A DISSERTATION ON

"EFFICACY OF SURYA NAMASKAR ON NON ALCOHOLIC FATTY LIVER PATIENTS – A INTERVENTIONAL STUDY"

By

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Dissertation Submitted to
The Tamil Nadu Dr. M. G. R. Medical University, Chennai, Tamil Nadu
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DOCTOR OF MEDICINE

IN

YOGA

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The Institution Ethical Committee of Government Yoga & Naturopathy Medical College & Hospital, Chennai reviewed and discussed the application for approval of **"Efficacy of SURYA NAMASKAR on NON ALCOHOLIC FATTY LIVER DISEASE patients- A INTERVENTIONAL STUDY ."** for project work submitted by **Dr.C.A.KAYELARASI,** 2nd Year M.D. YOGA, Post Graduate, Government Yoga & Naturopathy Medical College & Hospital, Chennai – 600 106.

The proposal is APPROVED.

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Above all I thank God for all that I am blessed with.

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LIST OF ABBREVATIONS USED

NAFLD	NON ALCOHOLIC FATTY LIVER DISEASE
NASH	NON ALCOHOLIC STEATOHEPATITIS
IHD	ISHCHEMIC HEART DISEASE
PYS	PATANJALI YOGA SUTRAS
ALT	ALANINE AMINOTRANSFERASE
AST	ASPARTATE AMINOTRANSFERASE
SN	SURYA NAMASKAR
IR	INSULIN RESISTANCE
ITT	INSULIN TOLERANCE TEST
SH	SHAVASANA
CM	CYCLIC MEDITATION
TNF	TUMOUR NECROSIS FACTOR
HOMA	HOMEOSTATIC MODEL ASSESSMENT
GSH	GLUTATHIONE
USG	ULTRASONOGRAPHY

ABSTRACT

Background: The implementation of lifestyle modification and increase of physical activity has been proven to reduce NAFLD subjects. Regular exercise is known to a) reduce subcutaneous and visceral adipose tissue mass; b) reduce availability of adipose-derived FFAs to the liver; c) enhance adipose insulin sensitivity leading to lower FFAs and possibly reduced *de novo* lipogenesis. Rodent studies demonstrate that exercise increases d) β-oxidation; e) VLDL synthesis, removal and clearance and f) decreases *de novo* lipogenesis.

Methods: Fourty healthy volunteers of age group between 25-50yrs will participate in the study. After obtaining informed consent, the selected individuals would be screened by ultrasonography. The they taught with the practice of Surya Namaskar and they are followed up for three months of time. After three months , the individuals are made to undergo ultrasonography imaging again. The collection of first data is before the practice, Second data is taken immediately after the procedure.

Results: The study group showed reducation in fat accumulation in liver, with improvement in the heterogenecity and echogenecity of liver parenchyma.

Interpretation and Conclusion: Regular practice of Surya namaskar restores liver functions, reduces the fat accumulation, improves the lifestyle.

Key Words: Surya Namaskar, Ultrasonography, Non alcoholic fatty liver.

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1.0 INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is the buildup of extra fat in liver cells that is not caused by alcohol. It is normal for the liver to contain some fat. However, if more than 5% – 10% percent of the liver‟s weight is fat, then it is called a fatty liver (steatosis). Liver playing the central role in lipid metabolism, hepatic steatosis arises from an imbalance between triglyceride formation and utilization. The mechanism behind would be dysregulation of adipose lipolysis and dysregulation of hepatic de novo lipogenesis.(1) NAFLD appears to be most strongly associated with obesity, and insulin resistance states including diabetes and with other features of the metabolic syndrome, such as high triglycerides and low HDL. Prevalence of the disease is estimated to be around 9-32% in the general Indian population, with a higher incidence rate amongst obese and diabetic patients (from 44.1% in western India to 72.4% in northern states). NAFLD is also extremely common among patients undergoing bariatric surgery, ranging from 84% to 96%.(2)

Current management for NAFLD includes diet and lifestyle changes, management of underlying metabolic risk factors and pharmacological therapies. The objective of therapy is to prevent the complications. The problem with dietary and lifestyle interventions is that they are hard to implement. Compliance is the key. Until now, there is still no approved drug for the treatment of NAFLD. Insulin resistance is the main target of pharmacological therapy, but the question that we ask ourselves as physicians is who should receive medical treatment among NAFLD patients and for how long.(3) Over the past decades, application of herbal treatment for

NAFLD has received increasing attention due to its wide availability, low side effects, and proven therapeutic mechanisms and benefits. In recent years, some monomers and certain functional mixtures of herbs such as lyceum barbarum (wolfberry), garlic, green tea, resveratrol and milk thistle have been extensively used for NAFLD.(4)

Apart from the modern and herbal management of NAFLD, Yoga therapy can be given to alter its pathogenesis of development. The word „Yoga‟ is derived from the Sanskrit root „Yuj‟, meaning „to join‟ or „to yoke‟ or „to unite‟. As per Yogic scriptures the practice of Yoga leads to the union of individual consciousness with that of the Universal Consciousness, indicating a perfect harmony between the mind and body, Man & Nature. According to Patanjali‟s yoga sutras, yoga is “yogas chitta vritti nirodhah”, which means “yoga is the removal of the fluctuations of the mind”. Chitta is mind, vrittis are thought impulses, nirodah is removal. The various branches of yoga are raja yoga, jnana yoga, karma yoga, bhakthi yoga, kundalini yoga, mantra yoga and laya yoga. The astanga yoga comes under the raja yoga which defines yoga as having eight components (*aṣṭaṅga*, "eight limbs"): "The eight limbs of yoga are yama (abstinences), niyama (observances), asana (yoga postures), pranayama (breath control), pratyahara (withdrawal of the senses), dharana (concentration), dhyana (meditation) and samadhi (absorption).(5)

Surya namaskara, a sequential form of yoga practice has been handed down from the enlightened sages of the Vedic Age. The Sanskrit name *surya* here refers to the sun and *namaskara* means 'salutations'. It is an ancient Indian method of

offering prayers to the rising Sun, facing east, in the morning along with a series of physical postures with regulated breathing aiming at range of physical, mental and spiritual benefits. Surya namaskar is a graceful combined sequence of twelve positions along with regulated breathing and relaxation.(6) It is proved to relieve stiffness, revitalizing the body, refreshing the mind and to purify the subtle energy channels. The series of postures is highly proved scientifically to reduce obesity and to treat various metabolic disorders.(7)

The purpose of the research is to prevent and reduce the complications of liver disorders, to reduce lipids in the liver and to maintain it healthy. Since there is no research has been carried with a yogic intervention like Surya namaskar to manage fatty liver disease, this study would benefit Non-alcoholic fatty liver disease patients.

AIM AND OBJECTIVES

AIM

To analyze the effect of Surya Namaskar on Non Alcoholic Fatty liver disease patients. (NAFLD)

OBJECTIVES

To evaluate the diffuse echogenicity and heterogenicity of liver parenchyma of non alcoholic fatty liver disease using ultra sound imaging

REVIEW OF LITERATURE

NON ALCOHOLIC FATTY LIVER DISEASE

Non-alcoholic fatty liver disease (NAFLD) is a very common disorder and refers to a group of conditions where there is accumulation of excess fat in the liver of people who drink little or no alcohol. The most common form of NAFLD is a non serious condition called fatty liver. In fatty liver, fat accumulates in the liver cells. Although having fat in the liver is not normal, by itself it probably does not damage the liver. A small group of people with NAFLD may have a more serious condition named non-alcoholic steatohepatitis (NASH). In NASH, fat accumulation is associated with liver cell inflammation and different degrees of scarring. NASH is a potentially serious condition that may lead to severe liver scarring and cirrhosis. Cirrhosis occurs when the liver sustains substantial damage, and the liver cells are gradually replaced by scar tissue, which results in the inability of the liver to work properly. Some patients who develop cirrhosis may eventually require a liver transplant.(8)

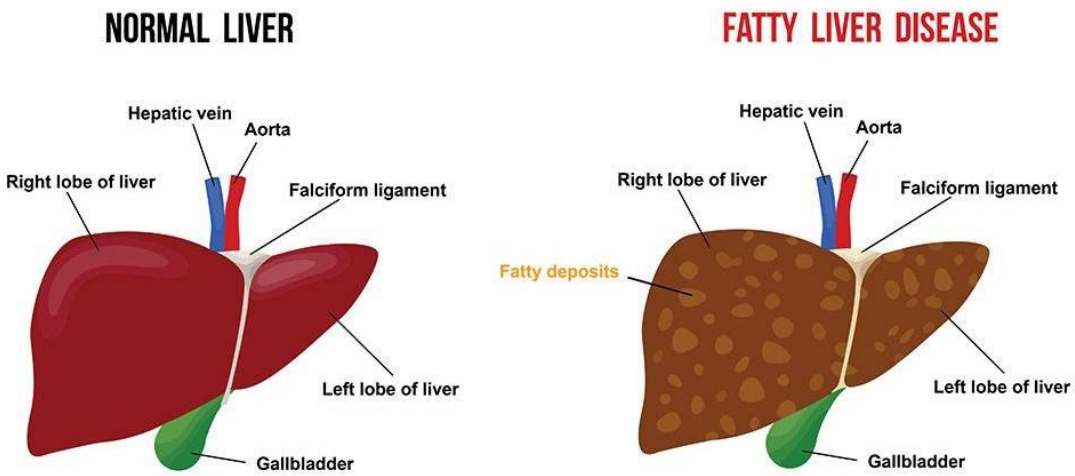

Figure-1: Normal and Fatty Liver

EPIDEMIOLOGY

The prevalence of NAFLD in the general population of Western countries is 20-30%. About 2-3% of the general population is estimated to have non-alcoholic steatohepatitis (NASH), which may progress to liver cirrhosis and hepatic carcinoma. As a rule, the prevalence of NAFLD is higher in males and increases with increasing age, and it is influenced by the diagnostic method and the characteristics of the population, especially lifestyle habits. The prevalence of NAFLD is 80-90% in obese adults, 30-50% in patients with diabetes and up to 90% in patients with hyperlipidemia. The prevalence of NAFLD among children is 3-10%, rising up to 40-70% among obese children. Moreover, pediatric NAFLD increased from about 3% a decade ago to 5% today, with a male-to-female ratio of 2:1. Prevalence of the disease is estimated to be around 9-32% in the general Indian population, with a higher incidence rate amongst obese and diabetic patients (from 44.1% in western India to 72.4% in northern states). Prevalence of the disease was found to be higher in females (60%) than in males (54.3%).(2)

RISK FACTORS FOR NAFLD

Based on the current knowledge, it appears that a combination of genetic, demographic, clinical and environmental factors may play a role in determining the likelihood of NAFLD in a given individual.(9)

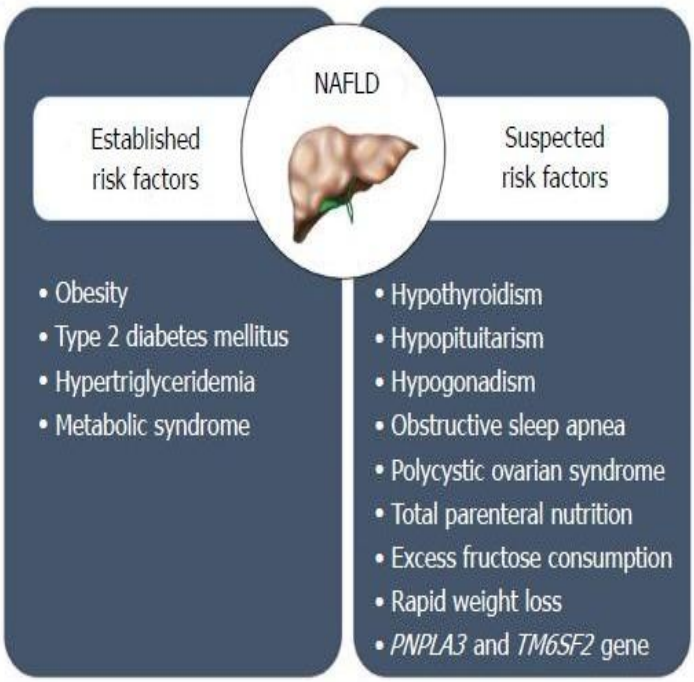

Figure-2: Risk Factors.

