

**IMPROVEMENT IN HANDGRIP STRENGTH IN NORMAL VOLUNTEERS
FOLLOWING SELECTIVE SUKSHMA VYAYAM PRACTICES
– A PILOT RANDOMIZED CONTROL TRIAL**

By

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1.0 INTRODUCTION

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.

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.

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.¹

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.

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.

The 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.

The eight limbs of yoga are as follows:

“yama niyama-asana pranayama pratyahara

dharana dhyana samadhayo-stavangani”

Meaning: 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).

1. Yama – Ethical and Moral Codes of Conduct

“ahimsa satya asteya brahmacharya aparigraha yama”

Meaning: 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.

2. Niyama – Personal Codes of Conduct

“shaucha santosha tapah svadhyaya ishvarapranidhana niyamah”

Meaning: Cleanliness and purity of body and mind (shaucha), and attitude of contentment (santosha), asceticism 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. Asana – Body Posture

“sthira sukham asanam”

Meaning: 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.

4. Pranayama – Breath Control

“tasmin sati shvasa prashvayah gati vichchedah pranayamah”

Meaning: 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.

5. Pratyahara – Withdrawal of Senses

*“sva vishaya asamprayoge chittasya avarupe
anukarah iva indriyanam pratyaharah”*

Meaning: 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.

6. Dharana – Concentration

“deshah bandhah chittasya dharana”

Meaning: 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.

7. Dhyana – Meditation

“tatra pratyaya ekatanata dhyanam”

Meaning: 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.

8. Samadhi – Enlightenment

“tad eve artha matra nirbhasam svarupa shunyam iva samadhih”

Meaning: 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.²

Among these 8 limbs of yoga, the 3rd limb asana (posture) helps in keeping the physical body healthy and in good structure. It 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.

One another style of yoga called Hatha yoga, in which few other practices of yoga were explained in detail like mudras and bandhas. Mudras are nothing but gestures and bandhas are locks.

Yogic sukshma vyayam (YSV) comprises of all these practices together like it has asanas, pranayama, mudras and bandhas. There are about 48 practices explained in the yogic SV text by Swami Dharendra Brahmachari.

The literal meaning of the word sukshma vyayam(SV) is nothing but subtle exercise.

SUKSHMA – Subtle

VYAYAM – Exercise

SV was developed by Maharishi Karthikeya Ji Maharaj of the Himalayas. He developed these practices based on the essential and mysterious aspects of Hatha yoga particularly related to the mudras ad bandhas. Later he taught these practices to Swami Dhirendra Brahmachari, who in turn propagated these practices to the humanity by publishing it in books as well as through videos.

The benefits of yogic SV are so great that even skipping the rest of the aspects of Hatha yoga such as asanas, it is highly possible to attain extremely noticeable benefits in a quicker manner.

SV is the only system in the world where every part of the body like organs, joints and muscles is taken into consideration and a particular set of exercises combined with breathing, gestures and locks with a specific point of mental concentration is prescribed.

The complete sequence of 48 yogic SV starts with the top of the body that is the head, eyes, nose, ears, neck, shoulders, arms, elbows, fingers, upper chest, middle chest, abdomen, different aspects of trunk, thighs, buttocks, rectum, bladder, knees, ankles, foot and toes. Thus the practices prescribed in the yogic SV covers literally from the top to the toe in the above mentioned sequence.

So as the name explains the yogic SV is meant for the subtle body that is the sukshma sarira and not for the gross body or sthula sarira.

The best possible positive effects of the yogic SV are,

- It removes the blocks and clips in the muscles and strengthens them,
- It improves the body mobility and makes it flexible and plastic,
- It increases the flexibility of the ligaments,
- It develops equilibrium and coordination in the body,
- It improves the blood circulation and metabolism of the body,
- It strengthens the immunity,
- It harmonizes the internal environment of the body,
- It increases the endurance of the body,
- It increases the vital lung capacity and volume,
- It prepares the body to do more complex asanas and pranayamas.

Out of the 48 yogic SV practices, the selective 10 practices which governs the upper limbs only is taken as the intervention in this study³.

Many daily functions and sporting events require high activity levels of the flexor musculature of the forearms and hands. These are the muscles involved in gripping strength. From sports like wrestling, tennis, football, basketball, and baseball to daily activities such as carrying laundry, turning a doorknob, and vacuuming, some degree of grip strength is necessary to be successful. For example, without adequate grip and forearm

strength, tennis players may run the risk of developing lateral epicondylitis, otherwise known as tennis elbow. Often overlooked or taken for granted, the strength of one's grip plays a key role in injury prevention and overall strength development⁴.

Reliable and valid evaluation of hand strength can provide an objective index of general upper body strength. The power grip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal bio-kinetic conditions. The synergistic action of flexor and extensor muscles and the interplay of muscle groups is an important factor in the strength of the resulting grip. Many factors influence the strength of the grip, including muscle strength, hand dominance, fatigue, time of day, age, nutritional status, restricted motion and pain⁵.

The study is aimed at increasing the hand grip strength with the normal volunteers by incorporating the selective 10 SV practices and thereby introducing these practices to the hand grip strength weaker population.

2.0 AIMS AND OBJECTIVES

2.1 Aim:

To know the effect of selective SV practices in hand grip strength among two groups of normal volunteers.

2.2 Objectives of the study:

To assess the effect of selective SV practices in hand grip strength.

3.0 REVIEW OF LITERATURE

3.1 Hand Grip Strength:

Bilateral handgrip strength assessment is an important anthropometric measure in different situations like determining the work capacity of an individual, assessing the efficiency of muscle function, etc⁶.

The hand grip strength diminishes as age advances. Hence maintaining good hand grip strength can enable the old age people to complete the daily tasks readily and effectively. The hand grip strength readings are a reliable predictor of an increased mortality rate. Thus testing the hand grip strength can help to monitor and can give a clear indication of the risk⁷.

The hand grip strength norms can vary due to several factors like age, sex, dominant and non-dominant hand. The hand grip strength assessment is useful in both clinical and non-clinical conditions. In case of weak muscle strength and stamina, the hand grip strength assessment helps to make a good rehabilitation protocol. At the same time it is also useful to assess an individual's fitness level and morbidity rate.

The hand grip strength is nothing but the force applied by the hand to pull or suspend from objects. Grip strength is a general term used by the athletes referring to the muscular power and force that can be generated by the hands. Grip strength is highly necessary for the rock climbers, martial arts people and the professionals who use their hands for their regular work.

Human hand can be used to hold objects in different positions. These different positions demand different types of grip strength. These different types of grip strength are quantified based on the way the hand is being used. There are various types of grips available like,

- Crush Grip – As the name itself explains much that it involves ‘handshake’ type grip, where the object being gripped firmly against the palm and all fingers.
- Pinch Grip – Here the fingers will be on one side of an object and the thumb is on the other side. This grip is used to grab some objects like weight plate or lifting a plywood sheet, etc.
- Support Grip – Here the hands used to hold something like the handle of a bucket for a given period of time. A great deal muscular endurance is highly essential for this grip.

In the medical field, the hand grip is often used for the following purposes:

- To diagnose the diseases,
- To evaluate and compare the treatments,
- To document the progression of muscle strength,
- To provide feedback during the rehabilitation process,
- As a measure indicating the hand function level⁸.



Figure 1



Figure 2



Figure 3



Figure 4

Yoga is a science of mind-body fitness that involves combination of muscular activity and internally directed mindful focus on awareness, breath and energy.

Yoga is used as a therapy for treating various conditions and thus it is called as therapeutic yoga. Yoga therapy involves instruction of yogic practices and teachings to prevent, reduce or alleviate physiological, structural and emotional pain and sufferings.

Yogic practices enhance body flexibility and muscular strength. It promotes and improves cardiovascular and respiratory functions. It also helps in recovery from the ailments, addiction, stress, depression, anxiety, chronic pain, sleep impairments and thereby enhances overall well-being together with improvement in the quality and productivity of life.

Hatha yoga enhances the capacity of the physical body through its various practices like asanas (body postures), breathing techniques (pranayama), bandhas (locks) and mudras (gestures).

A study on 3 months yoga training among sports teachers conducted by S. Telles et al, concluded that yoga practices including asanas, pranayama and meditation showed significant improvement in general health in terms of body weight, blood pressure and lung function. Even though the subjects are sports teachers, undergoing physical training since last 8.9 years, the 3 months yoga training decreased the autonomic arousal and gave more of psychophysiological relaxation. Thus this study shows yogic practices helps in improving the stamina and muscle strength along with healthy internal homeostasis⁹.

A 5 arm study conducted by P. Raghu Raj et al, on school children concluded that one side nostril breathing and alternate nostril breathing practiced for 10 continuous days showed significant improvement in the hand grip strength bilaterally. This shows that the hand grip strength can improved not only by the practice of posture, even with the help of pranayama also one can easily improve the hand grip strength. Hence practicing posture together with pranayama will surely double the effect on hand grip¹⁰.

A 1993 study conducted by Shirley Telles et al, on 45 school children with 19 days of yoga practices showed significant improvement in the static motor performance. The yogic practices administered in this study are asanas, pranayama, dharana and meditation. Through this study it is concluded that the static motor performance, body and mind coordination improves effectively and consistently through the practice of yoga that too just in 10 days of time¹¹.

A study was conducted by Rinku et al, to study the isometric handgrip exercise training on resting blood pressure in normal healthy individuals. Isometric handgrip exercises was given to 30 normal healthy volunteers of age between 20-40 years. Five bouts of 3 mins exercise were given to the group with 5 min relaxation in between each about 3 times per week for 10 weeks. The blood pressure was measured before and after the exercise given. Both systolic and diastolic blood pressure was reduced significantly after the 10 week period of the handgrip exercise¹².

