁹

Braun et al. 2012 suggested that Kripalu yoga-based, residential weight loss program suggests the psychological well-being, improved nutrition behaviors, and weight loss in obese individuals.¹⁰⁰

Okonta NR, 2012 study suggested that yoga not only reduce high BP, but it has also been very effective in reduction of blood glucose level, cholesterol level, and body weight, major problems affecting the American society.¹⁰¹

Littman et al. 2012 showed that six month intensive yoga program on overweight and obesity breast cancer survivors can decrease waist circumference and improve quality of life.¹⁰²

Pranayam (yoga breathing) involves controlling the respiratory functions of the body which is generally involuntary under the human control. We live because we breathe. But there are certain breathing techniques which if properly done can bring about energy, cheerfulness and improve the health of the individual. We breathe in through the nose and the lungs function in retaining the breath and it is later exhaled.

The breathing process depends on the health of the heart and lungs. If these are organs are healthy then breathing can occur normally. Thus in normal breathing inhalation and exhalation is not connected with the mind and hence it is not controlled. Moreover inhalation and exhalation does not occur in correct duration of time. Sometimes inhalation occurs for more period of time than the exhalation. In pranayam, the breathing procedure is connected with the mind and hence there is specific duration of breathing. This helps in making a healthy body. The person becomes cheerful and can help in managing various disorders. Pranayam helps in improving the supply of the oxygen. It can immensely improve the functioning of the lungs and initiate the proper way of breathing. It can thus provide a sense of well being and help to maintain a healthy heart. It prevents the development of various respiratory disorders. It helps in the management of respiratory disorders if an individual is already suffering from it. It keeps the body young and assists in weight loss. It improves the quality of blood and can enhance the mental health.

3.13 Bastrika Pranayama (Bellows Breathing)

3.13.1 Procedure for Pranayama Getting ready for Pranayama

Participants were instructed to sit in padmasana position (cross-legged on the floor with the feet on the thighs and the soles facing upwards) with relaxed body and erect spine. The hands were to be kept on the knees in Gyan Mudra Posture (the tips of the index fingers to be joined to the tips of the thumbs while keeping the other fingers extended

and loose). Eyes were to be closed gently. Body and the mind were to be relaxed for 2 minutes (min) followed by 3 min of normal breathing before starting the procedure.

The participants were asked to take a deep breath in and breathe out forcefully through the nose. Immediately afterwards breathe in with the same force. During inhalation the diaphragm descends and the abdomen moves outward. During exhalation the diaphragm moves upward and the abdomen moves inward. The above movements should be slightly exaggerated. Continue in this manner, counting 10 breaths. At the end of 10 breaths, take a deep breath in and breathe out slowly. This was continued for 4 minutes (min) which was considered as one round of bhasrika pranayama. This was followed by 1min rest. This 4 min bhasrika pranayama with one min gap was repeated two times and at the end of this, 3 min rest was followed. Altogether this one round was spanned for 10 min twice a day for morning and evening for 8 weeks.



Figure 9: Participant practicing Bhastrika Pranayama (individual practice)



Figure 10: Participant practicing Bhastrika Pranayama (Group Practice)



Figure 11: Group practice of Bhastrika Pranayama with the principal investigator

अथ भस्त्रिका ।

ऊर्वोरुपरि संस्थाप्य शुभे पादतले उभे ।
पद्मासनं भवेदेतत्सर्वपापप्रणाशनम् ॥ ५९ ॥

Placing both soles of the feet on top of the thighs is padmasana which destroys all sins (bad karma).

सम्यक्पद्मासनं बद्ध्वा समग्रीवोदरः सुधीः ।
मुखं संयम्य यत्नेन प्राणं घ्राणेन रेचयेत् ॥ ६० ॥

Sitting properly in padmasana, keeping neck and abdomen in alignment, exhale prana through the nose.

यथा लगति हृत्कंठे कपालावधि सस्वनम् ।
वेगेन पूरयेच्चापिहृत्पद्मावधि मारुतम् ॥ ६१ ॥

And again the air should be quickly inhaled up to the heart lotus. Accordingly, the resounding is felt from the heart and throat up to the cranium.

पुनर्विरेचयेत्तद्वत्पूरयेच्च पुनः पुनः ।
यथैव लोहकारेण भस्त्रा वेगेन चाल्यते ॥ ६२ ॥

In that way it (the breath) is inhaled and exhaled repeatedly, with the same motion as a pair of bellows being pumped

तथैव स्वशरीरस्थं चालयेत्पवनं धिया ।
यदा श्रमो भवेद्देहे तदा सूर्येण पूरयेत् ॥ ६३ ॥

Thus, in this way, one keeps the breath moving with mindfulness (awareness) and body steadiness. When the body is tired then inhale through the right nostril.

यथोदरं भवेत्पूर्णमनिलेन तथा लघु ।
धारयेत्सिकां मध्यातर्जनीभ्यां विना दृढम् ॥ ६४ ॥

Accordingly, when the abdomen becomes full of air, then quickly hold the nostrils (and breath) firmly, without using the index and middle fingers (i.e. using the thumb and ring finger as in nasikagra mudra).¹⁰³

विधिवत्कुंभकं कृत्वा रेचयेदिडयानिलम् ।
वातपित्तश्लेष्महरं शरीराग्निविवर्धनम् ॥ ६५ ॥

Having performed (pranayama and) retention systematically, exhale through the left nostril. Thereby imbalances of wind, bile and mucus are annihilated and the digestive fire increased. Bhastrika is the name of the pranayama which imitates the action of the bhastra or 'bellows' and fans the internal fire, heating the physical and subtle bodies. Bhastrika pranayama is similar to vatakrama kapalbhati, but in bhastrika, inhalation and exhalation are equal and are the result of systematic and equal lung movements. The breath has to be sucked in and pushed out with a little force. In kapalbhati, inhalation is the result of forced exhalation. Bhastrika should not be done so forcefully that the nostrils are sucked in with inhalation. The air creates a sound as it passes in and out of the nose, but it should not be a heavy sound. It should come from the nose and not the throat. Throughout the practice the body should remain steady. The shoulders and chest should not move at all, only the lungs, diaphragm. The correct sitting position for bhastrika is padmasana, but if it cannot be practiced, ardha padmasana or siddhasana/siddha yoni asana are good alternatives. In padmasana and siddhasana the body is firmly locked so that physical movement is restricted and the spine remains straight. Nervous impulses are then able to travel directly up through the central nervous system. Siddhasana also maintains the blood pressure.¹⁰³

Preparation:

Sit comfortably in your meditative posture with the hands on the knees and the eyes closed.