ETIOLOGY

Insulin resistance

Insulin resistance is believed to be the key factor that leads to increased lipolysis in peripheral adipose tissue and increased uptake of fatty acids by hepatocytes. Hyperinsulinemia resulting from insulin resistance also adds to fatty acid content of hepatocytes by increasing glycolysis and by decreasing apolipoprotein B-100 production, and hence export of fatty acids as very low density lipoproteins (VLDL). The end result is an increase in fatty acids and triglycerides in the hepatocytes leading to steatosis. Insulin resistance is almost universal in patients with NAFLD and is related to an imbalance between proinsulin (adiponectin) and anti-insulin cytokines (TNF-α), particularly those secreted from adipose tissue (adipokines).Insulin

resistance was tested using insulin tolerance test (ITT) and HOMA–IR since many studies from many Indian centers have reported insulin resistance to be common in patients with NAFLD. Though glucose clamp studies are ideal method of studying insulin resistance, most studies in Indian patients with NAFLD have used HOMA-IR.(10)

Metabolic syndrome

Currently, NAFLD is considered to be an integral part of the metabolic syndrome with insulin resistance as a central pathogenic factor. Metabolic syndrome is characterized by the presence of insulin resistance in association with other metabolic abnormalities such as obesity, diabetes, dyslipidemia and hypertension. According to adult treatment panel III (ATP III) criteria, metabolic syndrome is defined by presence of at least 3 of the 5 criteria, namely obesity, diabetes mellitus, hypertension, low HDL, high triglycerides. Studies found full-blown metabolic syndrome as defined by the ATP III criteria in 50% of the patients, and at least one of the above criteria in 90% of patients (unpublished data). Other centers from India have also reported the presence of metabolic syndrome in 21–68% of patients, and at least one criterion in almost all the patients.(8)

Overweight/obesity

Studies from India used the international criteria for defining overweight and obese states reported obesity in only 12–30% of patients with NAFLD. Recommendations for BMI are: normal 18–22.9 kg/m2 , overweight 23–24.9 kg/m2 and obesity as BMI ≥25 kg/m2 [42]. Central or abdominal obesity is more commonly associated with insulin resistance and has been

observed in 80–90% of Indian patients with NAFLD. A high prevalence of abdominal obesity is seen in Asians, including Asian Indians even when the BMI is less than 25 kg/m2. Lower cutoffs (waist circumference ≥90 cm in males and ≥80 cm in females) are also recommended for identifying abdominal obesity in Asian Indians.(10)

Diabetes mellitus

NAFLD has been associated very closely with the presence of type 2 diabetes mellitus. DM is an important determinant of both presence and severity of NAFLD. It was found that DM and impaired glucose tolerance was uncommon in patients of NAFLD presenting with raised transaminases, being present in only 12% and 14% of our patients, respectively; however, IR was found in more than 80% of patients. It was hypothesized that milder degree of IR in our patients with NAFLD may be adequate to cause fatty liver, but may not cause DM.(10)

Hypertension

As with DM, hypertension is also not common in Indian patients with non-cirrhotic NAFLD presenting with raised transaminases.(10)

Dyslipidemia

In contrast to low prevalence of DM and hypertension, dyslipidemia is a common feature, and is present in approximately 50% of Indian patients with NAFLD. Both components of metabolic syndrome (high triglycerides and low HDL) were observed with almost equal frequency, being present in 53% and 66% patients with NAFLD, respectively.(10)

Oxidative stress

An increased load of fatty acids in hepatocytes increases the rate of mitochondrial β-oxidation and levels of cytochrome P450 4A and cytochrome P4502E1, leading to increase in reactive oxygen species. The increased mitochondrial oxidative stress provides the second hit, facilitating progression from steatosis to steatohepatitis and fibrosis through three main mechanisms, namely lipid peroxidation, cytokine induction, and Fas ligand induction. A high ratio of reduced glutathione (GSH) to oxidized glutathione (GSSG) protects against oxidative stress. In patients with NAFLD, hepatic GSH levels are reduced, but the redox imbalance may be lower than that seen in patients with alcoholic liver disease.(8)

Iron/HFE gene mutations

The relationship between iron overload and NAFLD is complex and remains unresolved, with researches both favoring and refuting a role for iron in the pathogenesis of NAFLD. Saturation of mitochondrial β-oxidation leads to peroxisomal oxidation and generation of hydrogen peroxide, which in the presence of increased iron is converted to hydroxyl radicals, adding to the oxidative stress and cellular injury.(8)

Genetic predisposition to NAFLD

Although obesity, lifestyle variation, and insulin resistance are the most prevalent risk factors leading to the development of NAFLD in a person, NAFLD varies substantially among subjects with comparable lifestyle, environmental impact, and metabolic abnormalities, indicating that other factors contribute to pathogenesis. The heritability and interethnic variations

in susceptibility suggest that genetic factors may play an important role in determining the phenotypic manifestation and overall risk for NAFLD. NAFLD clusters in families with certain genetic variants on or near *TM6SF2*, *PNPLA3*, *NCAN*, and *PPP1R3B* genes that increase the heritability of NAFLD by up to 27% within families. One genetic variant that is associated with NAFLD is a missense mutation [Ile148 - > Met148 (I148M)] in the palatin-like phospholipase domain-containing 3 gene (*PNPLA3*).(8)

Gender and age-related risk

Generally, gender differences exist in NAFLD. Prevalence of NAFLD and NASH was higher in men. Women are at a reduced risk of NAFLD compared with men at their reproductive period, whereas after menopause women lose the protective effect and have a comparable prevalence of NAFLD as men. These associations were consistent with children.(8)

Contribution of diet composition

Due to the evidence supporting that obesity is associated with NAFLD, some macro- and micro-nutrients contribute more to the epidemic of NAFLD. Fructose is a major player, either from sucrose or high fructose corn syrup found in beverages. Consumption of such beverages has increased five-fold in the United States since 1950, and drinking two average size sugar containing beverage servings for 6 months ends up mirroring many features of NAFLD. It is hypothesized that sugars promote de novo lipogenesis and trigger inflammatory response leading to hepatocyte apoptosis via the c-Jun-N-Terminal pathway.(8)

Sleep deprivation

Sleep disturbances and disorders are common medical problems in the current era. Epidemiological studies have provided evidence that poor sleep quality and sleep deprivation is associated with obesity which plays a key role in the pathogenesis of NAFLD. Biologic plausibility for this independent association has been explored by evaluating the role of inflammatory cytokines interleukin 6 and TNF-α. These cytokines are increased by sleep disturbances and play a role in pathogenesis of NAFLD by increasing adipocyte lipolysis which in turn can cause hepatic overflow of free fatty acids. Further, sleep deprivation can affect hypothalamus pituitary adrenal axis, which in turn affects cortisol metabolism leading to hepatic fat accumulation.(10)

PATHOGENESIS

The first step appears to involve deposition of excess fat in the liver; this is followed by increased fatty acid oxidation, oxidative stress and cytokine production, resulting in progression to steatohepatitis and fibrosis.(11) Various pathogenetic mechanisms that pay a role include cytokines (tumor necrosis factor (TNF)-α, adiponectin, resistin, leptin, interleukins, transforming growth factor ß etc.) that lead to insulin resistance, and serum and liver iron overload and oxidative stress that lead to necroinflammation and fibrosis.(12)

Hepatic triglyceride concentration is a function of

a. The delivery of free fatty acids (FFAs) to the liver from dietary sources and adipose tissue
b. De novo lipogenesis

c. Hepatic β-oxidation

d. Very low density (VLDL) lipoprotein synthesis, export and clearance. (11)

Donnelly *et al* demonstrated that in obese individuals with NAFLD, adipose-derived plasma FFAs are the dominant contributor to hepatic steatosis, with de novo lipogenesis and dietary fatty acids accounting for approximately 25% and 15% of hepatic triglyceride formation, respectively. Based on this data, we could conclude that strategies which ameliorate the delivery of FFAs to the liver from adiposetissue should impart the most significant benefit in reducing liver fat.(11)

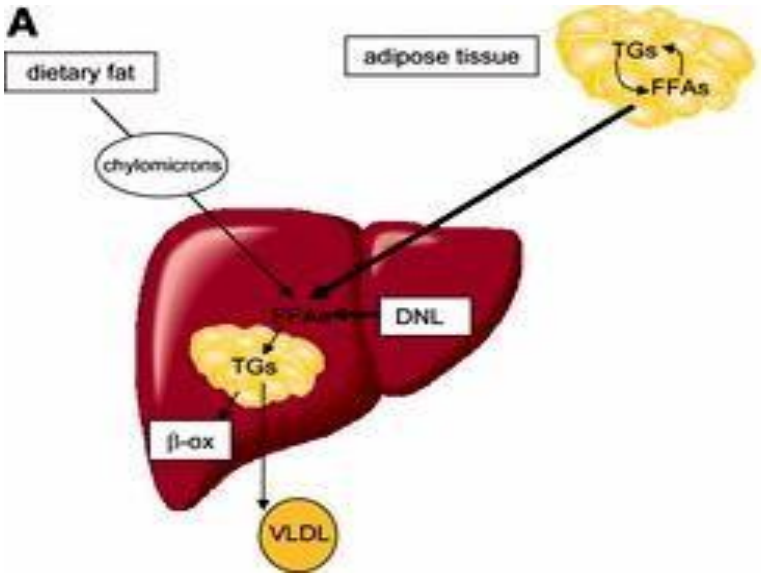

Figure-3: Processes involved in the development of hepatic steatosis.

Thick lines indicate dominant effect on triglyceride concentration. FFAs from adipose tissue are the dominant source of fatty acids for hepatic triglyceride, followed by *de novo*lipogenesis and chylomicron-derived fatty acids from dietary

fat. Hepatic triglyceride concentration is also a function of hepatic β-oxidation and the synthesis, removal and clearance of very low density lipoproteins.(13)

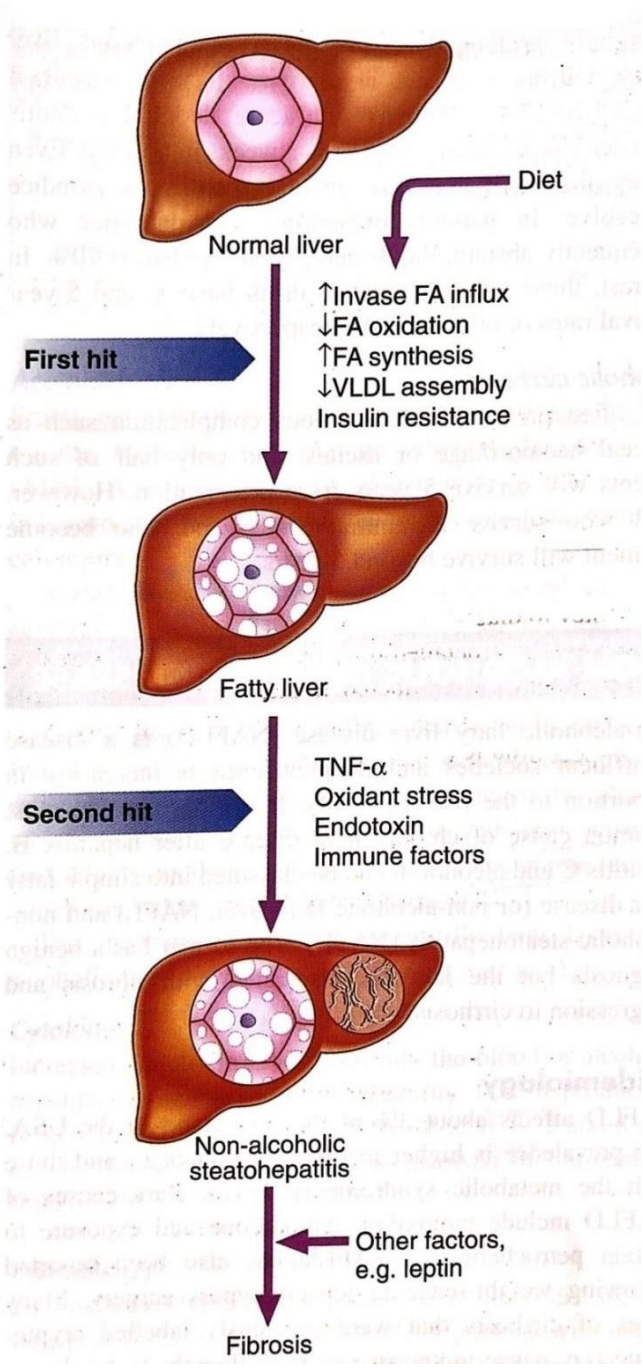

Figure-4: Pathogenesis and complications of fatty liver

SYMPTOMS

Nonalcoholic fatty liver disease usually causes no signs and symptoms. When it does, they may include:

- Enlarged liver
- Fatigue
- Pain in the upper right abdomen.(14)

SIGNS OF NAFLD/NASH

- an enlarged liver
- signs of insulin resistance such as darkened skin patches over your knuckles, elbows, and knees
- signs of cirrhosis, such as jaundice, a condition that causes your skin and whites of your eyes to turn yellow

COMPLICATIONS

The main complication of nonalcoholic fatty liver disease and nonalcoholic steatohepatitis is cirrhosis, which is late-stage scarring (fibrosis) in the liver. Cirrhosis occurs in response to liver injury, such as the inflammation in nonalcoholic steatohepatitis.(15) As the liver tries to halt inflammation, it produces areas of scarring (fibrosis). With continued inflammation, fibrosis spreads to take up more and more liver tissue. If the process isn't interrupted, cirrhosis can lead to:

- Fluid buildup in the abdomen (ascites)
- Swelling of veins in your esophagus (esophageal varices), which can rupture and bleed

- Confusion, drowsiness and slurred speech (hepatic encephalopathy)
- Liver cancer
- End-stage liver failure, which means the liver has stopped functioning.(16)

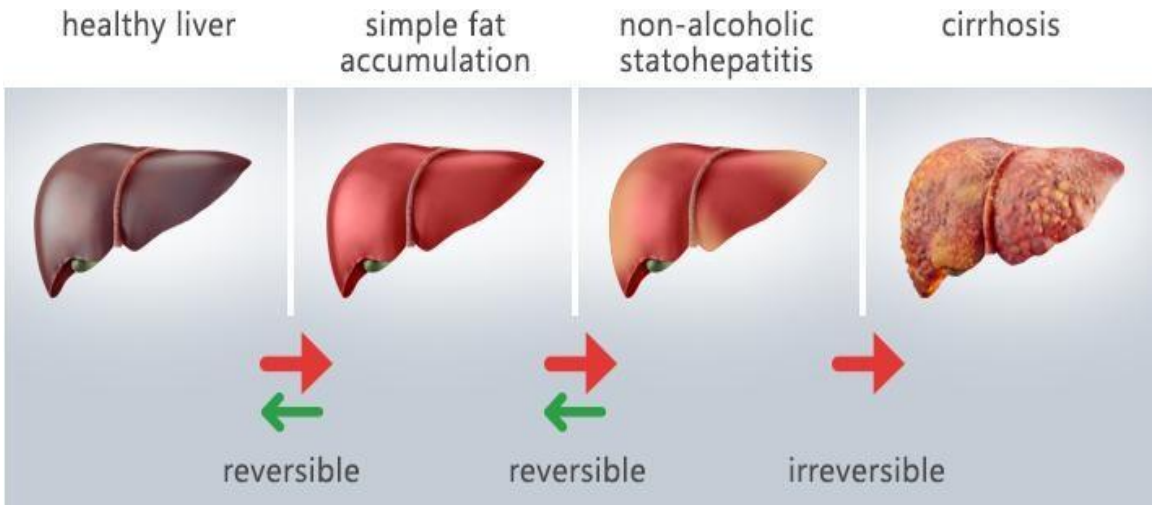

Figure-5: Complications of Fatty Liver Stages

DIFFERENTIAL DIAGNOSIS

- Wilson‟s disease
- Medication induced steatosis
- Hepatitis C
- Cholesterol Ester Storage Disease
- Type 1 Diabetes and fatty liver:
- Congenital mitochondrial hepatopathies
- Mitochondrial dysfunction disorders (17)

PHYSICAL EXAMINATION

During a physical examination, first it‟s necessary to check the weight and height of the patient to calculate the body mass index.(18)

INVESTIGATIONS

- Blood tests,
- Imaging tests,
- Liver biopsy to diagnose NAFLD and NASH.(18)

Blood tests

In NAFLD or NASH, blood shows increased levels of the liver enzymes, alanine aminotransferase (ALT) and aspartate aminotransferase (AST).