A comparative study was conducted among the 90 MBBS students. The students were divided into three groups 30 each. A group practiced yoga, other group practiced physical exercise and the third group was a control group. Baseline and post interventional measures were recorded with handgrip strength, and other psycho physiological parameters like visual reaction time, audio reaction time, depression tests, state trait anxiety test etc. the study was not randomized, the option was given to the students to make a choice in three groups. It was found that the group of students who have chosen the yoga were found to be more stressed and anxiety prone in their baseline assessments. It was shown that the improvements were found in both the yoga and exercise group but significant improvement was found in the yoga group as compared with the exercise group. It was concluded that yoga was a less intense exercise that had an impact on the persons stress levels by positively bringing out changes in the HPA axis. It also helps in reducing the autonomic distress caused during exams which is the so called exam stress¹³.

A study was conducted to evaluate the effect of high frequency yoga breathing and breathe awareness among 50 healthy individuals. Both practices were given separately on each day but at the same time. The participants were divided into two parts and yoga practice was given for all the participants on alternate days and the measures were recorded. A markable observation in this study was that the handgrip strength was improved only in the right hand and not in the left hand. Left hand strength was same in pre and post. But the right hand showed considerable improvement¹⁴.

This study was conducted to find whether the decline in functional, physiological and social health among the oldest old can be predicted by the handgrip strength analysis. Around 599 participants of age 85-90 were included in the study. From this study it was concluded that the poor hand grip strength indicates the accelerated decline in the health of the oldest old. It was also noted that poor hand grip strength was an indicator of the cognitive decline in the oldest old¹⁵.

Walking is the most simple and effective exercise which is practiced by most of the people in and around the world for weight loss. This study compares the effect of walking and yoga in obese and overweight individuals. Yoga or the walking was supervised one practiced for 90 mins daily for 15 days. Related biochemistry values, anthropometric measurements, body composition, postural stability and handgrip strength were measured in both the groups before and after the intervention is given. Both the groups showed considerable decrease in the anthropometric measurements, body water and total cholesterol. Yoga group showed a considerable change in the leptin levels and the LDL cholesterol. Serum leptin showed increase and there was a decrease in level of LDL in the yoga group. This study supports the evidence that yoga influences adipokine levels in the human body¹⁶.

Ganguly S.K et al, examined the effects of 3 year Yoga exercise programme on health related physical fitness and academic achievements of schoolboys, aged 10-13. Physical fitness variables tested were cardiovascular function, body fat percentage, abdominal muscle strength/endurance and flexibility, whereas the variables of academic achievement

were the marks secured in theoretical subjects as per the school examination. The subjects participated in the selected Yoga exercise programme 3 days per week for 45 min. per day for consecutively three years. Results indicate that performance on all variables of physical fitness and academic achievement was improved significantly. A comparison of Yoga exercise subjects with a comparable control group revealed significant interaction between treatment and time on all variables. During three year period of experiment, pre-test to post-test scores of the yoga exercise subjects tend to improve progressively with faster rate over the scores of control subjects. The results of Pearson correlation indicate that body fat % is inversely related to all the variables of academic achievement, whereas other attributes of physical fitness indicate a low but positive relationship with academic achievement¹⁷.

Declined health and fitness status of school children has become a challenging problem of research. Many recent investigations indicate increasing trend of severity in health problems that affect overall work capacity of school children, In a study conducted by Govindarajulu N et al, the status of work capacity of elite school players (n=75), age ranged 13-17 years, from some of the schools of Pondicherry (India), was evaluated. Work capacity of 13 years, 15 years and 17 years boys has been compared. Result of ANOVA and follow-up statistics revealed that work capacity varies as age increases. Regular participation in different exerciseregimes although helped to improve work capacity, however, the players habitually participating in yogic exercises along with exercise-regimes could show higher work capacity. The study suggests benefit in inclusion of yoga in the exercise regimes for exhibiting better performance in school sports¹⁸.

Yogic techniques are known to improve one's overall performance and work capacity. Sharma et al conducted prospective controlled study to explore the short-term impact of a comprehensive but brief lifestyle intervention based on yoga, on subjective well-being in normal and diseased subjects. Normal healthy individuals and subjects having hypertension, coronary artery disease, diabetes mellitus or a variety of other illnesses were included in the study. They reported significant improvement in the subjective well-being scores of 77 subjects within a period of 10 days as compared to controls. Therefore, even brief intervention can make an appreciable contribution to primary prevention as well as management of lifestyle diseases. This is vital in the elderly and Hatha yoga practices for 6 months by seniors [65-85 years] has shown significant improvement in quality of life and physical measures compared to walking exercise and wait-list control groups¹⁹.

Scientific studies on yoga demonstrate that yoga improves dexterity, strength and musculo-skeletal coordination of the practitioners. Postures assumed during yoga practice are mainly isometric exercises which provide optimally maintained stretch to the muscles. Series of asana involve assumption of the pose followed by counter pose i.e. it involves coordinated action of synergistic and antagonistic muscles which brings increased steadiness, strength, stamina, flexibility, endurance, anaerobic power, better neuro-muscular coordination and improved orthostatic tolerance. Body weight is itself used to provide load to the muscles and bones. This load bearing strengthens the bones and prevents age-related weakening, thus helping in prevention of osteoporosis. A properly selected set of exercises stretches nearly all joints and joint capsules without much danger of injuries and exhaustion. Bera & Rajapurkar have reported significant improvement in ideal body

weight, body density, cardiovascular endurance and anaerobic power as a result of 1 year yoga training in children aged 12-15 years²⁰.

Clearly, yoga practices should be started at an early life. Hart and Tracy studied effects of Bikram yoga on strength, steadiness and balance in 10 young adults. 24 yoga sessions of supervised, standardized postures for 1.5 hr were conducted for 8 weeks. They reported that even short-term yoga program of this type in young adults improved the balance, produced modest improvements in leg strength, and improved leg muscle control for less steady subjects²¹.

Dhume & Dhume compared the relative effectiveness of dextroamphetamine and yogic meditation on the performance of medical students to concentrate on the task to balance on a balance board. The performance of meditators went on steadily and progressively increasing throughout the period of 10 trial days with overall percentile rise of 27.8% while amphetamine use deteriorated the task performance of students. Therefore, yogic meditation is of merit to achieve concentration for mental as well as physical task such as neuro-muscular coordination and dexterity²².

Raju et al demonstrated that in trained athletes, practice of pranayama for 2 years resulted in achieving higher work rates with reduced oxygen consumption per unit work and without any increase in blood lactate levels. Also, blood lactate levels were significantly lower at rest in the athletes after pranayama practice²³.

Ray et al studied the effect of training in hatha yogic exercises on aerobic capacity and perceived exertion after maximal exercise in young adults. They found that absolute value of VO₂ max increased significantly in the yoga group after 6 months of training. The perceived exertion scores after maximal exercise decreased significantly in the yoga group after the 6 months training period. Therefore, the practice of hatha yogic exercises along with games helps to improve aerobic capacity²⁴.

Chaya et al found that yoga practices [asana, meditation and pranayama] for a minimum period of six months results in significantly lower basal metabolic rate of the yoga practitioners as compared to that of the non-yoga group. It may be linked to reduced arousal, with the long term practice of yoga using a combination of stimulatory and inhibitory yogic practices²⁵.

DiBenedetto et al reported that 8 week Iyengar hatha yoga practice improved hip extension, increase stride length, and decreased anterior pelvic tilt in elders. They suggested that yoga programs tailored to elderly adults may offer cost-effective means of preventing / reducing age-related changes in indices of gait function²⁶.

Multiple sclerosis is a progressive disease condition which has no far recorded permanent cure. It calls for a lifelong physiotherapy exercises and other treatment in physiotherapy interventions. In this study the researchers compared the effects of the physiotherapy exercises and the yoga modules for the multiple sclerosis patients. The multiple sclerosis patients were divided into two strands. Strand 1 where the multiple sclerosis patients were able to walk with unilateral support and strand 2 who needed

bilateral support while they walk. The groups formed were the physiotherapy led interventions, group physiotherapy treatment, group yoga intervention and a control group. Each group had participants from both the strands (strand 1 and Strand 2). This was a trial registry made in the randomized controlled trials²⁷.

The study was conducted to analyze the effect of one week yoga practice in rheumatoid arthritis patients in pain, stiffness, disability index score and also the handgrip strength. 64 participants were selected for this pre post study. The baseline and post interventional assessments were made. One week yoga practice which comprised of two sessions per day was conducted to the patients. The yoga practices comprised of Asanas, kapalbhati, pranayamas (anulom vilom, bhramari and udgeeth pranayam) and sukshuma vyayams. Pranayams were practiced with kumbaka both bahya and anthar. There was a decrease in the disability index which is known as the improvement in the disability of an individual. There was an improvement in the handgrip strength after a week of yoga practice but the improvement was limited to the male patients. Here the reason for the non-improvement in the female cases is left unknown. Self-reported discomfort scale also showed an improvement after a week of yoga practice as compared to the other groups. This was most particularly related to the eating habits and common daily activities. HAQ (Health assessment questionnaire, disability index of the clinical health assessment questionnaire) was an important assessing criteria²⁸.

This study was conducted to assess the effect of yoga during two phases of the menstrual cycle in 50 young women of age 18-20 years. They were divided into two

groups, group I who performed yoga 6 times per week for three menstrual cycles. Yoga was taught by the qualified yoga instructor. Second group acted as the control group. Parameters measured were, anthropometric measurements, systolic and diastolic blood pressures, parasympathetic and sympathetic reactivity tests, handgrip test and cold pressor tests. Among two phases of premenstrual and post menstrual phase, significant results were found in the alteration is the autonomic functions and the psychological status in the premenstrual phase than the post menstrual phase. It is said that yoga brings about the parasympatho-dominance and a well-being in the psychological state by balancing the neuro-endocrine axis²⁹.