Take a slow deep breath in. Breathe out quickly and forcefully through the nose, but do not strain, and immediately afterwards breathe in with the same force.

When you breathe out the abdomen comes in and the diaphragm contracts. When you breathe in the diaphragm relaxes and the abdomen moves out. These movements should be slightly exaggerated.

Continue to breathe in this manner counting ten breaths. At the end of ten breaths, take a deep breath in and out slowly. This is one round. Practice three to five rounds.

As you become accustomed to this style of breathing, gradually increase the speed but keep the breath rhythmical. Inhalation and exhalation must be equal.¹⁰³

Technique 1

Stage 1:

Sit comfortably in your meditative pose, relax and prepare yourself for pranayama. Keep the head and spine straight. Place the right hand in nasikagra mudra and close the right nostril. Inhale slowly and deeply through the left nostril and then breathe in/out as described in the preparation, counting twenty breaths.

After completing the last exhalation, breathe in slowly and deeply, close both nostrils and bend the head forward into jalandhara bandha, but do not raise the shoulders. Hold for as long as comfortable.

Raise the head and exhale slowly through the right nostril. Take a deep inhalation through the right nostril and practice in the same way as you did through the left nostril, counting twenty breaths. After the last exhalation, inhale slowly and deeply through the right nostril. When inhalation is complete, close both the nostrils and practice jalandhara, hold, and release as before. Complete one round by practicing on both sides. Perform three rounds.¹⁰³

Stage 2:

Practice as in stage 1, but after practicing through the right nostril, practice through both nostrils together counting up to forty breaths. Practice three rounds.

Stage 3:

Practice as in stage 2, but during retention add breaths. Practice three rounds. Moola bandha after jalandhara. On completion of retention, release moola bandha then jalandhara. Practice three to five rounds.

Stage 4:

Practice five rounds of stage 3 and increase by ten respirations every week until you are breathing in the ratio of 50:50:100 in each round.

Technique 2

Practice Technique 1 stage 4, but omit breathing through alternate nostrils, only breathe through both, one hundred times. Instead of performing antar kumbhaka (internal retention), practice bahir kumbhaka (external retention). That means, after the last exhalation of bhastrika, inhale slowly and deeply, and exhale rapidly through the mouth. Perform jalandhara and moola bandha.¹⁰³

Release in the same way as described previously. Practice five rounds. After a week or so of practice add uddiyana bandha after jalandhara, so that you now perform maha bandha with external kumbhaka.

Release moola bandha, then uddiyana, then jalandhara. Between each round concentrate on the natural breath or mid-eyebrow center. Practice five rounds of up to a hundred breaths unless your guru asks you to practice more. Bhastrika should be performed after asana and nadi shodhana pranayama, but before seetkari, sheetali or ujjayi. During warm seasons it should be followed by a few rounds of sheetali/seetkari so that the body does not overheat. The number of rounds of bhastrika may also need to be reduced. Those people with high blood pressure, heart disease, brain tumor, vertigo, stomach or intestinal ulcers, glaucoma, dysentery or diarrhea must not attempt this practice. If dizziness is experienced during the practice it means it is being performed incorrectly. Bhastrika must always be done in a relaxed manner with full awareness and the mind should not be allowed to wander.

In Hatharatnavali it is said that after the practice of bhastrika you should listen “with the right ear to welcome internally aroused sounds of crickets, flute, thunder cymbals, a black bee, bell, gong, trumpet, drum.”

कुंडली बोधकं क्षिप्रं पवनं सुखदं हितम् ।
ब्रह्मनाडीमुखे संस्थकफाद्यर्गलनाशनम् ॥ ६६ ॥

This (bhastrika) quickly arouses kundalini. It is pleasant and beneficial, and removes obstruction due to excess mucus accumulated at the entrance to brahma nadi.

सम्यग्गात्रसमुद्भूतग्रन्थित्रयविभेदकम् ।
विशेषेणैव कर्तव्यं भस्त्राख्यं कुंभकत्विदम् ॥ ६७ ॥

This kumbhaka called bhastrika enables the three granthis (psychic/ pranic knots) to be broken. Thus it is the duty of the yogi to practice bhastrika.

Hatha-Yoga-Pradipika-Muktibodhananda

Benefits:

The most important physiological effect of bhastrika is on the brain and heart. Bhastrika stimulates the circulation of cerebral fluid and increases the compression and decompression upon the brain, creating a rhythmic massage. The rhythmic pumping of the diaphragm and lungs stimulates the heart and blood circulation. Accelerated blood circulation and rate of gas exchange in each cell produces heat and ‘washes out’ waste

gases. Hyperventilation begins to occur and excites the sympathetic nerves in the respiratory center, but because there is an increased release of carbon dioxide, the center is subsequently relaxed and hyperventilation does not take place. If exhalation were to become less than inhalation, then there would be hyperventilation. Therefore, in bhastrika inhalation and exhalation must remain equal.¹⁰³

The rapid and rhythmic movement of the diaphragm also stimulates the visceral organs and this creates a massaging effect throughout the whole system. Bhastrika is the most dynamic and vitalizing pranayama techniques.

Bhastrika heats the nasal passages and sinuses, clearing away excess mucus and building up resistance to colds and all respiratory disorders. Therefore, it is useful in the yogic management of chronic sinusitis, pleurisy, asthma and bronchitis. Bhastrika improves digestion and stimulates a sluggish system. It increases the appetite, accelerates the metabolic rate and strengthens the nervous system. Bhastrika also helps in cases of tuberculosis, constipation, sciatica, spondylitis, arthritis, rheumatic problems, cancer and physical and mental tension. Pranic movement, particularly in the coccygeal, navel, thoracic and brain centers, is accelerated by the practice of bhastrika and this increases physical vitality and bestows clarity of mind. The tremendous heat generated by the practice clears sushumna nadi and prepares it for the ascent of kundalini. Within sushumna there are three granthis or psychic/pranic knots which prevent the passage of kundalini shakti. One is found in mooladhara chakra. It is called brahma granthi and it ties the awareness to sensual perception and the physical world. Another is in anahata

chakra and it causes the desire for emotional security, expression and fulfillment. It is called vishnu granthi. The third granthi is located in ajna chakra and is associated with attachment to siddhis, psychic phenomena and experiences. It is called rudra granthi. The shakti produced by bhasrika is said to break these granthis so that kundalini can move on unobstructed.