Imaging tests

The following imaging tests to diagnose NAFLD are:

Ultrasound uses a device called a transducer, which bounces safe, painless sound waves off your organs to create an image of their structure.

Computerized tomography (CT) scans. CT scans use a combination of x-rays and computer technology to create images of your liver. For a CT scan, a health care professional gives you a solution to drink and an injection of a special dye, called contrast medium. Contrast medium makes the structures inside your body easier to see during the procedure. You need to lie on a table that slides into a tunnel-shaped device that takes the x-rays.(19)

Magnetic resonance imaging (MRI) machines use radio waves and magnets to produce detailed images of your organs and soft tissues without using x-rays. A health care professional will give you an injection of contrast medium. With most

MRI machines, you will be made to lie on a table that slides into a tunnel-shaped device. Some machines allow you to lie in a more open space; examining the liver can be more difficult with these machines.

Ultrasonography allows for reliable and accurate detection of moderate-severe fatty liver, compared to histology. Because of its low cost, safety, and accessibility, ultrasound is likely the imaging technique of choice for screening for fatty liver in clinical and population settings. Conventional B-mode ultrasonography is the most common technique used to assess the presence of fatty liver in clinical settings and population studies. However, several limitations of ultrasonography, including operator dependency, subjective evaluation, and limited ability to quantify the amount of fatty infiltration, have raised concerns.(19)

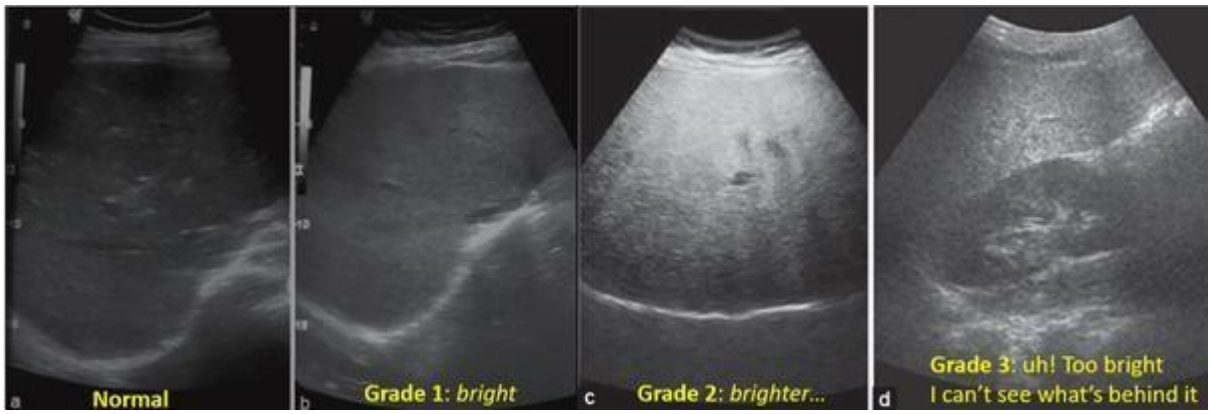

Figure-6: Grading of liver through ultrasonography

MANAGEMENT

In 2006, LA Adams, Pangulo published in postgraduate medical journal regarding the treatments of NAFLD. In their study the stated that the treatment of NAFLD should begin with screening and managing metabolic risk factor that may modify the risk of liver disease as well as non-liver related disease such as Ischemic Heart disease.(3)

Treatment strategies for NAFLD have revolved around

- Identification and treatment of associated metabolic conditions such as diabetes and hyperlipidaemia
- Improving insulin resistance by weight loss, exercise, or pharmacotherapy
- Using hepato-protective agents such as antioxidants to protect the liver from secondary insults.(3)

Insulin sensitizing drugs. It is well established that insulin resistance is a common association with patients with NAFLD and plays an important part in lipid accumulation within the liver and perhaps its progression to NASH.

Metformin is a biguanide antihyperglycaemic agent, giving doses of 1–1.5 g/day, have showed improvement in ALT levels whose mechanism of action improved hepatic steatosis, which was accompanied by down-regulation of TNFα and lipid transcription factors.

The **thiozoladinediones** bind to the peroxisome proliferator activated receptor γ (PPAR) resulting in improved insulin sensitivity and redistribution of adipose tissue. Those were pioglitazone - 30 mg daily and rosiglitazone - 4 mg twice daily showed improvement in ALT, hepatic steatosis, and features of hepatic inflammation.(3)

Antioxidants Subjects with NAFLD exhibit increased levels of oxidative stress and lipid peroxidation that may play a part in disease progression. Vitamin E (1000 IU/day) and Vitamin C (1000 mg/day) are potent antioxidants which been evaluated among paediatric and adult patients with NAFLD which reduced ALT levels and also improved hepatic inflammation and fibrosis(3)

Other hepatoprotective agents

A variety of hepato-protective agents used in other liver disease have been evaluated in patients with NAFLD. Pentoxifylline inhibits TNFα and has been shown to improve short term survival in severe alcoholic hepatitis. Similarly, betaine, a methyl donor that protects against hepatic lipid accumulation, lowered aminotransaminase levels and also improved steatosis, inflammation, and liver fibrosis.

Angiotensin II promotes insulin resistance and hepatic fibrosis in animal models. Losartan is an antagonist against the angiotensin II receptor that improved aminotransaminases, serum markers of fibrosis, and levels of profibrotic cytokine transforming growth factor β1. Ursodeoxycholic acid (UDCA) has anti-inflammatory, immune modulating, and antiapoptotic properties and is widely used in chronic cholestatic liver diseases.(3)

Lipid lowering drugs

As hypertriglyceridaemia and low HDL cholesterol levels are a manifestation of insulin resistance and common among subjects with NAFLD, several investigators have used lipid lowering drugs to treat

NAFLD like The use of statin drugs like atorvastatin showed improvement

in liver enzymes. In addition, a study states that pravistatin 20 mg given for six months normalized liver enzymes and improved hepatic inflammation.(3)

CONVENTIONAL MANAGEMENT

In 2013, Jia Xiao and colleagues published the herbal treatments of NAFLD in the journal of traditional and complementary medicine. Over the past decades, application of herbal treatment for NAFLD has received increasing attention due to its wide availability, low side effects, and proven therapeutic mechanism and benefits. Some monomers and functional derivatives of herbs like lycii fructus (wolf berry, goji berry), allium sativum (garlic), green tea from plant leaves of camellia sinensis, resveratrol (phytoalexin extracted from red grapes), sily marianum (milk thistles), a flowering plant from daisy family act on pathogenesis of NAFLD and helps in its prognosis.(20)

There are several medicine and science available around us to treat and manage the human ailments. But very few sciences only have the potential to prescribe the correct way of living. One such universal science is Yoga. The science, yoga doesn‟t belong to any particular community, religion, caste or country. It is common to all and not patented to any particular section.(4)

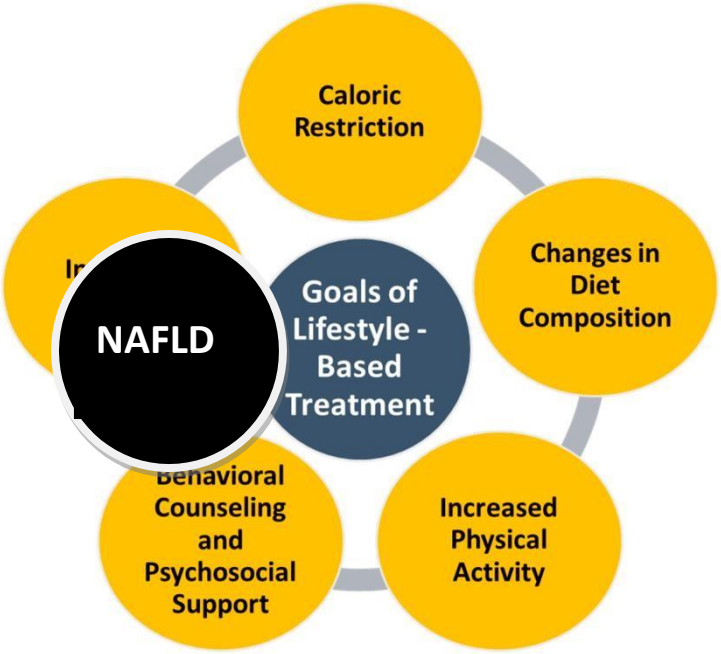

Figure-7: Lifestyle Modification

INTRODUCTION OF YOGA

The word yoga is derived from the word “Yuj” which means union of body and mind or human and nature. Everything in the universe is the manifestation of a single energy. One who really understands this knowledge becomes a great yoga expert. Thus the aim of yoga is to attain the self-realization and thereby to overcome the worldly sufferings. Health and harmony is the ultimate aim and objective of Yoga.(5)

Historically, yoga is said to be an immortal cultural outcome of Indus Valley Civilization dated back to 2700 B.C. The seals and fossil remains of the Indus Valley Civilization depict the persons performing yoga postures and practices explain the presence of yoga in the ancient India.

Though the yoga was practiced in the pre-vedic period, the great sage Patanjali systematized the practices of yoga, its objective, meaning and

benefits through his various yogic sutras called as Patanjali yoga sutras. He coined his yoga as Astanga Yoga, which means eight limbs of yoga. The text named patanjali yoga sutras consists of total 196 sutras and it is believed that it was written by around 350 CE by the great saint Patanjali. It is also believed that apart from yoga sutras, Patanjali also left his footprints in the field of ayurvedic medicine, Sanskrit and grammar. Very little information only is available about the great man Patanjali, infact it is completely uncertain whether Patanjali was an individual person or just a simple imaginary name created by the olden people. Whatever it may be about the sage Patanjali, the sutras are still lively and it explains various meanings about yoga till date.(21)

The patanjali yoga sutras are divided into 4 chapters or padas such as,

Samadhi Pada – Explains what yoga is,

Sadhana Pada – Explains how to attain the state of yoga,

Vibhuti Pada – Explains the benefits of yoga practices, and

Kaivalya Pada – Explains how to get free from the sufferings.

Samadhi pada contains 51 versus (sutras), sadhana pada 55 versus, vibhuti pada 56 versus and finally the kaivalya pada contains 34 versus.

Through his 196 yoga sutras, the great sage Patanjali taught and advised the people of the world how to lead a happy, contended and misery free life. Anyone by following the principles of these sutras will surely end up in a divine place where there will be no evils and sorrows prevail.(22)

Astanga yoga:

The eight limbs of yoga are as follows:

"yamaniyamaasanapranayama

pratyhara dharana dhyana samadhayo-stavangani"

The eight rungs, limbs, or steps of Yoga are the codes of self-regulation or restraint (yamas), observances or practices of self-training (niyamas), postures (asana), expansion of breath and prana (pranayama), withdrawal of the senses (pratyahara), concentration (dharana), meditation (dhyana), and perfected concentration (samadhi).(23)

Yama – Ethical and Moral Codes of Conduct

"ahimsa satya asteya brahmacharya aparigraha yama"

Non-injury or non-harming (ahimsa), truthfulness (satya), abstention from stealing (asteya), walking in awareness of the highest reality (brahmacharya), and non- possessiveness or non-grasping with the senses (aparigraha) are the five yamas, or codes of self-regulation or restraint, and are the first of the eight steps of yoga.

Niyama – Personal Codes of Conduct

"shaucha santosha tapah svadhyaya ishvarapranidhana niyamah"

Cleanliness and purity of body and mind (shaucha), and attitude of contentment (santosha), ascesis or training of the senses (tapas), self-study and reflection on sacred words (svadhyaya), and an attitude of letting go into one‟s source (ishvarapranidhana) are the observances or practices of self-training (niyamas),

and are the second rung on the ladder of yoga.

3.14.3.Asana – Body Posture

"sthira sukham asanam"

The posture (asana) for yoga meditation should be steady, stable and motionless, as well as comfortable, and this is the third of the eight rungs of yoga.

Pranayama – Breath Control

"tasmin sati shvasa prashvsayoh gati vichchhedah pranayamah"

Once that perfected posture has been achieved, the slowing or braking of the force behind, and of unregulated movement of inhalation and exhalation is called breath control and expansion of prana (pranayama), which leads to the absence of the awareness of both, and is the fourth of the eight rungs.

Pratyahara – Withdrawal of Senses

"sva vishaya asamprayoge chittasya avarupe anukarah iva indriyanam pratyaharah"

When the mental organs of senses and actions (indriyas) cease to be engaged with the corresponding objects in their mental realm, and assimilate or turn back into the mind-field from which they arose, this is called pratyahara, and is the fifth step.

Dharana – Concentration

"deshah bandhah chittasya dharana"

Concentration (dharana) is the process of holding or fixing the attention of mind onto one object or place, and is the sixth of the eight rungs.

Dhyana – Meditation

"tatra pratyaya ekatanata dhyanam"

The repeated continuation or uninterrupted stream of that one point of focus is called absorption in meditation (dhyana), and is the seventh of the eight steps.

Samadhi – Enlightenment

"tad eve artha matra nirbhasam svarupa shunyam iva samadhih"

When only the essence of that object, place, or point shines forth in the mind, as if devoid even of its own form, that state of deep absorption is called deep concentration or Samadhi, which is the eight rung.(22)

Among these 8 limbs of yoga, the 3rd limb asana (posture) helps in keeping the physical body healthy and in good structure. Its acts at all the systems of the body, but predominantly on the musculoskeletal system. The 4th limb pranayama (breath control) helps in keeping the respiratory and circulatory system healthy. It also indirectly governs the nervous system and the brain function.(6)

INTRODUCTION TO SURYA NAMASKAR

The Sanskrit name Surya refers to the sun and Namaskara means 'salutations'. Surya Namaskar word is a combination of two words, one is Surya and other one is Namaskar. It means Surya is form of fire and Namaskar is form of respect. Surya Namaskara has been handed down from the enlightened sages of Vedic Age. Sage Samarth Ramdas and the Marathas have performed Surya Namaskara as a physical training to develop fit bodies.(7)

The sun symbolizes spiritual consciousness and in ancient times was worshipped on a daily basis. In yoga, the sun is represented by pingala or surya nadi. Surya Namaskar is not regarded as being a traditional part of hatha yoga, as it was added to the original asana group at a later time. However, it is an effective way of loosening up, stretching, massaging and toning up of all the joints, muscles and internal organs of the body.