A study was conducted to analyze the effect of yoga in the improvement of handgrip strength, hand grip endurance, peak expiratory flow rate, forced expiratory volume and forced expiratory volume in 1s. Yoga training was given to 20 school students for a period of six months. Similarly 20 age and gender matched students became the control group. It was found that the yoga practices profoundly increased all the above mentioned parameters. Similar studies already have proven that yoga is effective in improving the endurance of an individual. This study proved the specific increase in the endurance in hand grip strength and hand grip endurance³⁰.

Improvement of physical health and mental health through yoga is been proved in many researches where in the efficacy of yoga in handgrip strength is not been proved in any studies. This study aimed to prove the efficacy of the yogic practices (including asanas, pranayamas, kriyas and meditation) in improving the hand grip strength of school boys. A

residential school was selected for this concern where the drop outs can be minimized or nullified. 15 such students were selected and given proper yoga training for one to one and half hours daily for six days a week for 4 consecutive weeks. Handgrip strength was assessed by the hand grip dynamometer before and after the training period. Yoga classes were handled by trained yoga instructors. Even though there were improvements in both left and right hand – hand grip strengths, the results were not that significant³¹.

Irritable bowel syndrome is one of the most annoying problems which is accompanied by many symptoms and drastically disturbs the quality of life of an individual. This study was conducted to analyse the effect of yoga in the symptoms and quality of life in the patients with irritable bowel syndrome, which can be measured in IBS-severity scale and IBS quality of life scale. Hand grip strength and also the autonomic measures were assessed. Three groups were formed, group 1 was yoga with limited conventional treatments for three days a week, group 2 was a combination group which had both yoga practice and the conventional treatment and group 3 was the control group which was given current care and lifestyle changes. A wait listed control group was also formed in this study. A remedial yoga module was designed for irritable bowel syndrome and was taught to the yoga and the combination groups for 12 weeks. It included breathing practices like vyagarasana, hand stretch breathing, shasankasan and padottasana breathing; sithalikiran vyayam which included forward bending, backward bending, sideward bending, pawanmuktasana and twisting; asanas like ardha kati chakrasana, ardha chakrasana, padahastasana, trikonasana, parivrita trikonasana, vrikshasana, sarvangasana, shalabasana, viparithakarani, vakrasana, bhujangasana, paschimottanasana and fish pose. It also included

kriyas, pranayamas and bandhas like uddyana bandha, kapalbhati, nadi shuddhi, bhramari, sitali and sitkari. Dhyana techniques were also included in the sessions. In subjective assessments yoga group proved much better than the combination group. In objective assessments both yoga and the combination group showed better results. Sympathetic reactivity test showed better result in week 12 in the yoga group. In parasympathetic reactivity tests, improvement was better in week 6 and week 12 than in week 0. Similar changes were observed in QOI (Quality of life) assessment also³².

Based on the body mass index lower body exercises were administered to improve the strength in certain areas like it was already established that the knee extension strength was improved after administering the lower body exercises observing the body mass index. The present study was designed to find the effect of body mass based exercise intervention in improving the hand grip strength and the knee extension strength in older individuals. The number of subjects selected for this study is 166. Among these 166 subjects, 160 completed the study. Among this group, a self-selected group of about 37 individuals constituted the control group. Hand grip strength, knee extension strength and the anterior thigh muscle strength using ultrasound were all measure before the intervention was given to the subjects. The same was also measured post the intervention and the relative strength was calculated³³.

The study solely to estimate the importance of the handgrip strength was conducted. It was found that the measuring the hand grip strength will help in assessing the future disability chances. Measuring the hand grip strength in older adults helped in finding out

the result that the age related handgrip strength measures helped in assessing the future disability that would affect an individual. It was also found that this will of only help predict the future disability, but also the morbidity of an individual³⁴.

A study has conducted in a group of adults to compare the effect of birth weight and the handgrip strength. From this study it has been proven that birth weight has positive correlation with the adult hand grip strength³⁵.

Handgrip strength has always served to be an excellent indicator of health status in old age which include mortality, functionality and nutritional status etc. this study was performed to analyze the hand grip strength of elderly person who are hypertensive and with different levels of physical activity. This was a cross sectional study with the sample size of 80 individuals. They were all divided into three groups based on their physical activity. The basis of grouping was the physical activity, gymnastics, weight training and hydro gymnastics. It was found that there was no significant difference in the handgrip strength in the sedentary and the active exercise group. From this we can infer that the hand grip strength seems to be associated with the type of activity performed and not merely on the intensity of the workout carried on³⁶.

A study was conducted to find whether normal daily activity also. Because it is not easy for everyone to maintain a perfect exercise schedule and do it every day. So a study was conducted to evaluate the effect of daily activities like squats on the muscle growth and the muscle strength improvement was analyzed. It was found that the daily activities also improved muscle growth and the muscle strength. It is generally difficult for many people

to practice or follow a different schedule of exercises along with their daily activities. A study was conducted to find out whether some of the daily activities which is similar to the low body mass index training has really an effect on the hand grip strength. For example exercise like squats were used in this study, as squats is a position which is generally performed in many houses where special training is not essential. In this study it was proved that such low intensity exercises also had significant improvement in the hand grip strength. The daily activities were also found to have effect in the hand grip strength³⁷.

Another study conducted to find out whether the metabolic fatigue and the mechanical stress caused after any exercise has some positive effect on the muscle strength improvement. It was found that even normal activity increases the muscle growth. During any training program there would be a considerable degree of mechanical stress and metabolic fatigue observed in any individual. A study was conducted to find out whether this metabolic fatigue and mechanical stress had any effect in improving the muscle strength or any positive effect in the muscle growth. As generally even exercises designed for muscle growth would cause mechanical stress and also metabolic fatigue in individuals. This study showed that the mechanical stress and the metabolic fatigue had actually contributed to training induced muscle growth and muscle strength among sports persons³⁸.

It is proved in a study that 150 mins of physical exercise in a week or more than that is essential to call a person physically active. Any time less than this will not be considered as physically active or active needed for maintaining their health. Anytime more than 150 mins were accepted as the physically active criteria³⁹.

A study was conducted to evaluate the finger exercise movements and finger weight lifting exercise in very elderly adults whose age is more than 80 years. A total of 80 participants were selected for the study and were divided into two groups, a control and an intervention group. The intervention group received a finger strength exercise and finger weight lifting exercise for three months. Control group did not receive any interventions and they were blinded about the intervention given to the other group. After three months it was found that the finger strength was increased in the intervention group and there was a decrease of the same in the control group. This was concluded that these exercises would improve the self-care abilities of the elderly persons to improve their well-being⁴⁰.

In another study it was found that handgrip strength served as a criterion for the health care assessment in the elderly people. Assessing the hand grip strength would be a valuable assessment to score the health related quality of life in them⁴¹.

Evidence supports the above report stating that assessing of the handgrip strength in elderly individuals can be used for the general health of older adults and also helps predicting the disability⁴².

It is also clearly proved in a study that the hand grip strength declines as the person ages. This declination starts from the age of 46 years and a rapid decline after 85 years of age. This study also creates an importance of the yoga modules that will help in the improvement of the handgrip strength which can be easily taught, learned and practiced by people of any age groups⁴³.

The gender difference always exists in any kind of experiments. Proper analysis of which will help in removing the bias in the study. A study was conducted to find out the gender difference in the hand grip strength as the age of the person increases. It was found that the hand grip strength declination was more for men than women in the elderly population. The difference reported was 1.53 kg/year for men and 0.85kg/year in women⁴⁴.

There are many observational studies conducted to evaluate the association between handgrip strength in the cardiovascular diseases. This is the specific study conducted to evaluate these results. This is a mendelian randomized study. In this study the genetic instruments were used to find the association between the handgrip strength and the cardiovascular health. The used genetic instrument was the two single nucleotide polymorphisms. Each single nucleotide polymorphism was measured separately based on its weightage to the cardiovascular diseases. This estimate arrived were used to find the effect of increased handgrip strength in the cardiovascular diseases. The drawback of the study was that, no association was found between the markers like low density lipoprotein, high density lipoprotein, triglycerides, fasting glucose, body mass index etc. It was found that increase in hand grip strength was associated with decrease in chances of cardiovascular diseases. A Similar effect was also observed in myocardial infarction. Till this study was conducted there were no randomized controlled study done on the association between the handgrip strength and the cardiovascular health⁴⁵.

A genome wide association study was conducted to find the association of genomes and the disease or body conditions. In this research, it was found that the single nucleotide

polymorphism is associated with cardiovascular disease and the coronary artery disease⁴⁶.

The observation made from this study gave a light on the association of the muscular strength and the hand grip strength in an individual. It was found that even though the person may have higher handgrip strength, if his overall muscular strength is low, then they will be less healthy individuals prone to any cardiovascular or other systemic disorders⁴⁷.

This study was conducted to find whether the age, body mass index, arm length, forearm circumference were all in predictive to the hand grip strength in healthy individuals. 116 subjects were recruited for this study. All were healthy volunteers. Fore mentioned measurements and details were collected from all the subjects. The study showed that the handgrip strength of an individual can be stronger if the hand length is more, hand circumference is more and also if the age is less. Age is inversely proportional to the hand grip strength of an individual. From the demographic data of this study, men were found to have more hand length than the females. There are many drawbacks observed in this study like smaller sample size, lack of female participants, wide age group and a poor prediction model used in the study. As the study was cross sectional the aspect of longitudinal details were unable to be obtained from the individual grip strengths. But the data from this study can be used for a clinical application and also in rehabilitation purposes. A widespread knowledge on the relation of the handgrip strength and hand circumference, hand length, relationship with age etc was obtained from this study. It was proposed that the similar information could also be generated from the old age people who are healthy. This would give a good reference about the above said measures and the hand grip strength

measurement. This could also influence the clinical applications to the old age population and also the hand function training⁴⁸.

Hand grip strength has been found to be the predictor of health in many diseased conditions like heart diseases, cerebro-vascular diseases, healthy status of an individual, cognitive disabilities and mortality⁴⁹.