Through the practice of bhasrika, the indriya: jnanendriya (sensory organs) and karmendriya (motor organs) become less influential in motivating one's behavior, and the need for sensual enjoyment decreases. The nervous system becomes stronger, the emotions are harmonized and deeper inner satisfaction results. This occurs when brahma and vishnugranthis begin to unknot. When psychic experiences begin, bhasrika helps one to remain as a silent uninvolved witness who is not attached to any of these experiences. As rudra granthi starts to unfold, this attitude of sakshi (the witness) develops.

It is not easy to loosen the granthis because there are many physical, emotional and mental barriers. For the average person it is almost impossible to control sensual desires and to live without emotional security and fulfillment. As for psychic experiences, those who have them often end up in a mental hospital because they have no guru to guide them through their spiritual awakening.¹⁰³

So, although bhasrika helps loosen the granthis which obstruct kundalini's ascent, it is not enough just to practice bhasrika for hours together; a guru's guidance is necessary.¹⁰³

Benefits of Bhastrika Yoga Pranayama (Bellows Breath)

Primary

Boosts your metabolic rate so your body burns fat faster promoting natural weight loss.

Purifies your gross and subtle body by eliminating toxins and waste.

Generates heat in your body and opens up your energy pathways.

Builds lung capacity and helps clear and strengthen the respiratory system.¹⁰⁴⁻¹⁰⁶

Secondary

Expands and fortifies your nervous system. When done forcefully, the pulsating of the diaphragm massages the internal organs, thus improving your digestive system.¹⁰⁴⁻¹⁰⁶

Physiology of Bhastrika (Understanding the Bellows)

Effect of Bhastrika Pranayama on weight loss

Bhastrika pranayama helps clear your mind and body as part of a purification process, bhastrika pranayama helps improve your digestive system function and boosts your metabolism, thereby resulting in weight loss. bhastrika pranayama helps break down fats in the body,. However, scientific research does not yet validate these claims. Additionally, rapid, forceful breathing can make you feel lightheaded.¹⁰⁷

The bhastrika pranayama, or breathing exercise, simultaneously calms and energizes the practitioner. The process works by increasing the cellular metabolic rate, opening

energetic pathways in the body and increasing internal heat, according to Anmol Mehta. Bhastrika is also recommended for ridding the body of toxins, strengthening the lungs and nervous system and improving digestion. All of these functions work together to contribute to weight loss.¹⁰⁸

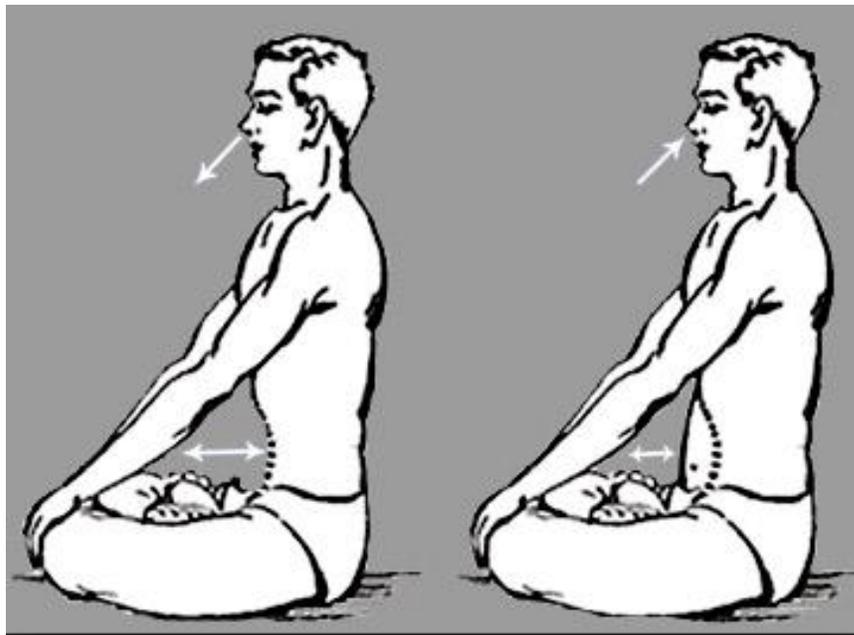


Figure 12: Bhastrika pranayama

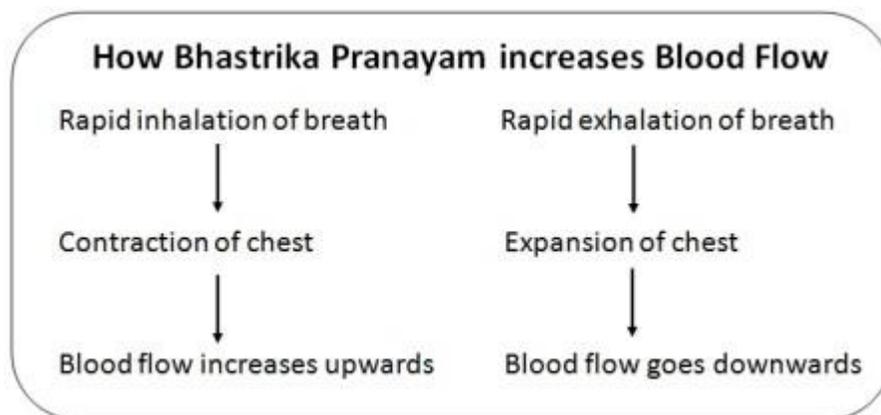


Figure 13: Physiology of Bhastrika Pranayama

As your lungs become full of oxygen after performing Bharstika, the metabolic and other functions of the body are improved. The process of energy production in the cells is taken to the next level, as the excess of oxygen in your body accelerates cellular metabolism. Enhanced metabolism helps to remove unwanted fats and toxins.¹⁰⁹

Effect of Bhastrika Pranayama on respiration and cardiovascular function:

University of São Paulo Medical School Sleep Laboratory research involving 76 elderly people revealed that those who practiced yoga breathing for four months showed improvements compared to a control group that did not practice yoga breathing. Individuals who engaged in yogic breathing showed improved respiration patterns and more balanced heart rhythms. This study was published in BMJ Open in 2011.¹⁰⁷