The practice of Surya Namaskar comprises of actions such as flexion, extension, forward bending, back ward bending, stretching , inhalation, exhalation, squeezing, and compression of almost all the muscles of the body. By these actions, the physiological effects are obtained. Its versatility makes it one of the most useful methods of inducing a healthy, vigorous and active life. The practice of surya Namaskar, at the same time helps for spiritual awakening and the resulting expansion of awareness.(24)

Surya Namaskara is a complete sadhana and spiritual practice in itself as it includes asana, pranayama, mantra and meditation techniques. It is an excellent set of asanas with which to start morning practice.Regular practice of Surya

Namaskara regulates pingala nadi, whether it is under active or over active. Regulation of pingala nadi leads to a balanced energy at both mental and physical levels.

Surya Namaskara is composed of three elements: form, energy and rhythm. The twelve asanas generate prana, the subtle energy which activates the psychic body. The performance of the asanas in a steady, rhythmic sequence reflects the rhythms of the universe; the twenty four hours of the day, the twelve zodiac phases of the year and the biorhythms of the physical body. The application of this form and rhythm to the body and mind complex helps to generate the transforming force which produces a more dynamic life.(6)

Historically, it is believed that in the state of Maharashtra, Shivaji Maharaja, Sage Samarth Ramdas and the Marathas have all performed Surya Namaskar as a physical exercise to develop fit bodies. This may be related to vyayam "physical exercise" in Sanskrit.(25)

Surya Namaskar is a procedure in which 90% to 95% of muscles are stretched and activated. This series gives a profound stretch to the body that it is considered to be a complete yoga practice by itself. Therefore Surya Namaskar has been rightly called “Sarvang Sunder Vyayam” or the best all round exercise.(26)

"David Coulter explains, the various mechanism involved in each posture of Surya Namaskar.(27)

- **Standing postures (Pranamasana and Hasta Uttanasana)** floods the nervous system with sensory input from all over the body.

- **In Ashwa Sanchalasana,** one thigh is flexed with respect to the body and the other thigh is hyper extended. In this sense, the abducted hip is more in alignment with the frontal plane of the trunk. Such Position helps in facilitation of autonomic nervous system causing increased awareness of the nervous system, co-ordinating and stretching of the muscles, leading to increase in blood supply and pain relief.
- **Forward bending Padahastasana,** tends to inhibit the somatic nervous system and sympathetic limb of the autonomic nervous system. Flexing forward enough in the spine and hips compresses the abdomen and have mildly invigorating effects on abdominal organs and causes stimulation of enteric nervous system. Relaxation of pelvic floor muscles will lead to the reduction of stimulus passing through the spasmodic muscles and will lead to pain relief.

Karel Nespor published an article on yoga and pain relief in which he mentions that, decreased activation of brain may be due to decreased input of stimuli from the internal as well as external environment.[76] Lying posture like Shavasana, will minimise the sympathetic effects on organs and tissues throughout the body. Thus when a person lies in Shavsana, the sympathetic nervous system calms down, reduces the muscle tone in smooth muscle that encircles the artery and arterioles which allows those vessels to dilate to increase the blood supply.(27)

PRACTICE OF SURYA NAMASKAR:

Preparation

Before commencing the practice, stand with the feet together or slightly apart. The arms should be hanging loosely by the side of the body. Close the eyes gently and have awareness on the whole physical body as one homogeneous unit. In this position the body may sway. Try to minimize the oscillation by balancing the body weight equally on both feet.

Bring the awareness inside the body and mentally begin to relax. Starting from the top of the head, take the awareness systematically through all the parts. By doing so, try to release any tension. Intensify once more, the awareness of the whole physical body and feel in harmony with it.

Take the awareness to the soles of the feet in contact with the floor. Feel the whole body is being pulled downwards due to gravity and that any tensions are being pulled down into the ground. At the same time, experience the vital force rising up from the earth and flooding the whole body.

Finally, take the awareness to the eyebrow center and visualize a rising sun. The rays of the sun infuses the whole body and mind and produces a vitalizing and healing effect.(6)

TWELVE STEPS OF SURYA NAMASKAR

Figure-8: Pranamasana

Position 1:

- Remain standing upright with the feet together.
- Slowly bend the elbows and place the palms together in front of the chest in Namaskara mudra.
- Relax the whole body.

Breathing: Breathe normally.

Awareness: Physical - on the chest area. Spiritual - on Anahata chakra.

Mantra: Om Mitraya Namaha, salutations to the friend of all

Benefits: This pose establishes a state of concentration and calmness in preparation for the practice to be performed.(6)

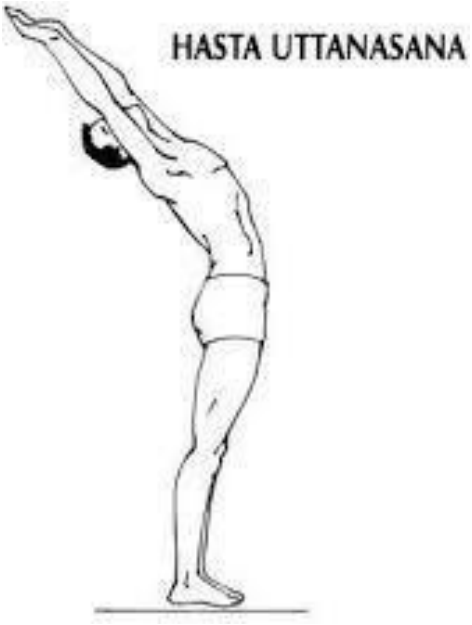

Figure-9: Hasta utthanasana(Raised arm pose)

Position 2:

- Raise and stretch both arms above the head. Keep the arms separated, shoulder width apart.
- Bend the head, arms and upper trunk backward.

Breathing: Inhale while raising the arms.

Awareness: Physical - on the stretch of the abdomen and expansion of the lungs.

Spiritual: on Vishuddhi chakra.

Mantra: Om Ravaye Namaha, salutations to the shining one.

Benefits:

- This pose stretches all the abdominal organs and improves digestion.
- It exercises the arm and shoulder muscles
- It helps to tones the spinal nerves
- It helps to remove excess weight.(6)

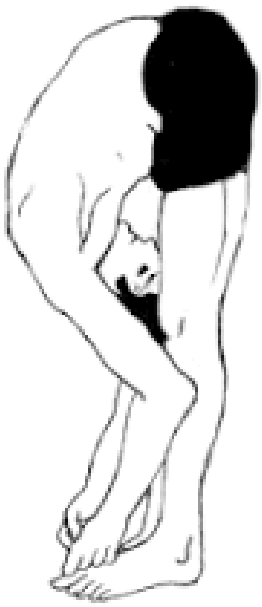

Figure-10: Padahastasana (Hand to foot pose)

Position 3:

- Bend forward until the fingers or palms of the hands touch the floor on either side of the feet.
- Try to touch the knees with the forehead.
- Make a note to keep the knees straight.

Breathing: Exhale while bending forward. Try to contract the abdomen to expel the maximum amount of air from the lungs.

Awareness: Physical - on the pelvic region.

Spiritual - on Swadhisthana chakra.

Mantra: Om Suryaya Namaha, salutations to he who induces activity.

Contra-indications: People with back conditions should not bend forward fully. They should bend from the hips, keeping the spine straight. Slowly bend until the back forms ninety degree angle with the legs or bend only as far as comfortable.

Benefits:

- This pose is useful in eliminating or preventing stomach or abdominal ailments.
- It reduces excess weight in the abdominal region, improves digestion and helps to remove constipation.
- It improves blood circulation, makes the spine supple and tones the spinal nerves.(6)

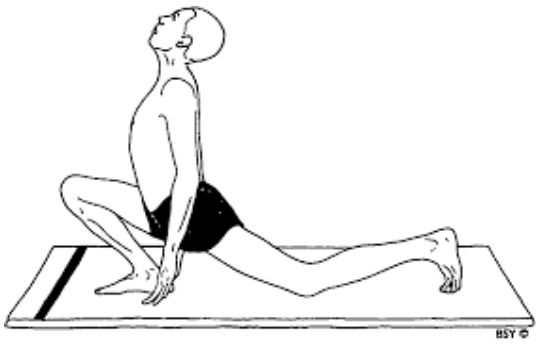

Figure-11: Ashwa Sanchalasana (Equestarian pose)

Position 4:

- Place the palms of the hands flat on the floor beside the feet.
- Stretch the right leg back as far as possible. At the same time, bend the left knee, keeping the left foot on the floor.
- Keep the arms straight and in the final position, the weight of the body should be supported on hands, the left foot, right knee and toes of the right foot.
- The head should be tilted backward, the back arched and the inner gaze directed upward to the eyebrow center.

Breathing: Inhale while stretching the leg back.

Awareness: Physical - on the stretch from the thigh to the chest or on the eyebrow centre. Spiritual - on Ajna chakra.

Mantra: Om Bhanave Namaha, salutations to he who illumines.

Benefits:

- This pose massages the abdominal organs and improves their functioning.
- It strengthens the leg muscles
- It induces balance in the nervous system.

Practice note: In the final pose the palms of the hands are kept flat on the floor initially. Later on, more advanced practitioners may use the fingertips.(6)

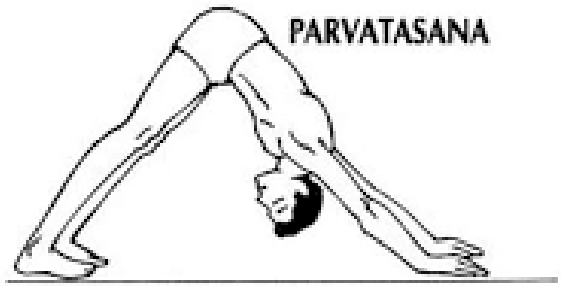

Figure-12: Parvatasana (Mountainpose)

Position 5:

- Take the left foot back beside the right foot. Simultaneously, raise the hips and lower the head between the arms, so that the back and legs form the two sides of a triangle.
- The legs and arms should be straight in the final position. Try to keep the heels on the floor in the final pose and bring the head towards the knees. Do

not strain.

Breathing: Exhale while taking the left leg back.

Awareness: Physical - on relaxing the hips or on the throat region. Spiritual - on vishuddhi chakra.

Mantra: Om Khagaya Namaha, salutations to he who moves quickly in the sky.

Benefits:

- This pose strengthens the nerves and muscles in the arms and legs.
- The spinal nerves are toned and circulation is stimulated especially in the upper spine, between the shoulder blades.(6)

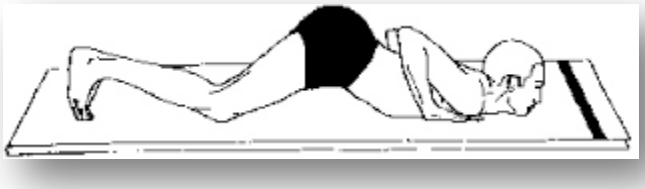

Figure-13: Astanga namaskar

Position 6:

- Lower the knees, chest and chin on to the floor.
- In the final position only the toes, knees, chest, hands and chin should touch the floor.
- Try to touch the knees, chest and chin to the floor simultaneously. If this is not possible, first try to lower the knees, then the chest, and finally the chin.
- Keep the buttocks, hips and abdomen raised.

Breathing: The breath is held outside in this pose. There is no respiration.

Awareness: Physical - on the abdominal region. Spiritual - on Manipura chakra.

Mantra: Om Pushne Namaha, salutations to the giver of strength.

Benefits:

- This pose strengthens the leg and arm muscles
- It develops the chest and exercises the region of the spine between the shoulder blades.(6)

Figure-14: Bhujangasana (cobra pose)

Position 7

Lower the buttocks and hips to the floor. Straighten the elbows, arch the back and push the chest forward maximum into the cobra pose. Bend the head back and gaze upward to the eyebrow centre. The thighs and hips remains on the floor and the arms supports the trunk. Unless the spine is very flexible the arms will remain slightly bent.

Breathing: Inhale while raising the torso and arching the back.

Awareness: Physical - on relaxation of the spine. Spiritual - Swadhisthana chakra.

Mantra: Om Hiranya Garbhaya Namaha, salutations to the golden, cosmic self.

Benefits:

- This pose keeps the spine supple, improving circulation in the back region and toning the spinal nerves.
- It tones the reproductive organs, stimulates digestion and relieves constipation. It also tones the liver and massages the kidneys and adrenal glands.(6)

Position 8: Parvatasana (mountain pose) This stage is same as that of position 5. From Bhujangasana assume Parvatasana. The hands and feet do not move from position 7. Raise the hips and lower the heels to the floor.

Breathing: Exhale while raising the hips.

Awareness: Physical - on relaxing the hips or on the throat region. Spiritual - on vishuddhi chakra.

Mantra: Om Marichaye Namaha, salutations to the Lord of the Dawn.

Position 9: Ashwa Sanchalanasana (equestrian pose)

This stage is the same as position 4 but it is done with the opposite side.

The palms are kept flat on the floor. Bend the right leg and slowly bring the right foot forward between the two hands. Simultaneously lower the left knee so that it touches the floor and push the pelvis forward. Tilt the head backward and arch the back. Keep the gaze at the eyebrow centre.

Breathing: Inhale while assuming the pose.

Awareness: Physical - on the stretch from the thigh to the chest, or on the

eyebrow centre. Spiritual - on ajna chakra.

Mantra: Om Adityaya Namaha, salutations to the son of Aditi, the cosmic Mother.

Position 10: Padahastasana (hand to foot pose) This position is same as position 3. Bring the left foot forward next to the right foot and straighten both knees. Bring the forehead as close to the knees as possible without straining.