Another research study has confirmed the reliability of hand circumference as a predictor of the handgrip strength⁵⁰.

There are also studies which claim that the hand length is also a reliable criterion for the prediction of the handgrip strength.

This was a literature study which analyzed around 11604 papers for the relation of handgrip strength and the health of an individual. Among all these papers 189 were found suitable and relevant. The points in point grip endurance; hand grip strength was all compared and analyzed⁵¹.

Reference values are always important and useful in any condition may it be a research study or to find the health status of an individual or the degree to which he is affected and also to the degree to which he has to be improved. This study is conducted to find a reference value for the hand grip strength. The association of age and the handgrip strength was properly analyzed in this study. The hand grip strength is always found to be providing effective measure in diagnosing various conditions like wrist orthoses, painful arc syndrome, rheumatoid arthritis etc. Already grip strength is serving as an effective

measure for many clinical conditions and also in many research purposes. The reference for hand dominance, height or weight was not properly analyzed in the previous studies. Around 19 schools were selected for the study. Many students were excluded from the study due to many reasons, even if the form is not completed properly. In a total 2241 students participated in the study. Age related variations, hand dominance variations were all noted. It was found that for male students the significance of the hand dominance was profoundly more as the age progresses for example from 11 to 13 years of age. For girls the hand dominance was found comparatively less when compared to boys. The girls did not show much of the hand grip strength increase as they grow old as effectively as males, but a meager improvement was found. But with boys there was a significant increase in the hand grip strength from the age of 4 years to 14 years. This was not as evident with the girls. It was also observed that there was a significant relation between age, height and weight with the hand grip strength. This was observed in both the dominant and non-dominant hands. This was one of the largest study conducted to generate the values of handgrip strength in children in relation to their age, sex, height, weight and dominant hand. But still due to the differences in the methodology of the study the values were not easy to be consolidated. Some equations were mentioned in this study that if the height and weight of the patient was available, few predictions could be made in regard with the hand grip strength⁵².

A study was conducted to find the handgrip strength in different group of people performing different athletes. Both male and female were recruited for this study. 90 females and 90 males were recruited for this study. There were all from different athletic

groups and their hand grip strength was recorded. Their demographic details were also collected. It was concluded that there were no observed differences in the handgrip strength of different athletic groups⁵³.

Hand grip strength is always associated with the functional anomalies in the hand. So it can be served as an effective measurement in case of rheumatoid arthritis patients. This systematic review was conducted to create a standardization of the test procedures to make the study reliable. The review was conducted with the recommendation from PRISMA. This was based on the data collected from the web of science, other journals website of the Brazilian government agency CAPES. Only articles which involved the measurement of hand grip strength through dynamometer was included in the review. Two independent reviewers were included in the study. Among 628 articles, 40 were included for qualitative syntheses. Other measures such as the hand dominance, acquisition time, rest period and repetitive contraction intensity was all noted. It became a clear factor that the standardization of the procedure is very essential, to use the instrument which is right for the hand grip measurement, and also the clinical conditions of the patients of rheumatoid arthritis⁵⁴.

In different yoga programs with various combinations of different components of yogic practices, with regulated duration and frequency of specific yogic practices the physical performance improvement can be achieved. Different combinations of yogic practices may be incorporated in physical fitness program based on the situation both in normal and diseased individuals. All practices should not be performed by everybody. The

comparatively physically fit individuals may practice all the practices by increasing the frequency and duration of individual components. On the contrary, for sedentary and diseased individuals asanas with the lower or moderate intensity of exercise without any complicated postures should be preferred. One has to be selective to choose specific yoga practices in case of sedentary and diseased persons to accrue the benefits⁵⁵⁻⁵⁷.

Yogic exercises not only increase the general strength but also tone up the muscles because these exercises stretch out the muscles and due to their slow stretch and hold nature along with breathing mechanism improves the muscular tone and strength of the muscles. In the study conducted by Dr. Harbans Lal Godara Ten weeks yoga training was administered and AAPHER fitness test is framed to find out the minimum physical fitness required to participate in the training programme and also to find out the improvement in Physical fitness after the training programme. The 40 handball players (Boys) who is regularly playing handball in evening at STPS Suratgarh Rajasthan. Their age ranged between 12 – 17 years. Students were given the treatment of selected yogic asana & pranayama for 10 weeks. The result showed that the regular practice of yoga improved Physical fitness significantly⁵⁸.

Yoga affects every cell of the body. It brings about better neuro-effector communication, improves strength of the body, increases the optimum functioning of all organ-systems, increases resistance against stress and diseases and brings tranquility, balance, positive attitude and equanimity in the practitioner which makes him lead a purposeful and healthier life⁵⁹⁻⁷².

From a postural standpoint, yoga seems to improve an individual's ability to stabilize their spine and pelvis leading to a reduced risk of low back pain. In a study published in the *Annals of Internal Medicine*, 12 weeks of yoga demonstrated some added benefit over traditional exercise and significant improvement over low back pain symptoms. Yoga seems to be at least equal and possibly superior to traditional exercise at reducing perceived stress. It is suggested by a growing body of evidence that yoga benefits physical and mental health via down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS).

A review of literature which analyzed studies comparing the effects of yoga and exercise seem to indicate that, in both healthy and diseased populations, yoga may be as effective as or better than exercise at improving a variety of health-related measures. Although more research is necessary to discern the distinctions between exercise and yoga and the different types of yoga on the SNS/HPA axis, it is evident both can be used to improve measures of mental health.

4.0 MATERIALS AND METHODS

4.1 Subjects:

A total of 60 subjects of both gender with age group of 18 years participated in the study.

4.1.1 Description of the subjects including the selection of samples:

The study subjects were randomly recruited from the college of Government Yoga and Naturopathy Medical College and Hospital, Arumbakkam, Chennai, Tamilnadu, India. The subjects were recruited from the above mentioned college through screening done to assess inclusion criteria, exclusion criteria. Sixty participants were screened and those satisfying the criteria of the study were recruited for the study.

4.1.2 Demographics:

Table No.1 Describes the demographic details of the subjects

Variables	Yoga	Control
Age (yrs)	18.0±0.11	18.01±.012
Height (cm)	143.42±8.52	146.58±9.65
Weight (kg)	58.77±6.23	56.35±4.35
BMI (kg/m²)	22.57±3.78	23.78±4.56

4.2 Ethical Considerations:

4.2.1 Ethical Clearance:

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

4.2.2 Written Informed Consent:

Subjects who fulfilled inclusion criteria were apprised about the purpose of the study and their rights as the research subjects. Informed consent form was administered in English. As all the subjects understood and spoke English, hence there was no requirement of translating the informed consent form into the native language i.e., Tamil. Adequate time was given to each patient to go through the information sheet and their queries were answered. The information sheet and the consent form were also once well explained to the subjects. Their right to withdraw anytime from the study at any point of time during 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 in the study by giving a signed informed consent. (A sample informed consent sheet is enclosed as Annexure I).

4.3 Screening of Subjects:

The subjects were taken into the study by measuring their height, weight and body mass index(BMI) with the help of standard height calibrator and weighing scale. The BMI was calculated as per the norms of World Health Organization. The normal BMI subjects were taken into the study.

4.3.2 Inclusion and Exclusion Criteria

4.3.2.1 Inclusion Criteria

The following criteria were used to select the subjects into the study.

- Age group: 18 to 28 years
- Both sexes
- Normal BMI individuals
- Persons who are ready to give their consent

4.3.2.2 Exclusion Criteria

- People who are underweight and overweight
- People with underlying pathological conditions with their upper limbs.
- People who are doing regular physical activities like sports, gym and aerobic exercises
- People who are pregnant, lactating and menstruating

4.4 Design

4.4.1 Type of the Design

A Randomized Controlled Trial.

4.4.2 Randomization

Simple randomization was used in the study. Among the various simple randomization methods, in this study the lottery method was incorporated.

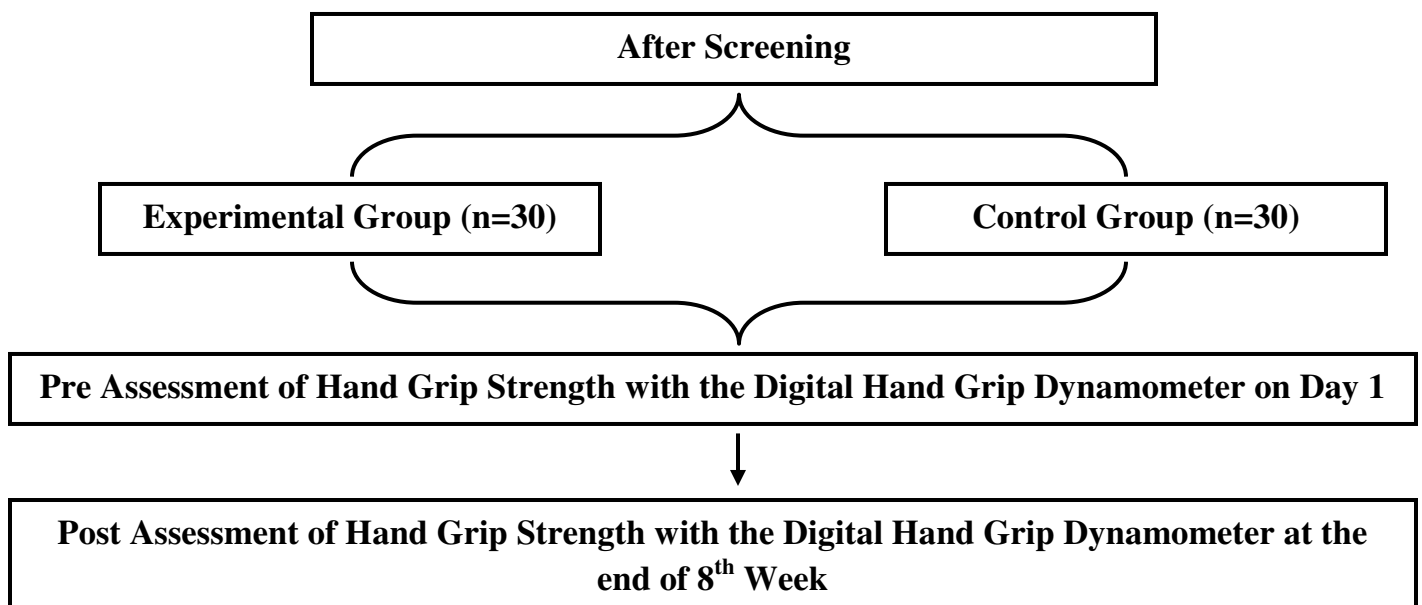
4.4.3 Allocation of Patient into Study and Control Groups

The patients were allocated randomly to the experimental or the control group. Neither the investigator nor the patients were blinded to the intervention. The subjects were not informed of the group they were taken in. 68 subjects were initially screened and sixty of them were recruited and randomly assigned to two groups based on the lottery method as Experimental group(Group A)(n=30) and Control Group (Group B)(n=30).