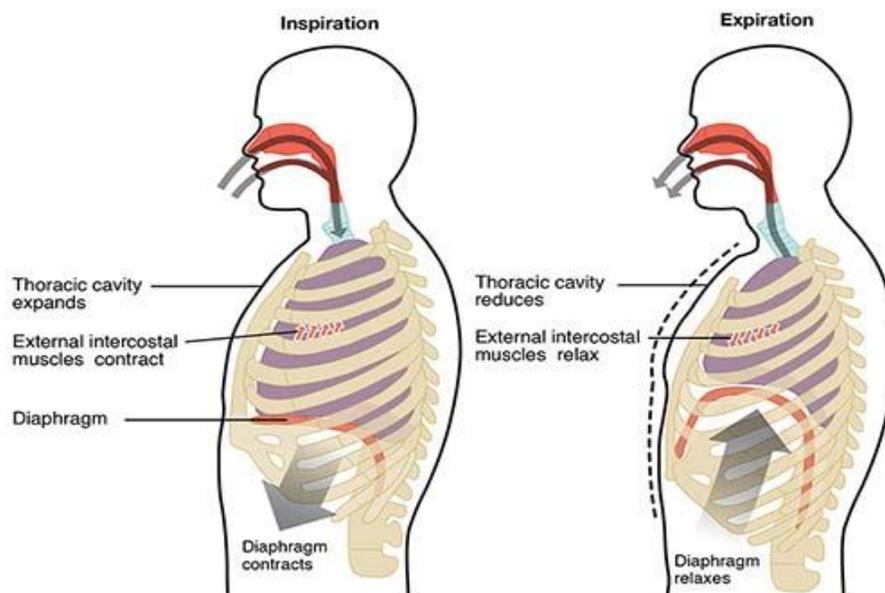


Figure 14: Bhastrika pranayama and lung function

Effect of slow pace bhastrika pranayama on blood pressure and heart rate.

Slow pace bhastrika pranayama (respiratory rate 6/min) exercise thus shows a strong tendency to improving the autonomic nervous system through enhanced activation of the parasympathetic system. Vagal cardiac and pulmonary mechanisms are linked, and improvement in one vagal limb might spill over into the other baroreceptor sensitivity can be enhanced significantly by slow breathing (supported by a small reduction in the heart rate observed during slow breathing and by reduction in both systolic and diastolic pressure).¹¹⁰

Bhastrika Pranayama (respiratory rate 6/min) for 5 minutes increases frequency and duration of inhibitory neural impulses by activating pulmonary stretch receptors during above tidal volume inhalation as in Hering Bruer reflex, which bring about withdrawal of sympathetic tone in the skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing decrease in peripheral resistance and thus decreasing the diastolic blood pressure.¹¹⁰

Effect of bhastrika pranayama on cardiovascular autonomic reactivity

Bhastrika pranayama increase the cardiac autonomic activity - increase in parasympathetic activity i.e. reduces basal heart rate, increase in valsalva ratio (ie.forced expiration against a closed glottis reduces heart rate) and reduction in sympathetic activity i.e., reduction in fall of systolic blood pressure on posture variation.¹¹¹

Effect of bhastrika pranayama on EEG waves

The effect of bhastrika pranayama on the autonomic nervous system noted that increases paroxysmal EEG waves immediately after practice in the healthy volunteers.²⁷ During the bhastrika pranayama practice all the subjects exhibited high frequency hyperphasic patterns, biphasic waves. They have found strong amplitude gamma waves after 30 days of bhastrika pranayama practice (two sessions per day). It was further concluded that continuous practice would cause the waves to remain for several minutes even after the practice is finished.¹¹²

Effect of bhastrika (a bellows type pranayama) on reaction time in mentally challenged adolescents.

Bhastrika pranayama decrease the Reaction time by improving the central neuronal processing ability and helps for greater arousal and faster rate of response to information processing, improve concentration, increases ability to ignore or inhibit extraneous stimuli. Mukha bhastrika altering afferent inputs from abdominal and thoracic regions, in turn modulating activity at ascending reticular activating system and thalamo-cortical levels and used as an effective means of improving neuromuscular abilities in special children.¹¹³

4.0 MATERIALS AND METHODS

4.1 Subjects

A total of 60 subjects of abdominal obesity of both gender with ages ranging between 18 – 45 years participated in the study.

4.1.1 Description of the Subjects Including the Selection of Samples

The study subjects were conveniently recruited from the Government Yoga & Nature Cure Hospital, Arumbakkam, Chennai District of Tamilnadu State in India. The Subjects were recruited from the above mentioned hospital through screening done to assess diagnostic criteria, inclusion and exclusion criteria.

Sixty participants were screened through a routine medical check-up and those satisfying the Diagnostic criteria for Obesity were recruited for the study (Table 2).

4.1.2 Demographics

Table 2 Demographic details of the subjects

	Study Group	Control Group
Age[Mean \pm SD]	32.8 \pm 4.56	31.67 \pm 2.46
Gender distribution	12 Males, 18 Females (n=30)	13 Males, 17 Females (n=30)
Total Participants completing the study	30	30
Ages range	18 – 45 years	

4.2 Ethical Considerations

4.2.1 Ethical Clearance

Ethical clearance was sought from the Institutional Ethics Committee prior to the start of the study and the approval for the same was granted.

4.2.2 Written Informed Consent

Subjects who fulfilled inclusion criteria were explained about the purpose of the study and their rights as research subjects. Informed consent form was administered in English.

Adequate time was given to each patient to go through the information sheet and their

queries were answered. Their right to withdraw anytime from the study and the need for willingness to participate voluntarily in the study was explained. All the subjects expressed their willingness to participate in the study by giving a signed informed consent.

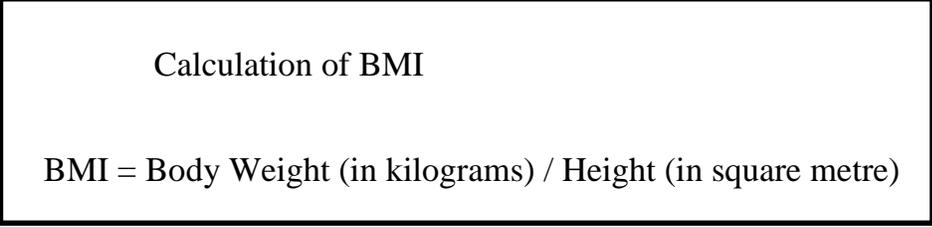


Figure 15: Written consent form

4.3 Screening of Subjects

4.3.1 Criteria for Diagnosis

4.3.1.a BMI



Calculation of BMI

$$\text{BMI} = \text{Body Weight (in kilograms)} / \text{Height (in square metre)}$$

Figure 16 Calculation of Body Mass Index

4.3.1.b Waist -Hip Ratio

Calculation of Waist -Hip Ratio = waist (cm) / hip (cm)

4.3.2 Inclusion and Exclusion Criteria

4.3.2.1 Inclusion Criteria

The following inclusion criteria would be the basis for selecting the subjects

1. Aged between 18-45 years
2. Both genders
3. Individuals who can perform pranayama
4. Obese individuals
5. No regular physical exercise

4.3.2.2 Exclusion Criteria

Participants will be excluded if they had:

1. Hormonal Imbalance, any Organic lesions and Metabolic syndromes like Hypothyroidism, Hypogonadism, Hypercortisolism, etc.
2. Nervous system or respiratory ailments, hypertension & diabetes mellitus.
3. Cardiovascular disease, renal complications, liver disorders and locomotor disabilities.
4. Glaucoma, hernia, or ulcers of the stomach or intestine
5. Recent abdominal or spinal surgery
6. Obese female with Pregnancy or Lactation and children
7. Any type of Addiction like smoking, alcoholism, tobacco chewing, etc

4.4 Design

4.4.1 Type of the Design

A Randomized Controlled Trial with control group

4.4.1.1 Convenient Sampling

The patients who satisfied the Inclusion and Exclusion criteria were conveniently grouped into Study and Control groups as per the patient availability and period of stay.