Breathing: Exhale while performing the movement.

Awareness: Physical - on the pelvic region. Spiritual - on Swadhisthana chakra.

Mantra: Om Savitre Namaha, salutations to Lord of Creation.

Position 11: Hasta Utthanasana (raised arms pose) This stage is the repetation of position 2. Raise the torso and stretch the arms above the head. Keep the arms separated at shoulder width apart. Bend the head, arms and upper trunk backward as much as possible.

Breathing: Inhale while straightening the body.

Awareness: Physical - on the stretch of the abdomen and expansion of the lungs. Spiritual - on Vishuddhi chakra.

Mantra: Om Arkaya Namaha, salutations to he who is fit to be praised.

Position 12: Pranamasana (prayer pose) This is the final position and is the same as position 1. Bring the palms together in front of the chest.

Breathing: Exhale while assuming the final position.

Awareness: Physical - on the region of the heart. Spiritual - on anahata chakra.

Mantra: Om Bhaskaraya Namaha, salutations to he who leads to enlightenment.(6)

Figure-15: Shavasana (corpse pose)

Method: Lie down flat on the back with the arms about 15 cm away from the body with the palms facing upward. A thin pillow or a folded cloth may be placed behind the head to prevent any discomfort. Let the fingers curl up slightly. Move the feet slightly apart to a comfortable position and close the eyes. The head and spine should be kept in a straight line. Make sure the head does not fall to any side. Relax the whole body and stop all physical movement even a slightest as much as possible. Become aware of the natural breath and allow the breath to become rhythmic and relaxed.

Awareness: Physical - first on relaxing the whole body, then on the breath and counting. Spiritual - on ajna chakra.

Benefits:

- This asana relaxes the whole psycho-physiological system. It should ideally be

practiced before sleep or before, during and after asana practice, particularly.

- After dynamic exercises such as Surya Namaskara. This can also be practiced when the practitioner feels physically and mentally tired.
- It develops body awareness. When the body is completely relaxed, awareness of the mind increases, developing pratyahara.

Practice note: Try not to move the body at all during the practice as even a slightest movement will cause muscular contraction. A personal mantra can be repeated with every inhalation and exhalation.(6)

FAST/ SLOW SURYA NAMASKAR

Various schools of yoga differ in the practice of SN. Some schools advocate performance in a slow manner in accordance with slow breathing, while others advocate a rapid method by performing multiple rounds in a fast manner very similar to physical exercise. It has been suggested that Surya Namaskar at different speeds gives different benefits and that when it is done rapidly, it warms the body and acts as a cardio tonic. When done slowly it strengthens and tones the musculature and enhances smooth functioning of internal organs. It has also been suggested that the practice of Surya Namaskar can relieve depression through fast rounds or it may even cool down hyperactivity with slow rounds.(28)

VARIATIONS OF SURYA NAMASKAR

Different forms of Surya Namaskar have been developed from ancient times till the present day. Some of the variations are:

- Vedic Surya Namaskar
- Aruna Surya Namaskar
- Maha Sauri Surya Namaskar
- Shiva Surya Namaskar
- Rishikesh Surya Namaskar (29)

PHYSIOLOGICAL EFFECT OF SURYA NAMASKAR ON VARIOUS SYSTEMS:

The practice of Surya Namaskar has its effects directly on the physical body, applying pressure, stretching, massaging, gently toning up and supporting the internal tissue structure. Thus, all the systems of the body are positively influenced by the practice of Surya Namaskar.(7)

Effect on respiratory system:

✓ The practice Surya Namaskar, significantly increases maximum inspiratory pressure and maximum expiratory pressure. This suggests that its training improves the strength of both expiratory as well as the inspiratory muscles.

✓ It improves the strength of intercostal muscles and ultimately leads to the increased vital capacity and contractility of lungs.

✓ Regular Surya Namaskar training causes significant change in forced vital capacity (FVC), peak expiratory flow rate (PEFR), forced expiratory vital volume in 1st second (FEV1) and Vital capacity (VC).

✓ These effects are especially seen in the practice of Hasta Uttanpadasana, which maximally expands the chest wall.

✓ Padahastasana, when performed with exhalation is a potent breath cleanser. By

the performance of the above asanas, respiratory diseases and excess mucus in air passages can be eliminated.(29)

Effect on cardiovascular system

✓ Surya Namaskar in daily routine life can improve cardiorespiratory efficiency and fitness with an increase in peak expiratory flow rate, systolic blood pressure, forced vital capacity, and reduction of respiratory rate, heart rate, and diastolic blood pressure.

✓ Regular Surya Namaskar practices leads to vagal dominance, reduced sympathetic tone, and an improved cardiovascular function.

✓ Padahastasana and Parvatasana aids return of blood from the lower body to the heart. It also stretches the leg muscles using the force of gravity in the inverted position.

Effect on lymphatic system:

✓ The circulation of lymph, which is an important factor in fluid balance and combating infections is toned by the practice of Surya Namaskar.

✓ The body gains increased resistance to infections and gains a better ability to heel with the practice of Surya Namaskar.(30)

Effect on Gastro intestinal system:

✓ The alternating stretching and compressing movements during the practice of Surya Namaskar tones the entire digestive system by thoroughly massaging all the abdominal viscera.

✓ Regular Surya Namaskar practice improves digestion, combat constipation

and many gastrological problems.

✓ Padahastasana and Bhujangasana are powerful in terms of compressing and stimulating the abdominal organs. They help to increase the digestive fire, promotes a healthy appetite and helps in complete and rapid assimilation of food.

Effect on Urinary System:

✓ Through the practice of Surya Namaskar, the entire spine and the muscles of the back are toned in such a way that it gently massages the kidneys.

✓ Bhujangasana, Astanga Namaskarasana and Ashwa Sanchalasana exert a strong influence on the kidney area.

Effect on Skin:

✓ Surya Namaskar produces perspiration, speeds up the circulation and enhances the elimination of waste through the skin.

✓ It maintains a healthy skin which is a reflection of the inner health.

✓ All asanas stretch the skin and its elastic tissues, toning it and helping to preserve its function.

Effect on Endocrine system:

✓ Regular practice of Surya Namaskar modulates the endocrinal system of the body especially, pancreas, thyroid, adrenals and pituitary glands. The overall effect is beneficial for Metabolic Syndrome, Obesity, Diabetes Mellitus, Hypothyroidism and menstrual disorders.

✓ Surya Namaskara influences the pineal gland and the hypothalamus, helping to prevent pineal degeneration and calcification.

✓ Asanas such as Hasta Uttanasana, Parvatasana, Bhujangasana and Ashwa Sanchalasana have powerful effect on neck thereby stimulating the thyroid gland.(7)

Effect on nervous system:

✓ Surya Namaskar tunes the central, Peripheral and autonomic Nervous system.

✓ The entire spine is stretched and compressed, stimulation the whole spinal cord and the nerve plexus.(7)

Effect on Reproductive system:

✓ Surya Namaskar has a positive effect in both male and female reproductive system.

✓ The supporting muscles of the uterus and vaginal walls are stretched. This helps in painless labour.

✓ Blood supply is improved to the pelvic region thus producing a toning effect on the ovaries. This helps to correct menstrual irregularities and pain during menstruation.

Effect on biochemical parameters:

✓ Surya Namaskar significantly decreases fasting blood sugar, postprandial blood sugar and Glycosylated hemoglobin HbA1c level in diabetic patients.

✓ Its regular practice significantly decreases the oxidative stress on the body which plays a key role in insulin resistance and complication in type 2 diabetes patients.

✓ It also improves the lipid profile in diabetic patients which plays a supportive

role in preventing complications. This causes a reduction of weight, BMI and waist-hip ratio.(7)

Effect on musculoskeletal system:

- ✓ Regular training of Surya Namaskar requires four times more energy than the daily requirement. Thus the practice is a very good fat burner.
- ✓ SN training improves the flexibility of most of the body muscles especially leg, back, chest and buttock muscles.
- ✓ Regular practice of Surya Namaskar may significantly increase Hand grip, strength and endurance.(7)

RESEARCH PAPERS ON SURYA NAMASKAR:

Ananda Balayogi et al did a comparative study on the physiological effects of fast and slow Surya Namaskar. suryanamaskar (FSN), respectively to each group. Group 1 completed fifteen rounds in 30–40 minutes and Group 2 completed 5 rounds in 30 – 40 minutes. They took 6 minutes to complete each round.(28)

The study stated that SN has positive physiological benefits as seen by the improvement of pulmonary function, respiratory pressures, hand grip strength and endurance, and resting cardiovascular parameters.

They also found a significant increase in isometric hand grip (IHG) and hand grip endurance (HGE) time after 3 months of Surya Namaskar training. The increase in muscle strength and endurance time can be explained on the basis of stimulation of skeletal muscles during the process of isometric contraction that is maintained during the steady state of the different postures in Surya Namaskar. This may be

also because of the delayed onset in muscular fatigue. This study gives evidence that both Slow Surya Namaskar and Fast Surya Namaskar improve muscle strength like other yoga practices and it is more apparent in the case of Fast Surya Namaskar.(28)

Ni M et al studied the activation of 14 dominant side muscles during the performance of each Surya Namaskar posture and stated that SN has significant effects in all pose for all fourteen muscles except middle trapezius ($p<0.02$) and of skill level for the vastus medialis; ($P=0.027$). A significant skill level × pose interaction existed for five muscles (pectoralis major sternal head, anterior deltoid, medial deltoid, upper rectus abdominis and gastrocnemius lateralis; $p<0.05$). They concluded that different poses can produce specific muscle activation patterns which may vary according to the practitioners skill levels. (31)

Amit Vaibhav et al in their review article discussed the positive health benefits of Surya Namaskar. They stated that Surya Namaskar has a positive impact on autonomic functions of the body. Its regular practice significantly decreases the oxidative stress on the body.

Surya Namaskara comprehensively includes asana, pranayama, mantra and meditative awareness. Different evidence-based study suggests that Surya Namaskar improves metabolic function, strengthens the musculoskeletal system, balances endocrinal system, tunes central nervous system, supports urogenital system and boosts the gastrointestinal system. Thus, there is an important need to incorporate Surya Namaskar practices in modern lifestyle for the maintenance of a healthy mind and body. (32)

In 2016, Rajini nautiyal, yoga instructor, HNB Garhwal university, Uttarakhand, India, published the effect of surya namsakar in reduction of weight in obese individuals in the International journal of science and consciousness. The study revealed that a regular practice of surya namaskar for 30 days significantly reduced weight in obese persons and it confirms the fact that obese persons can significantly reduce their weight with the help of surya namaskar.(33)

In 2017, Dr.Sarvesh kumar yadav and colleagues from Bharathi vidyapeeth deemed university – college of Ayurved, pune, published the efficacy of surya namaskar in obesity in World journal of pharmacy and pharmaceutical sciences. The study concluded that surya namaskar helped in combating the symptoms of obesity – following the diagnostic criteria of obesity according to Ayurveda and weight in kgs was lost in the selected samples of obese individuals.(33)

In 2016, Dr.M.Ramajayam, from Sri Ramakrishna mission vidyalaya, maruthi college of physical education, Coimbatore, published in international journal of adapted physical education and yoga, the study showed that the experimental group significantly altered the selected criterion variables percent body fat and basal metabolic rate. The study results showed that the experimental group who had practiced surya namaskar had the significant changes in their body fat percentage and their basal metabolic rate.(34)

Ananda Balayogi Bhavanani et al conducted a study on the immediate effect of Surya Namaskar on reaction time and heart rate in female Volunteers. They stated that, Reaction time (RT) is simple and effective method of studying the central neuronal processing. It has been reported that changes in breathing

period produced by voluntary control of inspiration correlate to changes in RT. Three rounds of Aruna Surya Namskar followed by 5 minutes of quiet sitting was given for volunteers in study group. Simple Auditory Reaction Time was recorded for auditory beep sound. Simple Visual Reaction Time was recorded with the help of red light. The results showed that performance of Surya Namaskar produced immediate and significant decrease in Visual Reaction Time and Auditory Reaction Time. Faster reactivity may be due to the intermediate level of arousal by conscious synchronization of dynamic movements along with breathing.

The study suggest that Surya Namaskar can be used as an effective training means to improve neuromuscular abilities.(30)

Manju Deorari et al conducted a study to determine the therapeutic effect of Surya Namaskara on Emotional Maturity and Psychological Well-Being among college going students. After 60 days of practice, there was significant (P= 0.01) improvement in emotional maturity and psychological well-being of the students**.**(34)

Sinha B et al conducted a study to determine the effect of yogic training on various cardiorespiratory responses during the Surya Namaskar practice in yoga trainees after an interval of 3, 6, and 11 months. The study was conducted in healthy male volunteers and Oxygen consumption and heart rate during the actual practice of SN was recorded. The results of the study indicated that yogic training caused significant conditioning of cardiorespiratory parameters.(35)

Sinha B et al did a comparative study on cardiorespiratory responses between Surya Namaskar and bicycle exercise at similar energy expenditure level. 20 healthy Yoga instructors practicing different Yogic practices including Surya Namaskar since 7-8 years participated in the study. Surya Namaskar and bicycle exercise were compared at three similar exercise intensity levels in terms of percentage of VO2 max. The exercise intensities were light (10-20% VO2 max), moderate (21-40% VO2 max) and high intensities (41-50% VO2 max). Heart rate at high work intensity was significantly increased in bicycle exercise than Surya Namaskar ($P < .001$). Also during high intensity work outs, the ventilation and carbon dioxide output were significantly higher in bicycle exercise than Surya Namaskar ($P < 0.001$). Overall, cardiorespiratory stress is much lower in Surya Namaskar than bicycle exercise at similar work intensities.(36)

Mody BS in 2010 conducted a study to assess the cardiorespiratory and metabolic responses of four rounds of Surya Namaskar and to determine its potential as a training and weight loss tool. Six healthy Asian Indian men and women (18-22 years) who had been previously trained in Surya Namaskar for over two years participated in the study. Testing was completed in a single session lasting about 30 minutes. Heart rate and oxygen consumption were measured while performing the four rounds of Surya Namaskar. Average intensity during the four rounds was 80% HRmax, sufficient to elicit a cardiorespiratory training effect. Oxygen consumption averaged 26 ml/kg/min during each round that resulted in an energy expenditure of 230 kcals during a 30 minutes session for an individual weighing 60 kgs. The results showed that the regular practice of Surya

Namaskar may maintain or improve cardiorespiratory fitness, as well as help in weight management(37).