4.4.4 Data Points

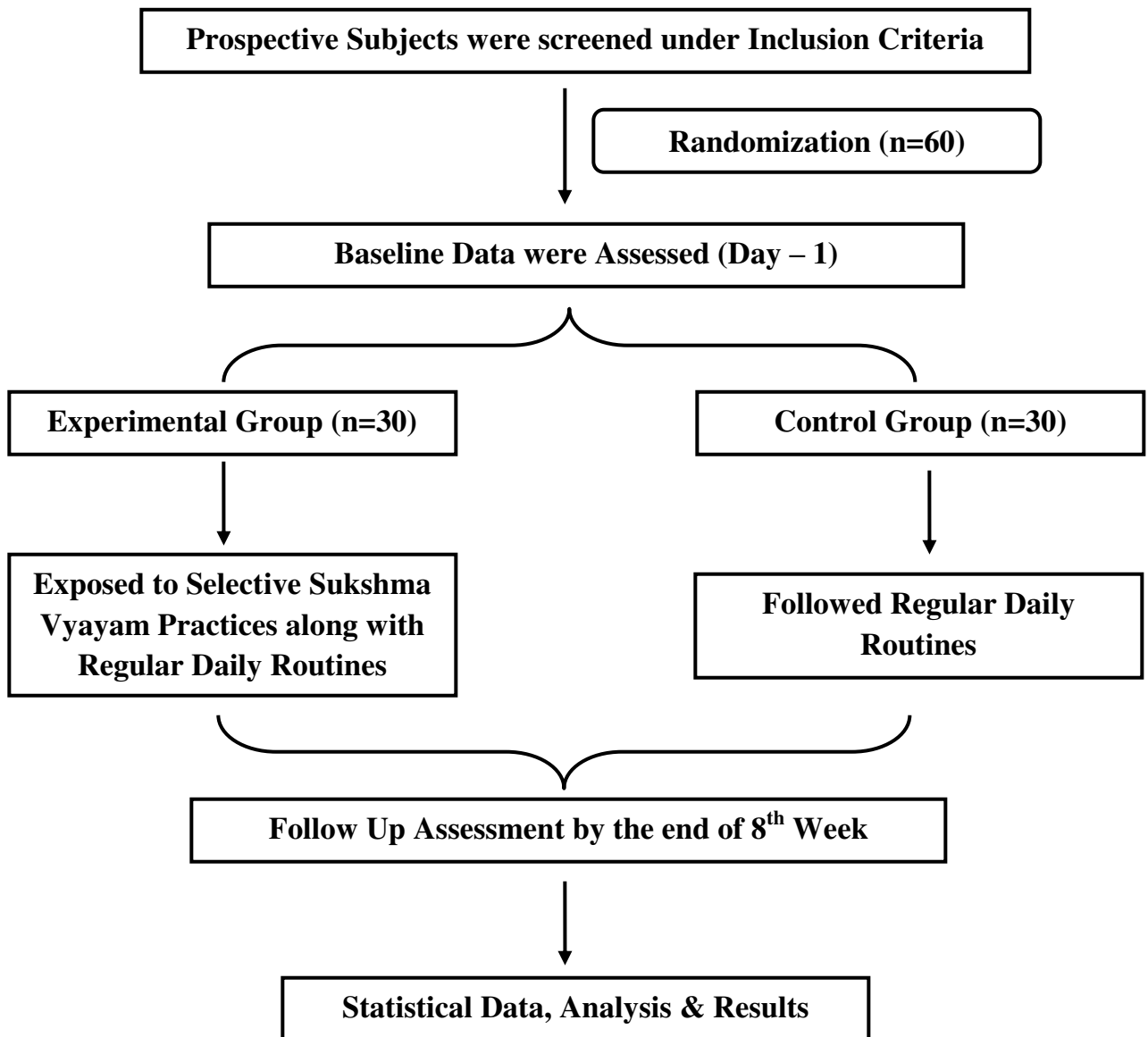
The data collection was done at different phases. After screening the subjects, the hand grip strength was assessed with the help of the hand grip dynamometer with each of the individual in both the groups. After this the subjects in the experimental group were taught and made to perform the selective SV practices daily in the morning for continuous 8 weeks. The control group subjects were said to follow their daily routine. After 8 weeks, the hand grip strength was assessed with the same hand grip dynamometer with both the experimental and control group subjects.

Figure 5:



The trail profile of the study is presented as **Figure 6** which illustrates the study plan, flow of patients across data points.

Figure 6:



4.5 Assessments

The baseline and post-intervention assessments consist of:

Table 2: Outcome Variable

OUTCOME VARIABLE
Hand Grip Strength Assessment with the help of CAMRY digital hand grip dynamometer

4.5.1 Hand Grip Strength:

Hand grip strength is a reliable and valid measurement when the standardized methods and calibrated equipment are used⁷³.

The hand grip strength is measured with the help of hand grip dynamometer. There are numerous types of dynamometers available presently out of which few are only validated and reliable. The normative data is available for very few dynamometers only⁷⁴.

The hand grip strength is related to and also a predictive tool of health conditions. It is positively related to the normal mineral density in the bones of the postmenopausal women. Thus it can be used as a screening tool for the women at risk of osteoporosis⁷⁵.

According to a study published in the year 2007 in the American journal of medicine, lower the hand grip strength readings are a reliable predictor of increased mortality rate⁷⁶.

A research study published in the Canadian medical association journal in 2010 suggests that the low grip strength in the elderly is highly associated with increased mortality. It also explains that the decreased hand grip strength probably indicates an

overall decline in the total body strength which in turn affects an individual's ability to perform the daily activities normally. It also states that one can improve or preserve the grip strength by practicing the hand grip exercises regularly by using simple and effective tools⁷⁷.

4. 5. 2 Hand Grip Dynamometer:

There are many ways for measuring the hand grip strength. Even a wide range of equipments and instruments also available to assess the hand grip strength. Out of those all the hand grip dynamometer is the chief and widely used tool for measuring the hand grip strength. Since the invention of the first hand grip dynamometer, the Regnier dynamometer by 1807, there have been many dynamometer designs and types came into existence.

Basically the hand grip dynamometer is used for hand grip test. The curved handle of the dynamometer reflects the pattern of the hand when making a fist. The handle is flexible and receptive to pressure against it. A monitor is attached to the hand grip which shows the strength of the squeeze in kilograms.

The various types of hand grip dynamometers available presently in common usage are,

- Jamar Grip Dynamometer – Hydraulic Dynamometer
- Camry Electronic Handgrip Dynamometer – Affordable digital dynamometer
- Smedley – Commonly used spring type dynamometer
- Budget – Very simple and usually inaccurate handgrip dynamometer

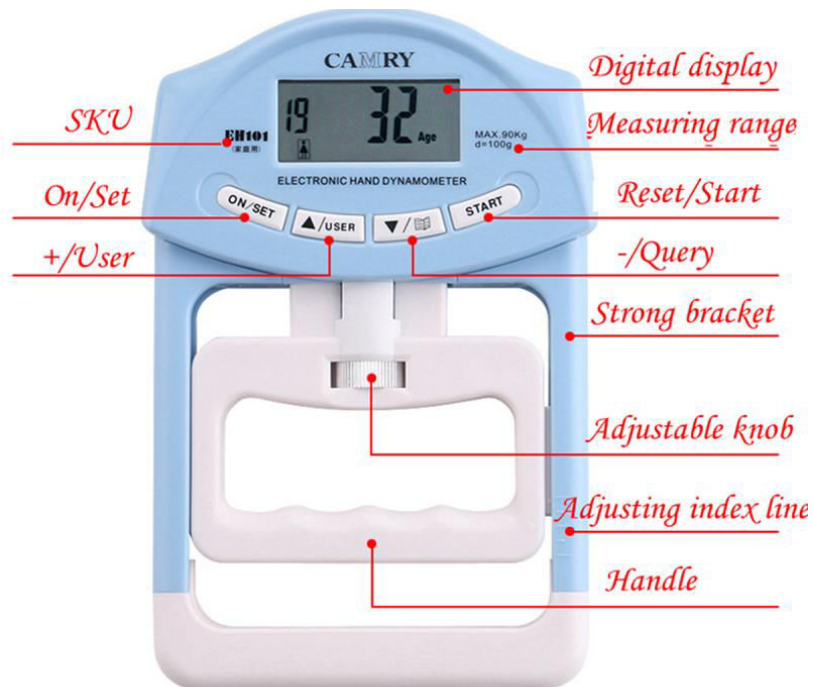
- Pneumatic – Simple method of measuring grip strength even with a sphygmomanometer.

Even there are several other types of dynamometer available based on the brand and forms.

The Camry electronic handgrip dynamometer is incorporated in this study. It captures maximum grip strength in either pounds or kilograms. It measures the isometric grip force up to 200 lb / 90 kg. it has adjustable grip sizes so that it can used by varying hand sizes. It has the digital LCD display with on screen rating of results according to the gender and age.