4.4.1.2 Allocation of patients into study & control groups

The patients were allocated conveniently to Study group or Control group.

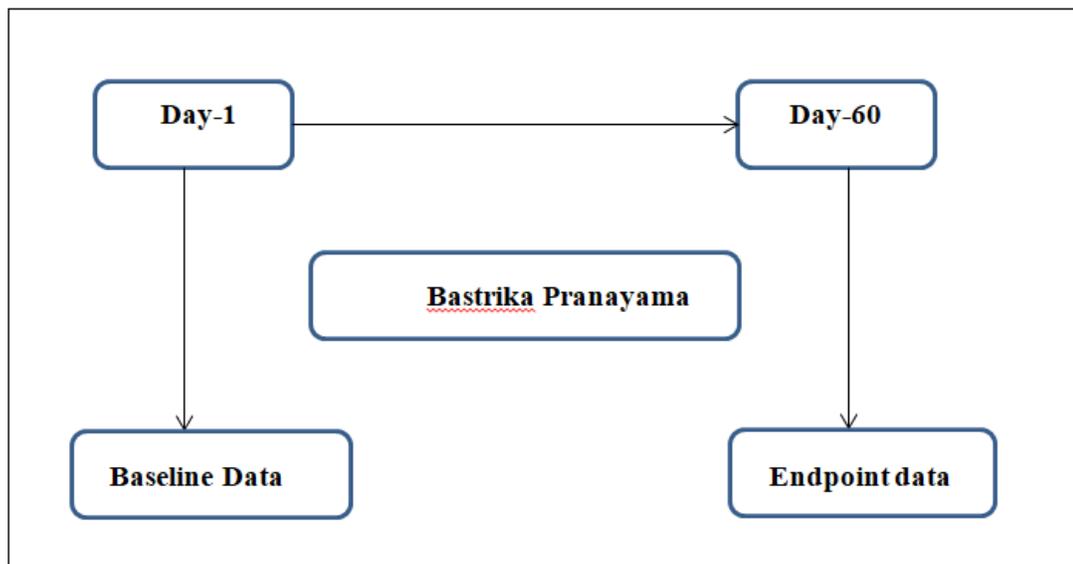
Sixty subjects were initially screened and assigned to two groups

i.e., Study group (n=30) and control group (n=30)

4.5 Data Points

The data collection was done before (day 1), and after (day 60) the intervention.

Figure 17: Illustration of Data Points



4.4 Trial Profile

The trail profile of the study is presented as Figure 18 which illustrates the study plan; flow of patients across data points and reasons for the drop out.

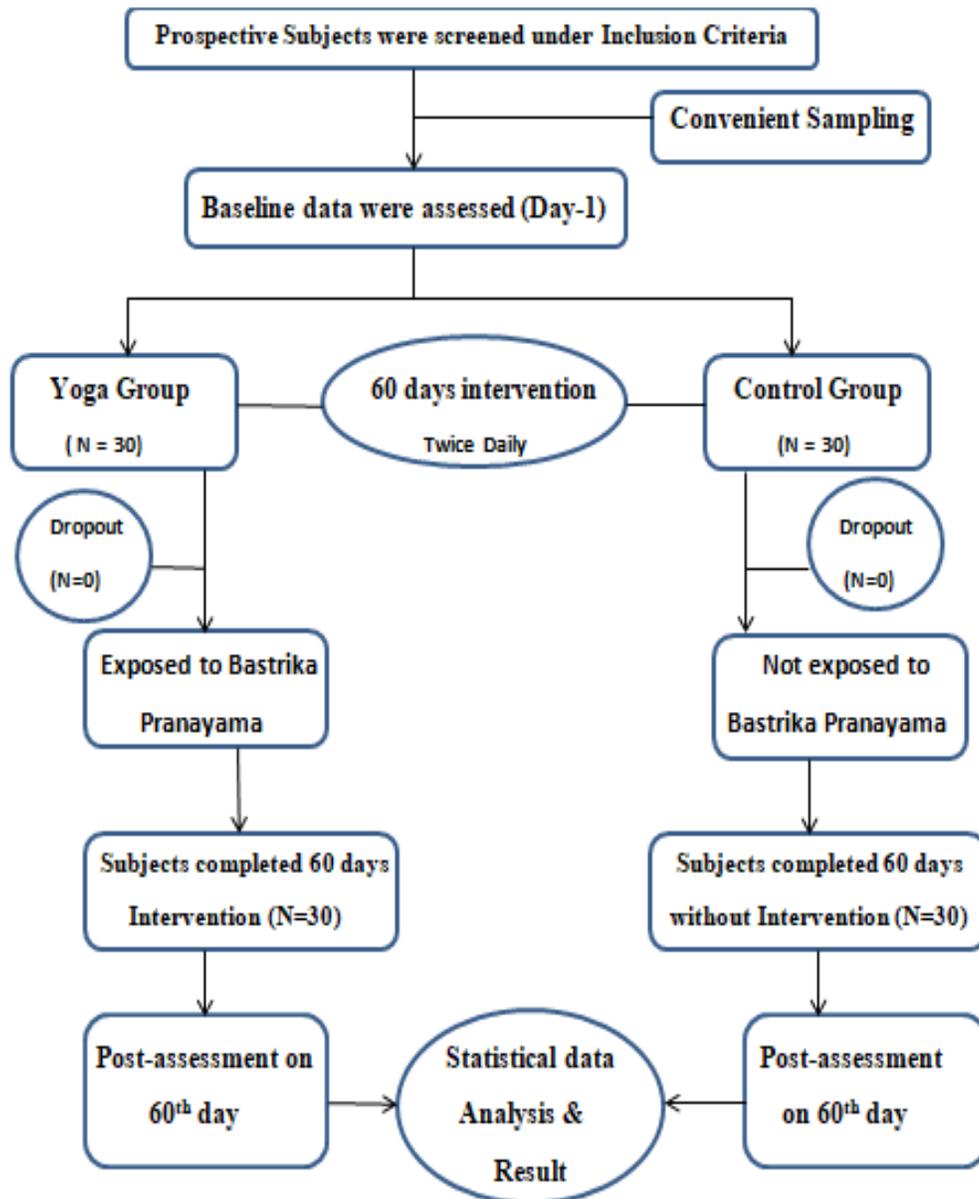


Figure 18: Trail Profile

4.6 Assessments

The baseline and post-intervention assessments consisted of:

Table 3: List of Primary and Secondary outcome variables

PRIMARY OUTCOME VARIABLES	SECONDARY OUTCOME VARIABLES
Body Mass Index Waist-Hip ratio	Resting Cardio-respiratory Parameters
Abdominal Skin-fold Thickness	Pulse rate
	Respiratory Rate
	Blood Pressure

4.6.1 Primary Outcome Variables

Body Mass Index (BMI = Weight / Height in sq.meter)

Waist Circumference & Waist-Hip Ratio (The waist-hip ratio was calculated as the ratio of waist and hip circumference). This is calculated as waist measurement divided by hip measurement ($W \div H$)

Abdominal skin fold thickness (To calculate body fat percentage using skin fold calipers.

The body mass index (BMI)

Height:

Using standard measuring tape, height in meters or centimetres or inches of each patient would be measured.

Weight:

Using standard measuring weighing machine KRUPS, ESSAE, EEROKA LTD to measure the weight in kilogram or pounds of each patient.

Waist -Hip Ratio:

Using the standard measuring tape Waist circumference was measured at the horizontal level exactly midway between the costal arch and iliac crest (at the level of umbilicus) and hip circumference, the latter was measured at the horizontal level at the place of the largest circumference either in the hip or buttock region (above the gluteal sulcus), depending on which was larger. The waist-hip ratio was calculated as the ratio of waist and hip circumference²⁶. This is calculated as waist measurement divided by hip measurement ($W \div H$). For both measurements, the individual should stand with feet close together, arms at the side and body weight evenly distributed, and should wear little clothing. The subject should be relaxed, and the measurements should be taken at the end of a normal respiration. Each measurement should be repeated twice; if the

measurements are within 1 cm of one another, the average should be calculated. If the difference between the two measurements exceeds 1 cm, the two measurements should be repeated.

Table 4a: Criteria for waist circumference in adults

Criteria for Waist Circumference in Adults		
Waist Circumference		
Risk Category	Females	Males
Very low	<27.5 in (<70 cm)	<31.5 in (<80 cm)
Low	27.5–35.0 in (70–89 cm)	31.5–39.0 in (80–99 cm)
High	35.5–43.0 in (90–109 cm)	39.5–47.0 in (100–120 cm)
Very high	>43.5 in (>110 cm)	>47.0 in (>120 cm)

Table 4b: Criteria for waist/hip ratio in adults ¹¹⁴

Waist-to-Hip Ratio (WHR) Norms				
Gender	Excellent	Good	Average	At Risk
Males	<0.85	0.85–0.89	0.90–0.95	>0.95
Females	<0.75	0.75–0.79	0.80–0.86	>0.86



Figure 19 Picture showing the measurement of Waist-Hip Circumference

4.6.1.1 Skin-fold Thickness of Abdomen and BMI

The Skin fold caliper is a device which measures the thickness of a fold of your skin with its underlying layer of fat. Landmark a mark is made 5 cm adjacent to the umbilicus (belly-button), to the right side. Pinch The vertical pinch is made at the marked site, and the calipers placed just below the pinch. Be careful not to place the caliper or fingers inside the navel. Do not release the fingers of the left hand while taking the readings. It

is important to keep holding firmly the fold of skin with the fingers so that the calipers are measuring just the thickness of the fold of skin. You will notice that when you place the calipers on the Skin fold that the calipers will "creep" a little, after a few seconds the "creep" will slow down and this is the time that the measurement should be taken. You must note the reading on the scale before releasing any pressure off the calipers.

4.6.1.2 Testing Method

Skin-fold Thickness of Abdomen measuring with the helping caliper.



Figure 20: Measurement of Skin-fold Thickness using a Caliper

4.6.2 Secondary Outcome Variables

4.6.2.1 Respiratory Rate

The respiration rate is the number of breaths a person takes per minute. The rate is usually measured when a person is at rest and simply involves counting the number of breaths for one minute by counting how many times the chest rises. Respiration rates may increase with fever, illness, and with other medical conditions. When checking respiration, it is important to also note whether a person has any difficulty breathing.

Normal respiration rates for an adult person at rest range from 12 to 16 breaths per minute.

4.6.2.2 Blood pressure

Blood pressure was obtained in standard manner by sphygmomanometer. All the reading was noted three times with five minutes interval and Mean of all the three values were included for the study.

4.6.2.3 Pulse Rate

The pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute. As the heart pushes blood through the arteries, the arteries expand and contract with the flow of the blood. Taking a pulse not only measures the heart rate, but also can indicate the following:

- Heart rhythm
- Strength of the pulse

The normal pulse for healthy adults ranges from 60 to 100 beats per minute. The pulse rate may fluctuate and increase with exercise, illness, injury, and emotions. Females ages 12 and older, in general, tend to have faster heart rates than do males. Athletes, such as runners, who do a lot of cardiovascular conditioning, may have heart rates near 40 beats per minute and experience no problems.

4.7 Intervention

4.7.1 Test Intervention

The patients in the study group were trained in the proper practice of bastrika Pranayama, was made to practice for a period of 60 days twice daily. (Preferably morning or evening)

4.7.2 Control Intervention

The control group was under other AYUSH treatments except Yoga for 60 days. They were also offered to be trained in the experiment intervention if interested after the study.

4.8 Data extraction and analysis

4.8.1 Data Extraction

The data was collected as self-reported observations using primary outcomes and

secondary outcome variables. The assessments were done on the first day (baseline data) and end of 60th day (post data). The data was organized in Microsoft Excel Sheets (Version 2010).

4.8.2 Data Analysis

Data expressed as Mean and SD. Inter group and intra group comparison of mean was done by paired and unpaired t test using R statistical software version 3.1.1.