Sinha B et al 2004, did a study on Energy cost and cardiorespiratory changes during the practice of Surya Namaskar. The participant‟s pulmonary ventilation, carbon dioxide output, Heart Rate, Oxygen consumption and other cardiorespiratory parameters were measured during the actual practice of Surya Namaskar. The study showed that as an aerobic exercise, Surya Namaskar seemed to be ideal as it comprises both of static stretching and slow dynamic component of exercise with optimal stress on the cardiorespiratory system.(37)

Sasi Kumar A et al 2011, did a study to evaluate the effects of a 45 days daily practice of Surya Namaskar on blood pressure(BP), heart rate(HR), respiratory rate (RR), forced vital capacity(FVC) and peak expiratory flow rate (PEFR) in school students of both sexes.115 school students aged 10 to 14 years were recruited for the study. The participants were trained to perform Surya Namaskar for 45 days study period. The cardio vascular and respiratory parameters Blood Pressure (BP), Heart Rate (HR), Respiratory Rate (RR), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR) were measured before and after practice of SN. The results showed that the Systolic blood pressure, PEFR and FVC increased significantly and RR, HR and diastolic blood pressure decreased significantly after the practice of Surya Namaskar study which proves that even a period of 45 days SN training can show significant change in the cardio and respiratory parameters.(38)

N. Veeraparameswari et al 2014 conducted a study to find out the effect of SN practices and physical exercises on selected biochemical parameters of college women to find the effect of Surya Namaskar practices and physical exercises on selected biochemical parameters of college women. 60 college women were randomised and divided into three groups consisting of 20 in each group. Group I underwent physical exercises (PEG), group II underwent Surya Namaskar practices (SNG) and group III was kept as control group. The physical exercises (PEG) group was provided with different types of physical exercises, consisting of walking, jogging, floor aerobic exercises and step aerobic exercises for 12 weeks and Surya Namaskar practices (SNG) group underwent, slow, medium and fast variations of Surya Namaskar. From the blood samples biochemical variables, fasting blood sugar and total cholesterol were obtained.

The results of this study proved that both the experimental protocols significantly contributed for fasting blood sugar and total cholesterol of the college women. Even though it was found that Surya Namaskar practices (SNG) group was found to be better than physical exercises (PEG), the difference between the experimental groups was not significant at 0.05 level.(39)

Pratima M. Bhutkar et al 2008, did a pilot study and found significant reduction in pulse rate after regular practice of Surya Namaskara which is attributed to increased vagal tone and decreased sympathetic activity. Decreased sympathetic activity in turn reduces catecholamine secretion and also leads to vasodilation leading to improvement in peripheral circulation. All these may be responsible for reduction in resting pulse rate. These factors also decrease work load on heart

leading to decrease in cardiac output and hence systolic blood pressure. They also stated that Yogic practices alter the hypothalamic discharges leading to decrease in sympathetic tone and peripheral resistance and hence the diastolic blood pressure.(40)

ENERGY METABOLISM IN RELATION TO SURYA NAMASKAR:

Review suggests that yoga is typically classified as a light-intensity physical activity. However, a few sequences/poses, including Surya Namaskar, meet the criteria for moderate- to vigorous-intensity activity.

Maintenance of body weight is regulated by the interaction of a number of processes, encompassing homoeostatic, environmental and behavioral factors. In homoeostatic regulation, the hypothalamus has a central role in integrating signals regarding food intake, energy balance and body weight, while an „obesogenic environment and behavioral patterns exert effects on the amount and type of food intake and physical activity.(41)

It is stated that during the practice of Surya Namaskar oxygen consumption was highest in the eighth posture (1.22+/-0.073 1 min (-1)) and lowest in the first posture (0.35+/-0.02 1 min(-1)). Total energy cost throughout the practice of SN was 13.91 kcal and at an average of 3.79kcal/min.(42)

Rajni Nautiyal 2016, conducted a study to determine the effect of Surya Namaskar on weight loss in obese persons. 30 obese persons with the age range of 25-30yrs, weight 70-82.5 kg and height 155-167 cm. were selected for the study. They were divided into two equal groups of 15 subjects each. The training of

Surya Namaskar was given to only experimental group. The training programme of 30 days was organized for 60 minutes daily practice of Surya and the weight of subjects of experimental & control groups were measured. The study established that one month regular practice of Surya namaskar helped obese persons to reduce their weight.(43)

Surya namaskar is a moderate physical exercise which is linked with the breathing. It consumes calories moderately without much fatigue or exhaustion. Since it is an isotonic type of exercise it does not increase the tension but increases the metabolic rate. Dynamic stretches in forward and backward direction and rhythmic positive and negative pressure changes in the viscera stimulate various viceroceptors. This is the reason why all the systems work at the optimum level. The intensity of the exercise is increased by adding one or two rounds to everyday practice. This increases the stamina and cardiovascular endurance. It mobilizes the stored or accumulated fat by increasing the blood circulation. The practitioner has little sweating but at the same time experiences refreshed feeling.(25)

Dr Sarvesh Yadav et al in a paper titled Surya Namaskar, A Holistic outlook towards Obesity, A Metabolic Disorder, stated that Surya Namaskar (Salutation to the sun) is the best way to burn the calories and reduce weight. Surya Namaskara is full Yoga by itself. It tones up the whole body & has a unique influence on endocrine, circulatory, respiratory, digestive and nervous system, helping to correct metabolic imbalances that cause and perpetuate obesity.(24)

PSYCHOLOGICAL ASPECT OF SURYA NAMASKAR Yogic concept of human body and surya namaskar:

According to yogic physiology, the human framework is comprised of five bodies or sheaths, which account for the different aspects to dimensions of human existence. These five sheaths are known as:

a) Annamaya kosha, the food or material body.

b) Manomaya kosha, the mental body.

c) Pranamaya kosha, the bioplasmic or vital energy body.

d) Vijnanamaya kosha, the psychic or higher mental body.

e) Anandamaya kosha, the transcendental or bliss body.

Since the practice of Surya Namaskar involves asanas, breathe modification, Mantra chanting as well as awareness of the chakra, the practice of Surya Namaskar works on all the five koshas.(32)

PSYCHOLOGICAL ASPECT OF DYNAMIC YOGA

It is stated that dynamic form of yoga called as Vyayam, has a relaxing effect on the mind. Telles et al, evaluated the efficacy of an ancient yoga text that suggests that a combination of calming and stimulating practices may be especially helpful in reaching a state of mental equilibrium. They conducted an experiment aimed to compare the effects of whether a combination of activation and relaxation, known as cyclic meditation (CM), or relaxation alone in the supine position, known as shavasana (SH), would alter metabolic and breath rates in the same or different directions.

40 male volunteer ages 20 to 47 years participated in the study. They were divided into two groups. One following cyclic meditation and the other Shavasana. Following both CM and SH, VO2 was measured with a closed-circuit apparatus. A significant difference was found between values recorded before and after the sessions of CM and SH for VO2 and ventilation. Oxygen consumption decreased by 32.1% after CM compared to 10.1% in SH, breath rate decreased by 18% after CM and 15.2% after SH, and ventilation increased by 28.8% after CM and 15.9% after SH.

The findings of the study support the idea that CM, which combines stimulating and calming techniques, when coupled with a background of relaxation and awareness, may reduce physiological arousal better than SH, lying in a supine position, which has also been shown to be calming.(44)

EFFECTS OF SURYA NAMASKAR ON MIND

The psychological benefits of Surya Namaskar are:

- ✓ Increase your mental focus and concentration.
- ✓ Reduce depression, anxiety and stress by reducing key markers like Cortisol.
- ✓ Increase the quantity of "good mood" neurotransmitters like Serotonin.
- ✓ Increase mind to body coordination which is very good especially for older persons.(45,46)

CONTRA-INDICATIONS OF SURYA NAMASKAR

- ✓ Fever and acute infections.Patients of hernia and high blood pressure.
- ✓ People suffering from back condition should seek proper advice commencing

Surya Namaskar.

- ✓ Women should avoid Surya Namaskar during menses.
- ✓ Coronary artery diseases, or by those who have had a stroke, as it may over stimulate or damage a weak heart or blood vessel system.
- ✓ Hernia or intestinal tuberculosis.(47,48)

DYNAMIC YOGA, PHYSICAL EXERCISE ON FATTY LIVER

In 2015, Maureen whitsett and Lisa B van wagner published in world journal of hepatology, to check the effectiveness of exercise as a therapy for NAFLD nd potential benefits in treating insulin resistance and atherosclerosis. The study concluded that exercise improved hepatic steatosis and underlying metabolic abnormalities.(49)

In 2015, an article was published in Journal of hepatology and in Elsevier, that all exercise doses irrespective of volume or intensity, were efficacious in reducing liver fat and visceral fat by an amount that was clinically significant, in previously inactive, overweight, or obese adults compared with placebo. In addition, both aerobic and resistance training regimens are equally effective in reducing liver fat in individuals with NAFLD even in the absence of weight loss.(50)

In 2014, Dr.K.Krishnan Sharma et al from mangalore university, mangalagangothri, India, published in European scientific journal that yoga practices have substantially and significantly reduced the level of globulin, alkaline phosphatase in the experimental group where as such changes were not seen in the control group. This implies that the various yogic practices is the right solution to enhance the functioning of liver of an individual. And yogic practices

for longer duration will be more effective to improve liver functions.(50)

In 2014, Naveen GH et all from SDM college of naturopathy and yogic sciences, Ujjire published a case report regarding the management of alcoholic liver disease by naturopathy and yoga intervention in the international journal of yoga and allied sciences. This report revealed that naturopathy and yoga life style intervention consisting of diet therapy, juice fasting therapy, hydrotherapy treatments, massage therapy and yoga practice plays a significant role in patients with Alcoholic liver disease by improving the liver function.(51)

In 2018, Dirk J.Vander windt et all published the effects of physical exericise in fatty liver disease in gene expression – the journal of liver research. The study summarizes the evidence for the effects of physical exercise on NAFLD and NASH. Several clinical trials have shown that both aerobic and resistance exercise reduce the hepatic fat content. Improved peripheral insulin resistance reduces the excess delivery of free fatty acides and glucoses for free fatty acid synthesis to the liver. In the liver, exercise increases fatty acid oxidation, decreases fatty acid synthesis, and prevents mitochondrial and hepatocellular damage through a reduction of the release of damage- associated molecular patterns. In conclusion, physical exercise is a proven therapeutic strategy to improve fatty liver disease.(52)

In 2011, Mr.Kate hallsworth et all from institute of cellular medicine, Newcastle university, UK, published in the journal of hepatology that 8 weeks of resistance exercise elicited a 13% relative reduction in liver lipid. Liver oxidation, glucose control, and homeostasis model assessment, insulin resistance were all improved. Resistant exercises had no effect on body weight, visceral adipose

tissue volume or whole bod fat masses.(53)

In 2019, Dr.Daniel pfirrmann et all from the department of sports medicine, disease prevention and rehabilitation, institute of sports sciences, Johnnes Gutenberg university, Germany published a web based exercise as an effective complementary treatment for patients with NAFLD as an intervention study published in journal of journal of medical internet research. The study showed that the patients with NAFLD can be effectively supported by a web based approach, which can increase the VO2 peak. To a similar extent as face to face intervention patients with low body fat and low VO2 peak benefitted the most from the intervention. (54)

In 2011, Nathan A. Johnson and Jacob George published in the journal of hepatology , the study titled Fitness versus fatness: Moving beyond weight loss in nonalcoholic fatty liver disease. According to the study, Diet and/or Physical Activity intervention is important in the management of NAFLD, and there is increasing evidence that exercise *per se* beneficially modulates liver fat independent of weight loss. Also, the latter effects should be emphasized and ideally delivered using a multidisciplinary approach.it also revelas that there is an obvious need for further research to understand the effectors of exercise- mediated benefits in NAFLD, including Physical Activity dose, modality, and the relative importance of structured exercise and cardiorespiratory fitness versus less structured lifestyle Physical Activity levels. Hence the study concludes that Clarification of these will be needed to enable the formulation of effective and time efficient Physical Activity programs which may ultimately enhance patient benefit, participation, and adherence.**(11)**

MATERIALS & METHODS:

Subjects

A total of forty subjects of both gender with age ranging between 30 – 50 years were participated in the study. Four subjects dropped out from the study in between. Finally data were collected for 36 subjects.

Description of the subjects and selection of samples

The study subjects were randomly recruited from the government yoga and naturopathy medical college and hospital, Arumbakkam, Chennai. The Subjects were recruited for the study from the above mentioned hospital after fulfilling inclusion criteria by screening of the subjects and by providing informed consent. Forty participants were screened through a routine medical check-up and those are satisfying the diagnostic criteria for NAFLD were recruited for the study.

Demographics

Table 1: Describes the demographic details of the subjects

Demographic Data		
	Male	**Female**
Gender Distribution (n=36)	16	20
Age(Mean±SD)	35.56+4.30	36.9+4.47
Age Range	30-48 years	

Table 1 shows the distribution of patients by age and gender. In terms of sex, female subjects participated more (20) than male subjects (16). Mean age of for the subjects would be 30-48 years.

Ethical Considerations

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.

Written Informed Consent

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

(A sample consent form and case sheet is enclosed as **Annexure I and II** respectively)

Screening of the subjects

Criteria for Diagnosis

The necessary criteria for the diagnosis of a NAFLD are:

(i) History

- Enquiry of the symptoms and lifestyle habits.

- Athropometric assessments.
- Observation of signs.

(ii) Physical examination

- Palpation of the liver to find the enlargement of the borders.

(iii) Radiographs

- Ultrasonography imaging used for Imaging the echogenicity and heterogenecity of fatty changes in liver parenchyma. Reports before the yogic intervention and after the intervention will be recorded.