This dynamometer is highly suitable for the people who are involved in strength training, sports in which the hands are used chiefly like catching, throwing, bowling, lifting, climbing, etc.

Figure 7



Hand Grip Dynamometer Procedure:

The procedure of handgrip dynamometer is so simple that if anyone learns can practice it easily without any difficulties. The only thing the subject have to maintain during the procedure of assessment of handgrip strength with the hand grip dynamometer is that they have to maintain a proper posture and without any strain or discomfort.

The participant is to be seated with his/her shoulder adducted and neutrally rotated. The elbow, flexed at 90° and the forearm in a neutral position. His/her wrist should be between 0° and 30° of dorsiflexion and between 0° and 15° of ulnar deviation. After the participant being positioned correctly, verbal instructions of, "I want you to hold the handle like this and squeeze the dynamometer as hard as you can" will be given. When the participant began to squeeze, I will say, "Harder!... Harder!... Relax". The procedure will then be repeated using the same verbal instructions for the second and third trials. A 15 second rest break between each trial will be given. The scores of three successive trials for each hand tested will be recorded. The average score of the three trials can be compared with the normative data, which is in kilograms⁷⁸.

Figure 8



Figure 9



Figure 10



Figure 11



4.6 Intervention

Yogic SV is the intervention given to the subjects in the experimental group. There are about 48 practices in the yogic SV. Out of these many, the selective 10 SV practices are only taken as the intervention in this study. Those 10 selective SV practices involved in the study are as follows:

1. Skandha Tatha Bahu Mula Sakthi Vikasaka
2. Bhuja Bandha Sakthi Vikasaka
3. Kaphoni Sakthi Vikasaka
4. Bhuja Valli Sakthi Vikasaka
5. Purna Bhuja Sakthi Vikasaka
6. Mani Bandha Sakthi Vikasaka
7. Kara Tala Sakthi Vikasaka
8. Kara Prstha Sakthi Vikasaka
9. Angula Mula Sakthi Vikasaka
10. Anguli Sakthi Vikasaka

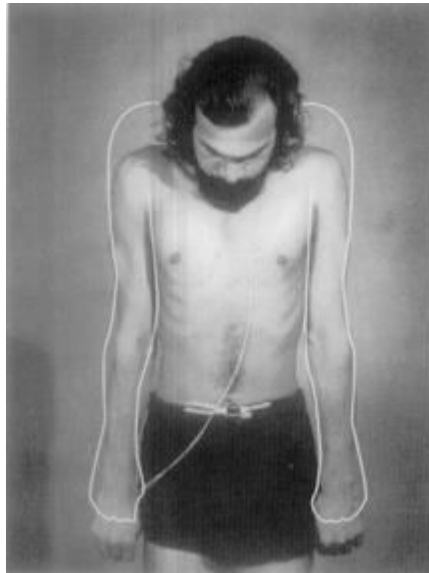
4.6.1.1 Procedure of Test Intervention

1. Skandha Tatha Bahu Mula Sakthi Vikasaka:

POSTURE: Feet close together, your back straight, your fingers clenched into fists with the thumbs tucked in.

EXERCISE: With your mouth pouting and forming the shape of a crow's beak, suck in air, blowing out your cheeks and hold your breath with your chin resting on the sternal notch. While holding your back straight move the shoulders vigorously and stiffly up and down, in a pumping motion. The arms should be kept rigidly straight at the side. Assume the normal posture and straightening your neck, open your eyes and exhale gradually through the nose. Repeat the process five times to begin with. The bones, blood vessels, the muscles and the nerves in the shoulder are toned up.

Figure 12



(Skandha Tatha Bahu Mula Sakthi Vikasaka)

2. Bhuja Bandha Sakthi Vikasaka:

POSTURE: Keep your feet close together, your hands formed into fists with the thumbs tucked in. Bend the elbows and raise the forearms at the angles of 90 degrees.

EXERCISE: Throw your arms vigorously forwards and backwards at shoulder level. The elbows must not go further back than the starting position. When pushed, the arms should be parallel to the ground. Breathe normally. In the beginning 25 times. The arms, which are under-developed with weak biceps, will develop good muscles. Heavy arms will become slender. The elbows-joints will receive unexpected strength; deformities of the arms and the shoulders will be cured. The constant practice of this exercise will make the arms look like an elephant's trunk, and will be just as strong.



Figure 13



(Bhuja Bandha Sakthi Vikasaka)

3. Kaphoni Sakthi Vikasaka:

POSTURE "A": Keeping the feet close together and standing straight, clench your fists with your thumbs tucked in.

EXERCISE `A': Raise your clenched fists forward to the level of the shoulders with a jerk, holding the upper arm stiff. Then bring them down, reverting to the original position. In the beginning 25 times.

POSTURE `B': Keep your feet together, your body straight and your palms open and turned front with the fingers close together.

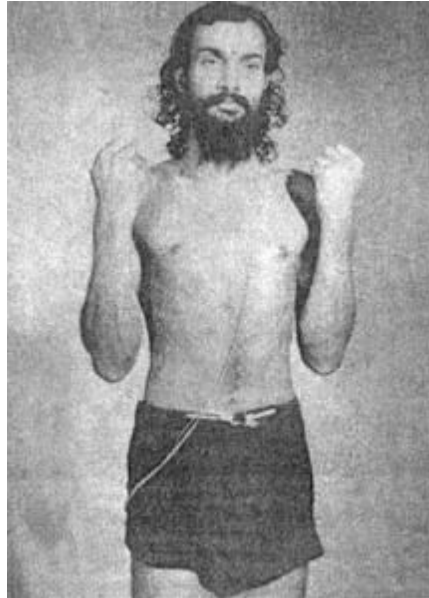
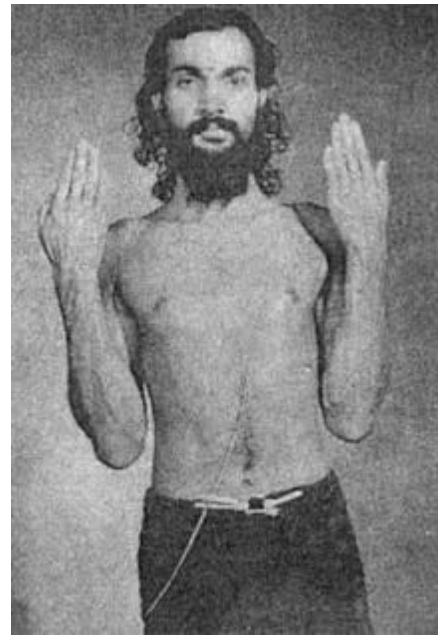


Figure 14



(Kaphoni Sakthi Vikasaka)

EXERCISE `B': Repeat doing this exercise, the palms must come up to the level of the shoulders and then down straight. The elbows should remain stationary. The palms must not touch the shoulder when going up, nor touch the thighs when coming down. This exercise cures malformation of the elbows and strengthens the joints. The circulation of blood in the arteries is accelerated bringing fresh strength to the entire length of the forearm beginning from the elbow. Constant practice gives women rounded forearms while those of men acquire strength and symmetry.

4. Bhujja Valli Sakthi Vikasaka:

POSTURE: Feet together, the body straight, the arms by the sides.

EXERCISE `A': Begin with your right arms. Let it hang relaxed; then raise it sideways above your head with the palm outward. Bring it down in the same manner. The arm must not touch the head when going up, or the thigh when coming down. Palms must be open, with the fingers together.

EXERCISE `B': Repeat the exercise with your left arm.

EXERCISE `C': Now bring both arms into action. Both should go up and come down together, but the arms should not touch the head nor the hands touch each other.

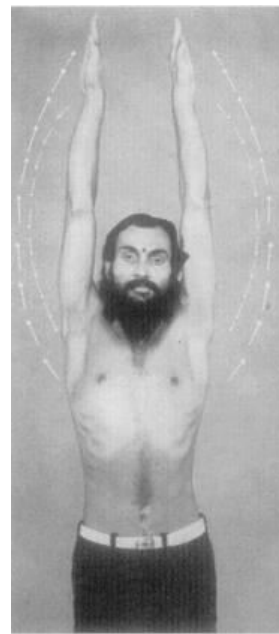


Figure 15

(Bhujja Valli Sakthi Vikasaka)

5. Purna Bhujja Sakthi Vikasaka:

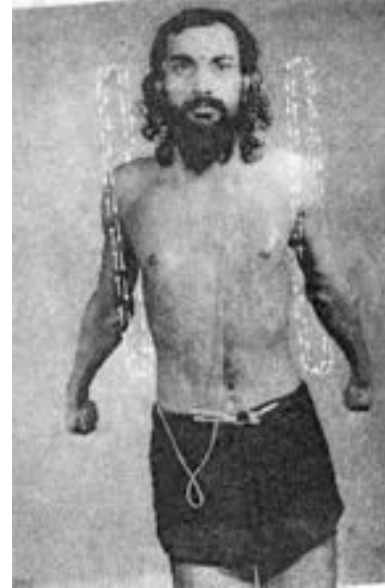
POSTURE: Keep the feet together, body erect, the hands clenched into fists with the thumbs tucked in.

EXERCISE `A': Inhaling through the nose and holding your breath, swing your right arm forward and backward in a circle as many times as you can. When you cannot hold your breath any longer stop with your arm bent at the elbow and breathe out forcefully while thrusting your arm forward at shoulder level.

EXERCISE `B': Repeat the exercise `A' in reverse, swinging the arm backward and then forward.



Figure 16



(Purna Bhujja Sakthi Vikasaka)

EXERCISE `C': Now repeat the exercise `A' with the left arm.

EXERCISE `D': Repeat the exercise `B', with the left arm.

EXERCISE `E': With both hands clenched into fists, let both your arms describe a full upward circle, and exhale with a hissing sound.