5.0 RESULTS

The present study was conducted to evaluate whether the practice of Bhastrika pranayama had any influence in any of the outcome variables viz., Body mass index, Skin fold thickness, Pulse rate, Blood Pressure and Waist: Hip Ratio in obese individuals. Results were compared within and between groups, wherein data was extracted at both baseline and post-intervention. At the beginning of yoga intervention the variables were compared in between the groups.

Table 5 Comparison of variables recorded at the beginning of the yoga program

Variables	Yoga group	Control group	P value
Weight (kg)	84.49±7.90	85.56±10.72	0.12
BMI	38.52±5.86	37.28±4.87	0.34
Waist ratio	40.53±3.90	40.90±4.68	0.24
Hip ratio	42.46±5.70	42.89±7.26	0.34
W/H ratio	0.98±0.12	0.97±0.32	0.45
Skin fold thicknes	39.2±3.89	38.67±3.80	0.26
SBP	118.73±4.26	119.46±6.80	0.11
DBP	78.13±2.90	82.68±6.87	0.04
PR	72.87±5.67	71.80±4.60	0.45
RP	21.56±3.23	20.64±5.60	0.52

BMI: Body mass index.

Table 5 shows the anthropometry parameters in yoga group and control group. In both the groups, all the parameters like Weight (84.49 ± 7.90 kg vs 85.56 ± 10.72) and BMI (38.52 ± 5.86 kg/m² vs 37.28 ± 4.87 kg/m²) were not showing a significantly ($p > 0.34$) difference and they were considered for the comparison.

Table 6 Comparison of variables recorded at the end of the yoga program in between the groups

	Yoga group	Control group	P value
Weight (kg)	81.26 ± 10.98	84.28 ± 4.67	0.04
BMI	34.27 ± 3.76	36.78 ± 3.90	0.03
Waist ratio	38.86 ± 6.90	41.86 ± 5.82	0.05
Hip ratio	40.49 ± 6.24	41.28 ± 6.40	0.06
WH ratio	0.93 ± 0.32	0.96 ± 0.13	0.03
Skin fold thickness	37.86 ± 3.87	37.90 ± 5.60	0.05
SBP	119.13 ± 5.64	120.86 ± 5.57	0.34
DBP	72.84 ± 6.12	80.56 ± 7.80	0.01
PR	70.82 ± 7.18	73.53 ± 5.66	0.05
RP	19.40 ± 3.98	22.50 ± 8.90	0.07

Data Expressed: Mean \pm SD. Independent and paired t-test was used to compare the intergroup and intra group differences. SBP, Systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; PP, pulse pressure; MAP, mean arterial pressure; RPP, rate pressure product; DoP, double product.

There was no significant difference found in Control group patients. After 60 days of intervention, Yoga group patients showed a significant ($p < 0.03$) reduction in the body mass index from 38.52 ± 5.86 to 34.27 ± 3.76 kg/m², Waist ratio from 40.53 ± 3.90 to 38.86 ± 6.90 , Hip ratio from 42.46 ± 5.70 to 40.49 ± 6.24 , Waist/Hip ratio from 0.98 ± 0.12 to 0.93 ± 0.32 , DBP from 78.13 ± 2.90 to 72.84 ± 6.12 , RP from 21.56 ± 3.23 to 19.40 ± 3.98 and PR from 72.87 ± 5.67 to 70.82 ± 7.18 . There is no significant difference noticed in skin fold thickness from 39.2 ± 3.89 to 37.86 ± 3.87 ($p < 0.05$) (Table 6).

Table 7: Comparison of variables after the yoga program in between the yoga and control groups

	Yoga group		P value	Control group		P value
	Before	After		Before	After	
Age	32.8 \pm 4.56		NA	31.67 \pm 2.4		NA
				6		
Height (cm)	152.67 \pm 4.80		NA	154.80 \pm 6.		NA
				90		

Weight (kg)	84.49±7.9 0	81.26±10. 98	0.04	85.56±10. 72	84.28±4.6 7	0.4
BMI	38.52±5.8 6	34.27±3.7 6	0.03	37.28±4.8 7	36.78±3.9 0	0.67
Waist ratio	40.53±3.9 0	38.86±6.9 0	0.05	40.90±4.6 8	41.86±5.8 2	0.34
Hip ratio	42.46±5.7 0	40.49±6.2 4	0.06	42.89±7.2 6	41.28±6.4 0	0.28
WH ratio	0.98±0.12	0.93±0.32	0.03	0.97±0.32	0.96±0.13	0.77
Skin fold thickness	39.2±3.89	37.86±3.8 7	0.05	38.67±3.8 0	37.90±5.6 0	0.24
SBP	118.73±4. 26	119.13±5. 64	0.34	119.46±6. 80	120.86±5. 57	0.42
DBP	78.13±2.9 0	72.84±6.1 2	0.02	82.68±6.8 7	80.56±7.8 0	0.48
PR	72.87±5.6 7	70.82±7.1 8	0.05	71.80±4.6 0	73.53±5.6 6	0.24
RP	21.56±3.2 3	19.40±3.9 8	0.07	20.64±5.6 0	22.50±8.9 0	0.43

* compared with after yoga and control. * P<0.05, ** P<0.01, *** P<0.001.

Yoga group patients showed a significant ($P < 0.05$) reduction in skin fold thickness after 60 days of yoga intervention compared to control group patients ($P > 0.05$). In yoga group, Waist/Hip ratio was significantly reduced from 0.98 ± 0.12 ms to 0.93 ± 0.32 ms reflecting a positive improvement. Skin fold thickness reduced from 39.2 ± 3.89 to 37.86 ± 3.87 in yoga group patients after yoga intervention but there was no significant changes (0.05) found in control group patients (Table 7).

6. DISCUSSION

The result of this study revealed that practice of Bhastrika Pranayama (NSP) decreased the Body mass index and Waist/Hip ratio in the interventional group significantly in comparison to that of the control group. In this study, there is a significant difference (p within the Study group) in the Weight, Pulse rate, Diastolic Blood Pressure, Body Weight, Body Mass Index, Waist circumference, and Hip circumference at the end of the 60 days in comparison to their baseline data. However, no significant differences in Respiratory Rate, Systolic Blood Pressure, Skin fold thickness, and Hip Ratio were seen within this intervention group following the intervention.

Similar effects noticed in previous studies for example, according to the study conducted on the “Effect of Bhastrika Pranayama on waist and hip circumference” in the study group, the waist circumference and hip circumference decreased significantly as compared to that of control group. This shows that Bhastrika Pranayama has reducing impact on waist circumference and hip circumference in overweight individuals¹⁷.