Inclusion Criteria:

- Age group : 30 to 50 years
- Both gender
- Patients with dyslipidemia, diabetes mellitus, polycystic ovarian syndrome, insulin resistance (with or without medications)
- Peoples who are willing to participate in study.
- BMI normal or above normal.
- Blood pressure normal.

Exclusion Criteria:

- Liver Cirrhosis
- Hepatitis
- Fibrosis of liver
- Jaundice
- Liver Carcinoma
- Diabetes patients on insulin

- Hypertension
- Subjects who are taking alcohol, tobacco.
- Subjects undergone hospitalization or surgery in the past 1 year

Withdrawal Criteria:

- All subjects are free to withdraw from participation in the study at any time, for any reason, specified or unspecified, and without prejudice to further yogic practices. Subjects who are withdrawn from the study will not be replaced.

STUDY DESIGN

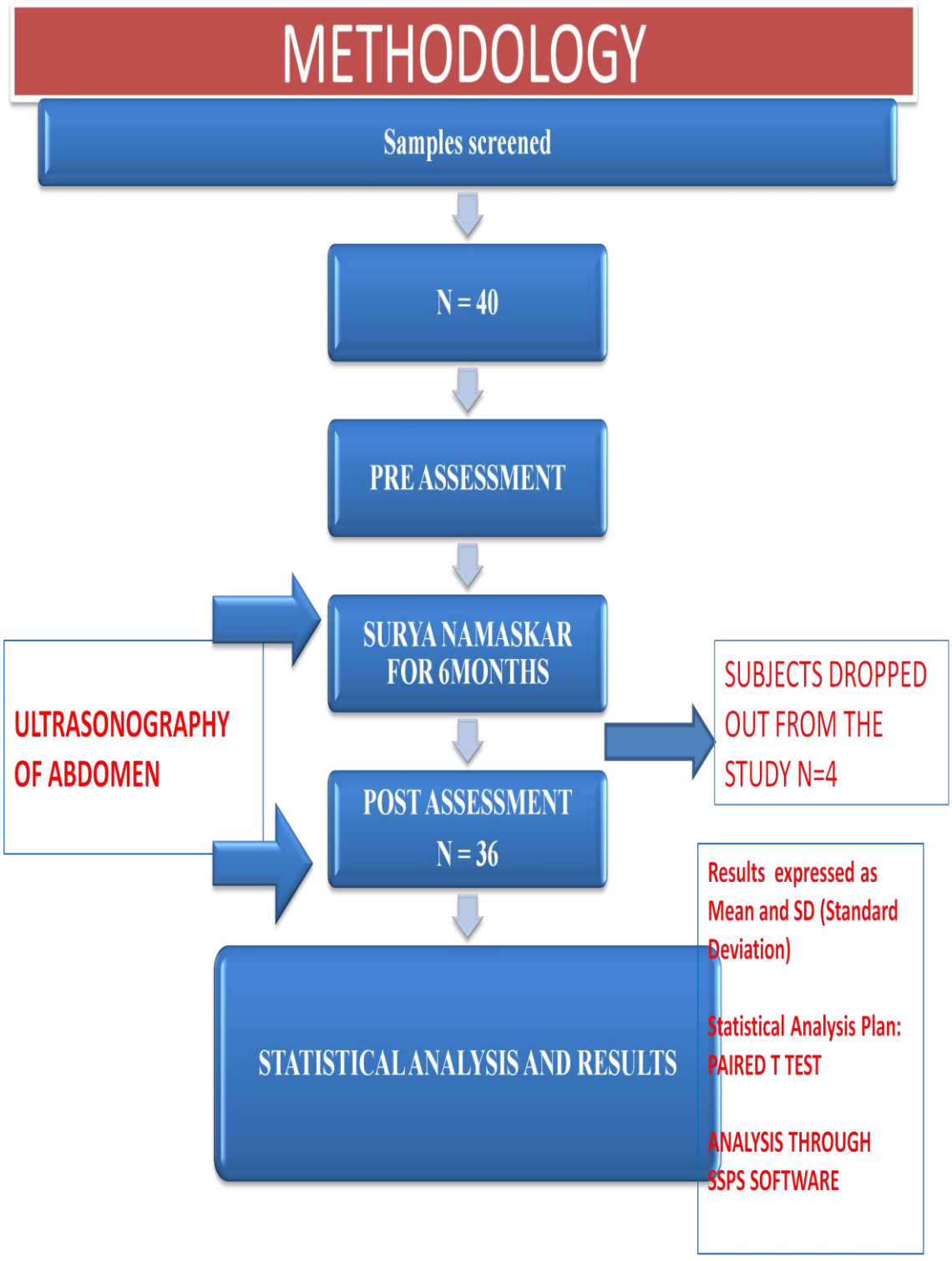

Figure-16: A Pre and Post – Interventional Study

ASSESSMENT OF PARAMETERS

Pre and post results are checked through Ultrasonography of abdomen

INTERVENTION

Surya namaskar , according to bihar school of yoga(6) is 24 steps.

First month - 3rounds daily, Second month- 6 rounds daily, Other 4 months- 12 rounds daily

i. Position1:Pranamasana(prayerpose)
ii. Position 2: Hasta Utthanasana (raised arms pose)
iii. Position 3: Padahastasana (hand to foot pose)
iv. Position 4: Ashwa Sanchalanasana (equestrian pose)
v. Position 5: Parvatasana (mountain pose)
vi. Position 6: Ashtanga Namaskara (salute with eight parts)
vii. Position 7: Bhujangasana (cobra pose)
viii. Position 8: Parvatasana (mountain pose)
ix. Position 9: Ashwa Sanchalanasana (equestrian pose)
x. Position 10: Padahastasana (hand to foot pose)
xi. Position 11: Hasta Utthanasana (raised arms pose)
xii. Position12:Pranamasana(prayerpose)

Positions 13-24: The twelve positions of surya namaskara are practised twice to complete one round. Positions 1 to 12 constitute half a round. In the second half, the positions are repeated with two small changes: In position 16, instead of stretching the right foot backward, stretch the left foot back. In position 21, bend

the right leg and bring the right foot between the hands.(6) To end with, relaxation in savasana for 3minutes.(6)

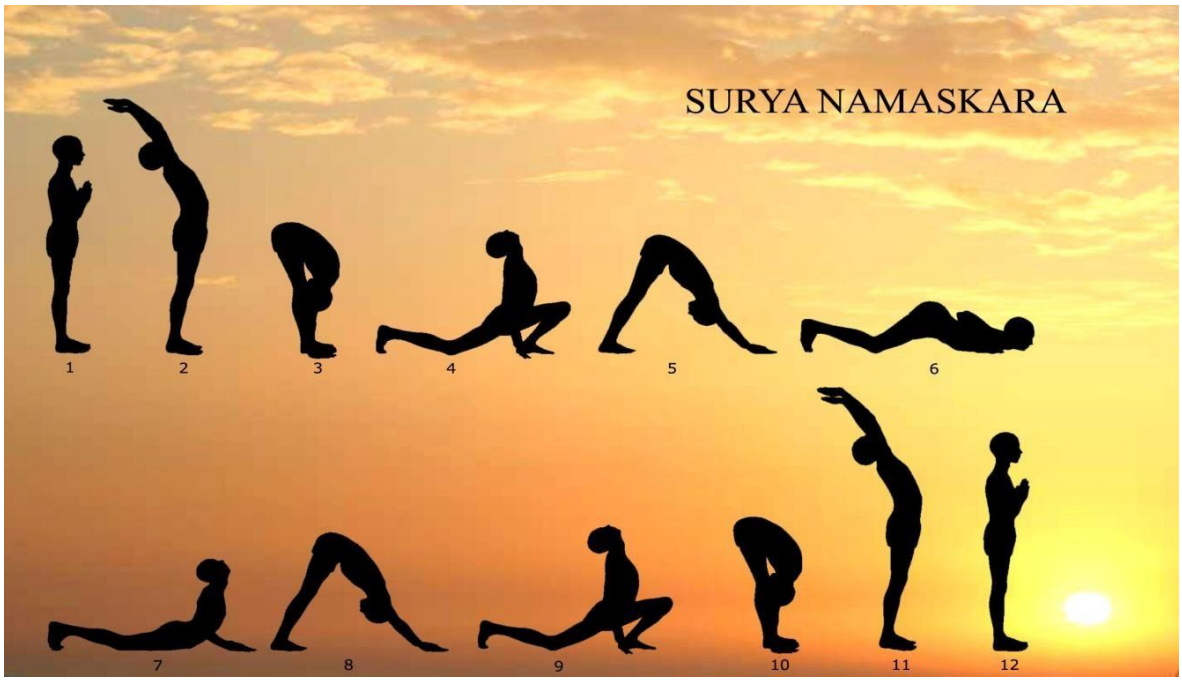

Figure-17: Surya Namaskar

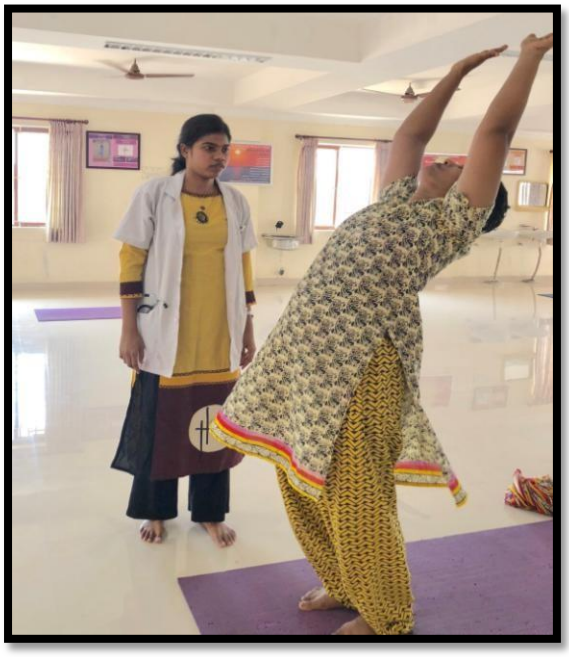

Figure-18: Teaching the yogic intervention to the subject

Figure 19: Teaching intervention to subjects

Figure-20: Correction of posture

.DATA EXTRACTION AND ANALYSIS

Data extraction

The assessments were done on the first day (baseline data) and end of 3rd month (post data). The data was organized in Microsoft Excel Sheets (Version 2010).

Data Analysis:

Data were analysed using IBM SPSS 16.0. The data was checked for normality by Shapiro wilk test, Parametric and non-parametric variables were analyzed through Paired Samples „t" test. For all the analysis, we present 95% confidence intervals and considered $p < 0.05$ as significant.

5.0 .RESULTS:

The present study was conducted to study the effect of surya namaskar on Non Alcoholic fatty liver disease (NAFLD) patients with primary and secondary variables viz. grading of fatty changes in liver through Ultrasonography and blood pressure, pulse rate, Body Mass Index (BMI). The Pre and Post Results was taken and compared within the study group, wherein data was extracted at baseline and post-intervention after 3 months.. Paired sample test was used to find the difference within groups. When the pre and post data of parametric and non parametric data were collected, it was analysed through Paired sample "T-test" and it showed that the primary outcome variable showed statiscally significant results of P value < 0.001, and secondary outcome variable also being statiscally significant ; blood pressure of P value <0.001. Other variables like the pulse rate and BMI showed no significant difference.

Table-2: Results of primary outcome variable

Contents	**ULTRA SOUND GRADING**	
	PRE	**POST**
Mean	1.917	0.528
Variance	0.536	0.371
Standard Deviation	0.732	0.609
Standard Error	0.122	0.1015
t Stat	16.854	
t Critical two-tail	2.0301	
***p* value**	0.0000001	

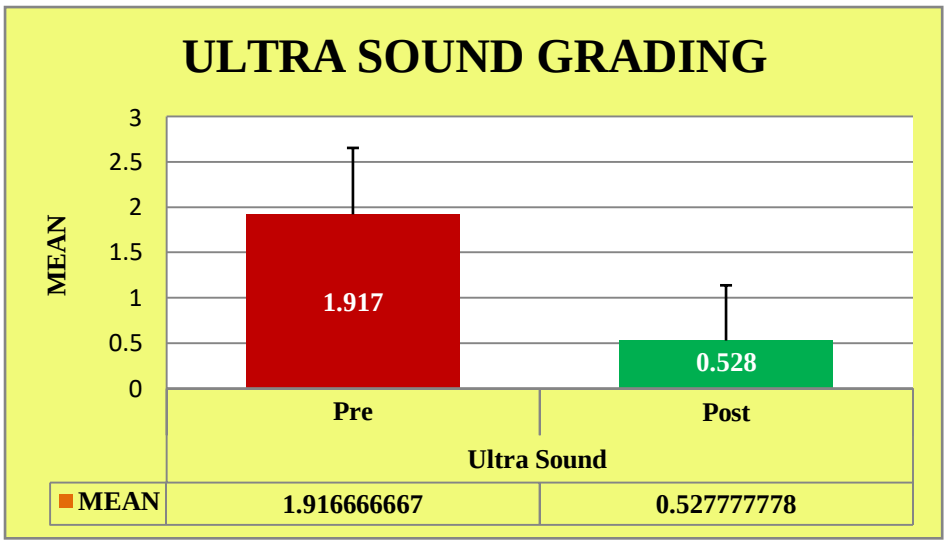

Figure-21: Comparison of pre and post results of us grading in a bar diagram

Out of 40 subjects, 4 were dropped out in between of the follow up. The bar diagram represents and compares the pre and post values and their mean.