EXERCISE `F': The same as exercise `E' in reverse. This set of exercises tones up the nerves. The arms and hands become shapelier. The entire length of the arm becomes stronger.

6. Mani Bandha Sakthi Vikasaka:

POSTURE: Stand with feet close together, with the body straight. Stretch out your two arms straight in front of you at shoulder level, keeping them parallel to the ground.

EXERCISE `A': With loosely clenched fists, let your wrists move the fists up and down with force. While bringing your fist up and down, try to touch the forearm. The arms should be kept as stiff as possible. Five times to begin with.



Figure 17



(Mani Bandha Sakthi Vikasaka)

EXERCISE `B': Raise the arms, bent at the elbow, sideways to shoulder level. The wrists should be moved up and down as in exercise `A'. While doing so, the fists should try to touch the forearm. Five times to begin with.

7. Kara Tala Sakthi Vikasaka:

POSTURE: Keep your feet close together, the body straight. Stretch your arms forward, with the fingers spread out as far as possible. The arms should be kept parallel to the ground, at shoulder level.

EXERCISE `A': From the wrists let your hands move up and down vigorously. While bringing the palms up and down the fingers must try to touch the arm.

EXERCISE `B': With the same posture, raise your arms sideways, bent at the elbows, keeping the fingers far apart from each other, and move the hands up and down as if the fingers were to touch the arm.

Figure 18



(Kara Tala Sakthi Vikasaka)

8. Kara Prstha Sakthi Vikasaka:

POSTURE: Keep feet together, the body straight, the arms stretch out in front parallel to the ground, at shoulder level. Palms open and the fingers close together.

EXERCISE `A': Move your wrists up and down with force while bringing your first up and down, try to touch the forearm. The arms should be kept as stiff as possible.

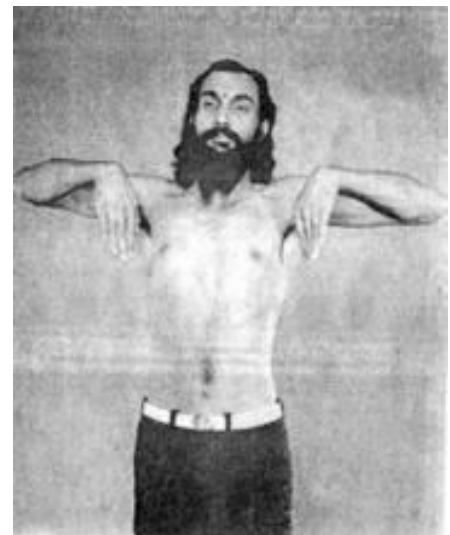
EXERCISE `B': Raise the arms, bent at the elbow. Sideways to shoulder level. The wrists should be moved up and down arms folded at the elbows with palms open, fingers together.



Figure 19



(Kara Prstha Sakthi Vikasaka)



9. Angula Mula Sakthi Vikasaka:

POSTURE: With the feet together and the body relaxed, raise the arms forward, parallel to the ground, at shoulder level. The hands beyond the wrists should be relaxed and drooping.

EXERCISE `A': While stiffening the entire arm, the hand alone must be relaxed. Hold for five minutes to begin with.

EXERCISE `B': As at `A' but with the arms bent at the elbows. Two minutes to begin with.



Figure 20



(Angula Mula Sakthi Vikasaka)

10. Anguli Sakthi Vikasaka:

POSTURE: Stand with the feet close together and the body erect. Throw out your arms in front, keeping them parallel to the ground at shoulder level.

EXERCISE `A': Let your fingers form the shape of the hood of a cobra, taking particular care to stiffen the entire length of the arms from the shoulder-joints to fingertips. The exercise will not be effective if enough force is not put into it to make the arms tremble. Five minutes to begin with.

Figure 21



(Anguli Sakthi Vikasaka)

EXERCISE `B': Posture the same as for `A'. Repeat the exercise `A', with the arms bent at the elbows. The fingers should be spread in the shape of a cobra's hood. Five minutes to begin with⁷⁹.

4. 6. 2 Control Intervention:

The control group participants are said to follow their daily routine activities. No special exercise or yogic practices were taught to them. They followed their regular day to day activities for the continuous 8 weeks and the assessments were done with them.

4.7 Data Extraction & Analysis

4.7.1 Data Extraction

The data were collected using the outcome variable. The assessments were done on the first day (baseline data) and on the last day of the intervention (post data). The data were organized in Microsoft Excel Sheets (Version 2010).

4.7.2 Data Analysis

Data expressed Mean \pm SD. Comparison of Mean in between the pre and post intervention was analyzed by paired t test. R statistical software version 3.1.1 was used for the analysis. $P < 0.05$ set as significant.

5.0 RESULTS

The study was conducted to assess the improvement in the hand grip strength followed by the 8 weeks practice of selective 10 SV practice among the normal volunteers of two groups. The experimental group and control group were formed by simple randomization and the study was conducted. The assessments were done at the baseline and at the post study levels among both the experimental and control group subjects.

The hand grip strength was assessed from all subjects of the study with the help of the CAMRY digital hand grip dynamometer. The assessment was done on the pre and post intervention period. The assessment was done with both right and left hands. Gender wise the subjects were equally distributed in both the groups.

Thus the pre and post interventional assessments results of both the groups are evaluated under different headings, like

- Comparison of hand grip strength before and after yoga
- Comparison of Handgrip strength before and after yoga among the male participants
- Comparison of Handgrip strength before and after yoga among the Female participants
- Comparison of Handgrip strength between Yoga and Control group

Table 3: Comparison of handgrip strength before and after yoga

Right Hand		P value	Left Hand		P value
Pre	Post		Pre	Post	
30.42±8.65	35.82±7.20	0.02	28.50±5.60	31.50±4.82	0.04

The above table explains the results of pre and post intervention assessment of the hand grip strength. The results are obtained from the 30 experimental group subjects. The results encoded above are from both the right hand and left hand assessment.

The significance in the experimental group with the right hand is $p=0.02$ and with the left hand is $p=0.04$ which is considerably significant ($p<0.05$). This shows that the hand grip strength is improved considerably over the 8 weeks of the intervention (selective SV practices).

Table 4: Comparison of Handgrip strength before and after yoga among the male participants

Right Hand		P value	Left Hand		P value
Pre	Post		Pre	Post	
34.58±4.64	38.50±7.54	0.01	29.60±5.50	32.45±8.48	0.03

The above table explains the results of pre and post intervention assessment of the hand grip strength of male subjects. The results encoded above are from both the right hand and left hand assessment.

The significance in the experimental group, male subjects with the right hand is $p=0.01$ and with the left hand is $p=0.03$ which is considerably significant ($p<0.05$). This shows that the hand grip strength is improved considerably after the 8 weeks of the intervention (selective SV practices) among the male subjects.

Table 5: Comparison of Handgrip strength before and after yoga among the Female participants

Right Hand		P value	Left Hand		P value
Pre	Post		Pre	Post	
19.47±4.56	21.25±9.54	0.05	17.68±4.86	19.56±7.67	0.05

The above table explains the results of pre and post intervention assessment of the hand grip strength of female subjects. The results encoded above are from both the right hand and left hand assessment.

The significance in the experimental group, female subjects with the right hand is $p=0.05$ and with the left hand is $p=0.05$ which is considerably significant ($p<0.05$). This shows that the hand grip strength is improved considerably over the 8 weeks of the intervention (selective SV practices) among the female subjects.

Table 6: Comparison of Handgrip strength between Yoga and Control group

	Yoga		P value	Control		P value
	Before	After		Before	After	
Right Hand	30.42±8.65	35.82±7.20	0.02	30.25±4.58	31.24±8.97	0.24
Left Hand	27.50±5.60	31.50±4.82	0.05	27.54±4.87	28.12±5.20	0.85

The above table explains the results of pre and post assessment of the hand grip strength among the experimental group and the control group. The results are obtained from the 30 experimental group subjects and 30 control group subjects. The results encoded above are from both the right hand and left hand assessment.

The significance in the experimental group with the right hand is $p=0.02$ and with the left hand is $p=0.05$ which is considerably significant ($p<0.05$).

Similar data were obtained from the control group also and the significance in the experimental group with the right hand is $p=0.24$ and with the left hand is $p=0.85$. This was also significant but less as compared to the experimental group. This signifies that shows that the hand grip strength is improved considerably in the experimental group when compared to the control group.

6. 0 DISCUSSION

The first randomized clinical trial on yoga was published in the year 1975 in the journal the Lancet. The study revealed that yoga was a more effective practice than relaxation in case of reducing the high blood pressure. But the study was conducted only in 34 participants and all of them were high blood pressure patients. So that it is difficult to judge whether the effect of yoga is real or false and thus it needed a trial with a larger group of population. Since then there occurred several numbers of research studies and publications on yoga and its effects on various systems of the human body as well as the impact of it on the disease states.

But after these many years also, there exists the same problem in the field of research in yoga like before, that the studies still involve a small number of subjects only. Even most of the yoga research studies lack a control group and several papers lack a comparison activity with the yogic intervention.

A high grip strength is associated with preserved mobility, decreased disability and higher activities of daily living⁸⁰. The present lifestyle and hectic work schedule make the human to run like a machine and thereby the ageing and degeneration of tissues starts very early. Therefore, it is highly necessary to identify the factors that preserve physical, psyche and social well-being and enhance a positive ageing process. In this study the physical well-being was estimated by the hand grip strength only⁸¹. Nevertheless, despite of the low number of participants the significant impact of the practice of SV is highly proved. The hand grip strength is significantly positively related to health – related quality of life⁸².

The Hertford Shire cohort study proved a significant association between higher grip strength and proved health related quality of life⁸³.

The meta-analysis of Rjik et al, showed a high predictive validity of hand grip strength for the decline in cognition, mobility, functional status and mortality⁸⁴.