In a study conducted on “Effect of Bhastrika Pranayama on selected body composition variables” the results showed significant effect on body fat % and no change was found in control group¹⁹.

Overall, the practice of Bhastrika pranayama for 60 days among obese individuals has resulted in the reduction in weight, waist hip ratio and the body mass index and no significant changes noticed in skin-fold thickness. Although Bhastrika pranayama improved the quality of living and confidence of the participants. This Yoga practice helped to reduce weight. The larger sample size is needed to gain better results.

7.0 CONCLUSION

This study showed that 60 days of Bhastrika Pranayama reduced Body mass index and waist hip ratio in obese patients. This revealed that yoga practice has significant role in improvement in the weight reduction. Decrease in Weight, Pulse rate, Diastolic Blood Pressure, Body Weight, Body Mass Index, Waist circumference, and Hip circumference showed that increase in the dominance of parasympathetic activity in Obese patients. However, the practice of Bhastrika pranayama showed not much appreciable changes in Respiratory Rate, Systolic Blood Pressure, Skin fold thickness, and Hip Ratio in these subjects. Further research need in this field with a larger sample size and duration is warranted to reveal accurate changes in this field.

8.0 SUMMARY

The aim of this study is to establish the effect of bhastrika pranayama on the abdominal obesity. Yoga is the frequently used as a lifestyle intervention to reduce obesity, stress, control blood glucose, cholesterol level, control hypertension. In this study, Sixty [male or female] patients with Abdominal Obesity of age group between 18-45 years will participate the bhastrika pranayama for 10 mins/twice a day for 60 days, under the supervision of Department of Yoga and Naturopathy, Government Yoga and Naturopathy Medical College, Arumbakkam, Chennai 106. 60 patients separated into two groups study group and control group. The assessment variables include pre-interventional and post-interventional .baseline data was collected on day 1 before subjecting the selected subjects into intervention and end point data collected on the day 60 ie., on the last day of the intervention after the subject finishes their concerned intervention. The collected data were properly maintained for the statistical analysis. Statistical analysis of the data collected was done by the method of unpaired 't' test. Following the analysis of the data, it was shown that there were significant changes in the abdominal obesity in the study group.

9.0 LIMITATIONS

1. The sample size is relatively smaller. Hence, generalizing the study outcomes to a larger population would not be definitely conclusive.
2. Duration of the practice is limited; longer exposure to the practice is needed.
3. Other naturopathic treatments acted as confounding factors during the study.

9.1 Direction for future research

1. This study should be replicated with a larger sample size.

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ANNEXURE 1

INFORMED CONSENT FORM

Title of the study: Effect of Bhastrika Pranayama on Abdominal Obesity in Men and Women – A Randomized Controlled Trial

Name of the Participant:

Name of the Principal Investigator: Dr. A. Jancy Rani

Name of the Institution: Government Yoga and Naturopathy Medical College, Arumbakkam, Chennai – 600 106.

Documentation of the informed consent

I _____ have read the information in this form (or it has been read to me). I was free to ask any questions and they have been answered. I am over 18 years of age and, exercising my free power of choice, hereby give my consent to be included as a participant in “Effect of Bhastrika Pranayama on Abdominal Obesity in Men and Women – A Randomized Controlled Trial”

1. I have read and understood this consent form and the information provided to me.
2. I have had the consent document explained to me.
3. I have been explained about the nature of the study.
4. I have been explained about my rights and responsibilities by the investigator.

5. I have been informed the investigator of all the treatments I am taking or have taken in the past _____ months including any native (alternative) treatment.
6. I have been advised about the risks associated with my participation in this study.
7. I agree to cooperate with the investigator and I will inform him/her immediately if I suffer unusual symptoms.
8. I have not participated in any research study within the past _____ month(s).
9. I am aware of the fact that I can opt out of the study at any time without having to give any reason and this will not affect my future treatment in this hospital.
10. I am also aware that the investigator may terminate my participation in the study at any time, for any reason, without my consent.
12. I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC. I understand that they are publicly presented.
13. I have understood that my identity will be kept confidential if my data are publicly presented.
14. I have had my questions answered to my satisfaction.
15. I have decided to be in the research study.

I am aware that if I have any question during this study, I should contact the investigator.
By signing this consent form I attest that the information given in this document has been clearly explained to me and understood by me, I will be given a copy of this consent document.

For adult participants:

Name and signature / thumb impression of the participant (or legal representative if participant incompetent)

Name _____ Signature _____

Date _____

Name and Signature of impartial witness (required for illiterate patients):

Name _____ Signature _____

Date _____

INFORMATION TO PARTICIPANTS

Investigator: Dr. A. Jancy Rani, B.N.Y.S

Name of Participant:

Title: Effect of Bhastrika Pranayama on Abdominal Obesity in Men & Women – A Randomized Controlled Trial

You are invited to take part in this research/ study /procedures. The information in this document is meant to help you decide whether or not to take part. Please feel free to ask if you have any queries or concerns. You are being asked to participate in this study being conducted in Government Yoga and Naturopathy Medical College, Arumbakkam, Chennai – 600 106.

The purpose of the research study is to determine the Effect of Bhastrika Pranayama on Abdominal Obesity in Men & Women – A Randomized Controlled Trial.

Study Procedures

The study involves assessment of Motor Nerve Conduction Velocity.

You will be required to visit the hospital during the study.

(The test involves Electro Myogram / EMG study before the commencement of therapies and after 56 days.)

You may have to come to the hospital (study site) for examination and investigations apart from your scheduled visits, if required.

Possible Risks to you - Nil

Possible benefits to you- Nil.

Possible benefits to other people

The result of the research may provide benefits to the society in terms of advancement of medical knowledge and/or therapeutic benefits to future patients.

Confidentiality of the information obtained from you

You have the right to confidentiality regarding the privacy of your medical information (personal details, results of physical examinations, investigations, and your medical history). By signing this document, you will be allowing the research team investigators, other study personnel, sponsors, IEC and any person or agency required by law like the Drug Controller General of India to view your data, if required.

The information from this study, if published in scientific journals or presented at scientific meetings, will not reveal your identity.

How will your decision to not participate in the study affect you?

Your decisions to not to participate in this research study will not affect your medical care or your relationship with investigator or the institution. Your doctor will still take care of you and you will not lose any benefits to which you are entitled.

Can you decide to stop participating in the study once you start?

The participation in this research is purely voluntary and you have the right to withdraw from this study at any time during course of the study without giving any reasons. However, it is advisable that you talk to the research team prior to stopping the treatment.

Signature of investigator

Signature of participant

Date