Table-3: Results of secondary outcome variables:

Outcome Variables	PRE	POST	t Stat	*p* Value
Systolic blood pressure	120.61	112.94	4.167	0.001
Diastolic blood pressure	79.38	72.94	3.842	0.001
Pulse	79.38	80.63	-1.263	0.215
Weight	72.97	68.08	11.712	1.162
BMI	28.7	26.76	9.442	3.721

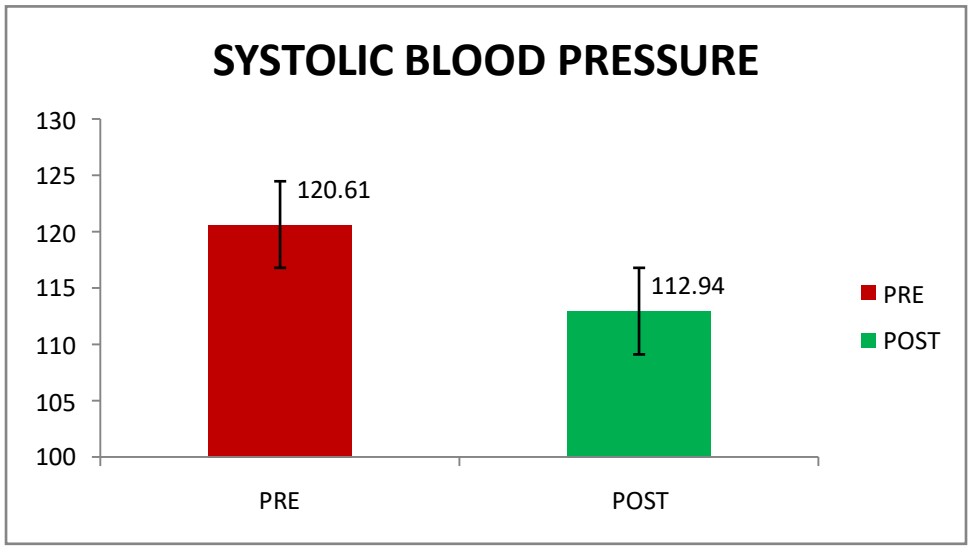

Figure-22: Bar diagram showing the comparison of pre and post values of systolic blood pressure

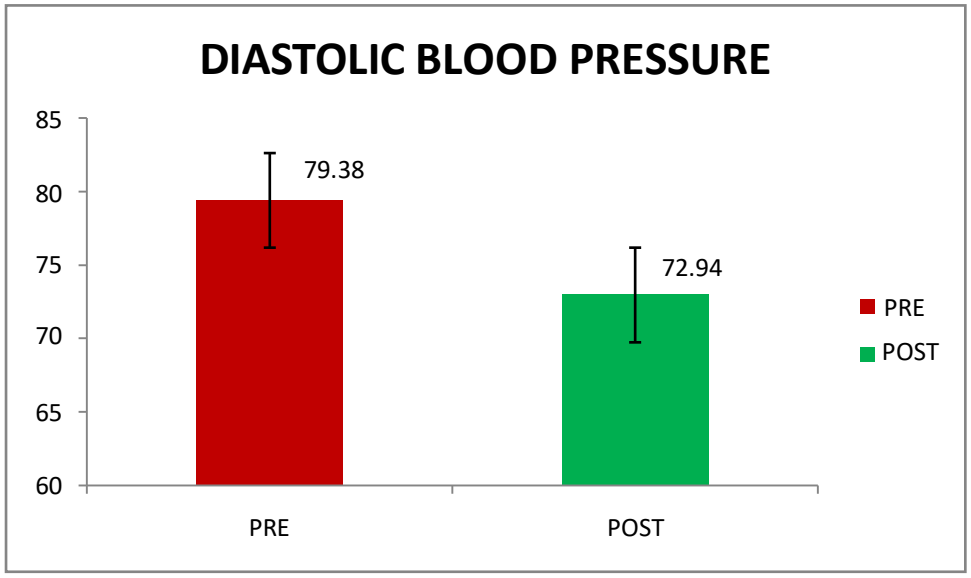

Figure-23: Bar diagram showing the comparison of pre and post values of diastolic blood pressure

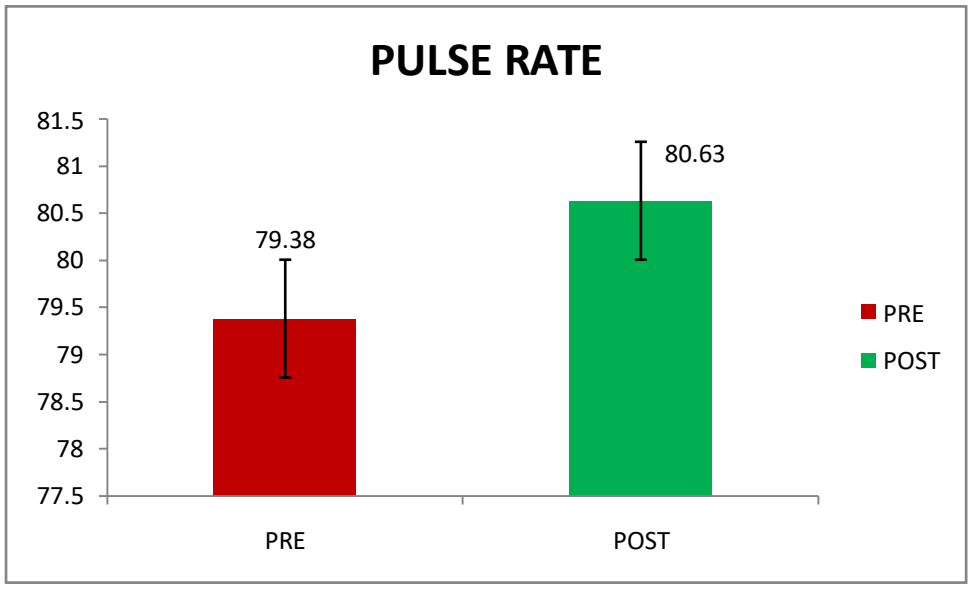

Figure-24: Bar diagram showing the comparison of pre and post values of pulse rate

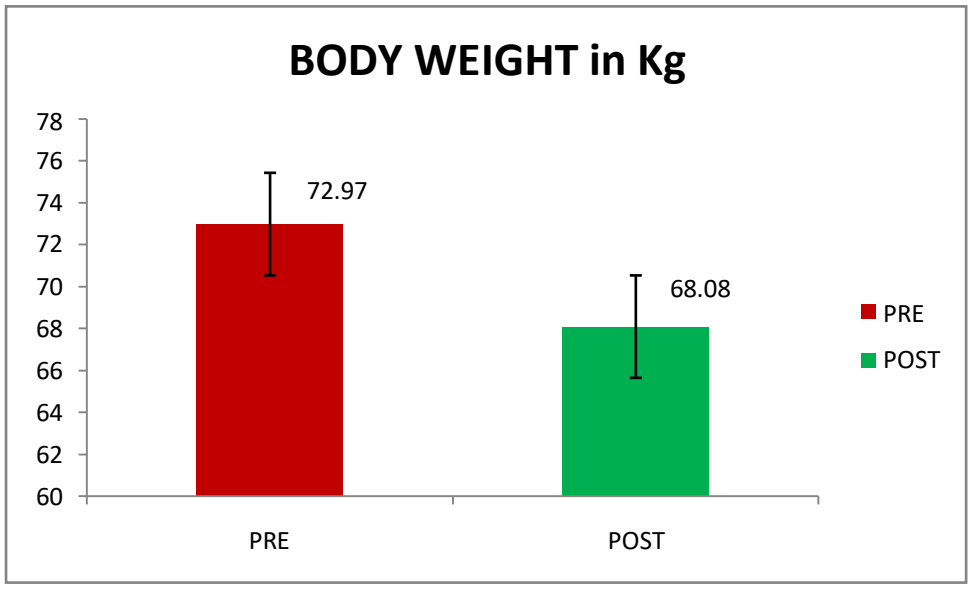

Figure 25: Bar diagram showing the comparison of pre and post values of body weight

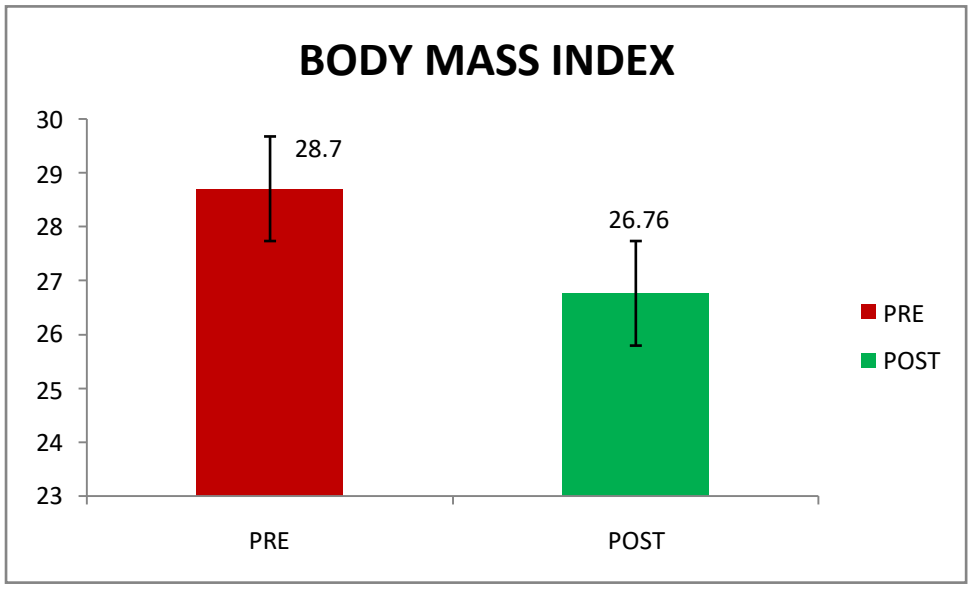

Figure-26: Bar diagram showing the comparison of pre and post values of BMI

6.0. DISCUSSION

Current medical therapy for NAFLD is based on good lifestyle modification, diet and exercise as well as taking medications to lower insulin resistance and lipids in blood. **(3)** With the existing therapy of allopathic management, the side effects are more alongside the prognosis is poor, liver however progresses into varied complications. Hence physical activity has been proved to reduce the hepatic steatosis in NAFLD patients**(49)**. Surya namaskar being a dynamic form of yogic intervention has worked for the patients of NAFLD, and has given statiscally significant results in reducing the fat in the liver on imaging through the Ultrasonography. Surya namaskar is well know to have varied effects of on the systems of the body**(7)** and an effective technique for weight loss in obese individuals,**(43)** it has proved to have effect in reducing liver fat.

Limitations

a) The sample size was relatively smaller.

b) Diurnal variations might have influenced the results.

c) Other physical activities and diet in home might acted as confounding factors for this study. Study consists of a single group.

Directions for future research

a) This study should replicate with lager sample size.

b) A randomized controlled trial with multi arm study could be better for definite conclusion.

c) Liver enzymes, and various biochemical variables can also be checked, to enhance the efficiency of the study.

7.0 CONCLUSION

The present study concludes that the yogic intervention like SN would significantly improve the condition of the liver, in elimination of the lipids in hepatic cells. Hence yoga can be given to treat and prevent fatty liver disease and is the right solution to enhance the functioning of the liver of an individual. Yogic practices of longer duration will be more effective to improve liver functions.

8.0 SUMMARY

The rapid emergence of non alcoholic fatty liver disease (NAFLD) as a cause of both liver-related morbidity and mortality and cardio metabolic risk has led to the search for effective lifestyle strategies to reduce liver fat. (1)Lifestyle intervention comprising dietary restriction in conjunction with increased physical activity has shown clear hepatic benefits when weight loss approximating 3% -10% of body weight is achieved. The need for conventional therapies and alternative medicines is increasing(14). Yoga being the best form of therapy and lifestyle intervention for healing physical as well as mental body, it could be incorporated for the management and prevention of NAFLD. The study finding clearly shows that Yogic intervention like surya namaskar, being a combination of twelve asanas followed by relaxation, one of the best form of Dynamic yoga can be used to prevent and reduce the complications of liver disorders, to reduce lipids in the liver and to maintain it healthy. And since there is lack of studies in implementation of yogic intervention to prevent and cure the fatty liver disease, the study would benefit patients and researchers to opt for the best lifestyle intervention like Yoga and SN.

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10.0. ANNEXURE 1

INFORMED CONSENT FORM

Title of the study : "Efficacy of Surya Namaskar on Non Alcoholic Fatty Liver disease patients - A INTERVENTIONAL STUDY"

Name of the Participant :

Name of the Principal Investigator : Dr.Kayelarasi

Name of the Institution : Government Yoga & Naturopathy Medical

College& Hospital,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

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_____

Address and contact number of the impartial witness:

Name and Signature of the investigator or his representative obtaining consent:

Name_____Signature_____

Date_____

ANNEXURE II- MODEL CASE SHEET

GOVERNMENT YOGA AND NATUROPATHY MEDICAL

COLLEGE, ARUMBAKKAM, CHENNAI-600106

P.G. DEPARTMENT OF YOGA PRINCIPAL

INVESTIGATOR:

Dr.C.A.KAYELARASI.BNYS

HEAD OF DEPARTMENT:

DR. S.T. Venkateswaran, N.D. (OSM), M.Sc. (Y&N) PGDOM,

PGDY, DNHE

NAME: O.P.NO:

SEX: PARTIPITANT NO:

AGE: DATE:

ADDRESS:

PHONE NO. :

OCCUPATION:

MARAITAL STATUS:

PRESENT COMPLAINTS:

HISTORY OF PRESENT COMPLAINTS:

PAST HISTORY:

MEDICAL HISTORY:

SURGICAL HISTORY:

FAMILY HISTORY:

OCCUPATIONAL HISTORY:

PERSONAL HISTORY:

Diet: Appetite:

Digestion: Bowel Movement:

Micturition: Sleep:

Exercise: Addiction:

Allergic to:

ANTHROPOMETRY:

Height: Weight: B.M.I.:

VITAL DATA:

Respiratory rate: Pulse Rate:

Temperature: Blood pressure:

OBG AND MENSTRUAL HISTORY:

SYSTEMIC EXAMINATION

CARDIOVASCULAR SYSTEM:

RESPIRATORY SYSTEM:

GASTRO-INTESTINAL SYSTEM:

INSPECTION :

PALAPATION:

PERCUSSION :

AUSCULTATION:

CENTRAL NERVOUS SYSTEM:

ENDOCRINE SYSTEM:

GENITO URINARY SYSTEM:

LOCOMOTOR SYSTEM:

PAST INVESTIGATIONS:

FINAL DIAGNOSIS:

YOGIC INTERVENTION: SURYA NAMASKAR

FOR THREE MONTHS

S.NO.	NAME OF THE SUBJECT	DATE AND TIME	NUMBER OF ROUNDS OF SN