According to Taekerna et al, poor hand grip strength predicts accelerated dependency and cognitive decline. Consequently hand grip strength is increasingly seen as an appropriate indication of physical well-being and social, psychic and somatic health⁸⁵. There is no doubt that hand grip strength is first of all a strong indicator of muscle strength and muscle mass⁸⁶. Reduced muscle strength and muscle mass are indicators of the condition of sarcopenia. Skeletal muscle represents the largest component at the tissue-organ level of body composition and it is essential for locomotion, mobility and consequently daily activities. The strong association between skeletal muscle mass and bone mass, which are interrelated throughout life, represents a special problem, and muscle loss and bone loss. In combination with reduced bone mass i.e., osteoporosis sarcopenia has dramatic consequences such as impaired functional performance, increased risk of falls and consequently an increased risk of fragility fracture⁸⁷.

In general, the maintenance of muscle strength, physical fitness and physical well-being is an important factor to preserve independence and consequently a high quality of life⁸⁸⁻⁸⁹.

The yogic SV practices involve sustained isometric contraction and relaxation of the shoulders, chest and arm muscles. Consequent improvement in the strength and endurance of these muscles can explain the significant increase in hand grip strength⁹⁰.

According to the study conducted by Dr. A. S. Barman et al, the metabolic count of yogic asana represents 2 to 4 K Cal/ min. The energy expenditure of asana was 1003 K Cal/week (450 minutes/week)⁹¹.

Scientists have shown that yoga training improves the cardiac-respiratory index, cardiovascular endurance and anaerobic power and decreased blood pressure either at rest or during exercise. Yoga in long duration affects hypothalamus and bring about decrease in the systolic and diastolic blood pressure through its influence on vasomotor center which leads to reduction in sympathetic tone and peripheral resistance⁹²⁻⁹⁴.

In this study, the 8 weeks practice of the selective SV showed significant improvement in the hand grip strength. The results showed good improvement in the hand grip strength in both right and left hand of both male and female subjects of the experimental group when comparing to the control group. This signifies that regular practice of yogic SV will increase the hand grip strength which in turn improves the quality of life. Hence this can be administered for the people who are using their upper limbs extensively in their daily life.

6.1 Limitations

- The sample size is relatively smaller. Hence, generalizing the study outcomes to a larger population would not be definitely conclusive.
- A single outcome variable is taken up in the study. More objective measures could validate the study.
- All the participants of this study were the college students, which limit the generalization of the result of a diverse group of people.

6.2 Directions for Future Research

- This study should be replicated with a larger sample size.
- The study should be conducted in a generalized population with a prolonged duration will be better.
- Objective measures can be assessed to make the study more credible.

7.0 CONCLUSION

The study is initiated to help the persons who use their upper limbs extensively in their day to day activities like tailors, sports persons, writers, surgeons, wrestlers, swimmers, computer professionals, etc.

There are very few research papers only available to prove the impact of yoga on the handgrip strength that too particularly the impact of yogic asanas. In this study through the practice of yogic SV, the benefits of yogic asanas that too in a dynamic way has been studied and the results also showed excellent results.

The practice of the selective SV in this study showed compromising results in improving the hand grip strength. The results are obtained from both sexes and hence any person can practice these SV to improve their hand grip strength and endurance of the body.

Hence, by incorporating these selective SV practices as a regular regime, one can improve the endurance and strength of the upper limbs effectively and therefore by regular practice of this, the persons who have weak stamina, endurance and strength in the body can improve better and thereby the production of work and quality of life can also be improvised further.

The yogic SV explored in this study explained very well about the improvement in the handgrip after the practices. Thus, incorporating the yogic SV in the daily regimen can not only increase the strength of muscles but also there will improvement in the flexibility,

muscle tone and durability. A healthy muscle shows excellent improvement in the muscle mass after the practice of SV.

The study limited to the college students, limited the effects among the generalized population. Further research may warrant these limitations.

9.0 BIBLIOGRAPHIC REFERENCES

1. Swami Vivekananda, Patanjali yoga sutras - Sanskrit text with Transliteration, Translation & Commentary.
2. Dr. K. Ramesh Babu, A comparative study yogangas in hatha yoga and patanjali yoga sutras, International journal of multidisciplinary educational research, Volume 1, Issue 3, Aug 2012.
3. Yogic SV: (The complete Sequence of 48 yogic exercises) by Dhirendra Brahmachari.
4. Budoff, Je. The Prevalence of Rotator Cuff Weakness in Patients with Injured Hands. J Hand Surg (2004 Nov;29(6):1154-9).
5. Fry, Ac, D Ciroslan, Md Fry, Cd Leroux, Bk Schilling, and Lz Chiu. Anthropometric and Performance Variables Discriminating Elite American Junior Men Weightlifters. Journal of Strength and Conditioning Research (2006 Nov;20(4):861-6).
6. Smith, T, S Smith, M Martin, R Henry, S Weeks, and A Bryant. Grip Strength in Relation to Overall Strength and Functional Capacity in Very Old and Oldest Old Females. The Haworth Press Inc. (2006) pp 63-78.
7. Yasuo, G, T Daisaku, M Nariyuki, S Jun'ya, O Toshihiko, M Masahiko, and M Yoshiyuki. Relationship Between Grip Strength and Surgical Results in Rotator Cuff Tears. Shoulder Joint (2005: 29(3):559-562).
8. The Importance of Grip Strength by Jason Shea C.S.C.S., PES

9. Improvement in Hand Grip Strength in normal volunteers and rheumatoid arthritis patients following yoga training, Manoj Dash & Shirley Telles, Indian Journal of Physiology & Pharmacology, 2001; 45(3): 355-360.
10. P. Raghu Raj et al, Pranayama increase grip strength without lateralized effects, Int J of Yoga, 1996.
11. S. Telles et al, Physiological changes in sports teachers following 3 months of training in yoga, Int. J of Yoga.
12. Rinku garg, varun Malhotra et al, Effect of Isometric Handgrip Exercise Training on Resting Blood Pressure in Normal Healthy Adults, journal of clinical and diagnostic research, 2014/8908.4850
13. Sharma VK, Kukreja A, Senthil Kumar S, Kanojia S, Gupta S (2012) Comparative Study of Yoga and Physical Exercises on Psychological Parameters, Hand Grip Strength and Reaction Time during Examination Stress in Young Female Medical Students. 1:362. doi:10.4172/ scientificreports.362
14. Shirley telles, sachin et al, Immediate changes in muscular strength and motor speed following yoga breathing, Indian journal of Physiology and Pharmacology, 2014; 58-1; 22-29.
15. Diana.e.Taekema, et al, Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old, oxford university press, 10 march 2010.

16. Shirley telles et al, A comparative controlled trial comparing the effects of walking and yoga for overweight and obese adults, e-ISSN 1643-3750 © Med Sci Monit, 2014; 20: 894-904 DOI: 10.12659/MSM.889805.
17. S.K Ganguly, T.K Bera, M.L Gharote, “Yoga in Relation to Health Related Physical Fitness and Academic Achievement of School Boys”, Yoga-Mimamsa, Vol. XXXIV, So. 3&4; 188-213, Jan.2003.
18. N. Govindarajulu, R. Murugesan, T.K. Bera, “Work Capacity of Elite School Players practicing Yoga in Pondicherry Region”, Yoga-Mimamsa, Vol. XXXIV, No. 2; 129-136, July 2000.
19. Sharma VK, Das S, Mondal S, Goswami U, Gandhi A. Effect of sahaj yoga on depressive disorders, Indian J Physiol Pharmacol. 2005; 49: 462-68.
20. Bera TK and Rajapurkar MV. Body composition, cardiovascular endurance and anaerobic power of yogic practitioner. Indian J Physiol Pharmacol 1993; 37: 225-228.
21. Hart CE, Tracy BL. Yoga as steadiness training: Effects on motor variability in young adults. J Strength Cond Res. 2008 Sep; 22: 1659-69.
22. Dhume RR and Dhume RA. A comparative study of the driving effects of dextroamphetamine and yogic meditation on muscle control for the performance of balance board. Indian Journal Physiol Pharmacol 1991; 35: 191-94.
23. Raju PS, Madhavi S, Prasad KV, Reddy MV, Reddy ME, Sahay BK, Murthy KJ. Comparison of effectsof yoga & physical exercise in athletes. Indian J Med Res. 1994; 100:81-6.

24. Ray US, Mukhopadhyaya S, Purkayastha SS, Asnani V, Tomer OS, Prashad R, Thakur L and Selvamurthy W. Effect of exercises on physical and mental health of young fellowship trainees. *Indian J Physiol Pharmacol* 2001; 45: 37-53.
25. Chaya MS, Kurpad AV, Nagendra HR, Nagarathna R. The effect of long term combined yoga practice on the basal metabolic rate of healthy adults. *BMC Complement Altern Med.* 2006;6: 28
26. DiBenedetto M, Innes KE, Taylor AG, Rodeheaver PF, Boxer JA, Wright HJ, Kerrigan DC. Effect of a gentle Iyenger yoga program on gait in the elderly: an exploratory study. *Arch Phys Med Rehabil.* 2005; 86: 1830-7.
27. Collins C. Yoga: Intuition, preventive medicine, and treatment. *J Obstet Gynecol Neonatal Nurs.* 1998;27:563-8.
28. Marlatt GA. Buddhist philosophy and the treatment of addictive behaviour. *Cogn Behav Pract.* 2002;9:44-50.
29. Kolasinski SL et al, Iyengar yoga for treating symptoms of osteoarthritis of the knees: A pilot study. *J Altern Complement Med.* 2005; 11:689093.
30. Williams K et al, Therapeutic application of Iyengar yoga for healing chronic low back pain, *Int J Yoga Ther.* 2003;13:55-67.
31. Shirely Telles et al, Improvement in static motor performance following yogic training of school children, *Int J of Yoga*, 1993.
32. Susan coote et al, Getting the balance right: A randomized controlled trial of physiotherapy and exercise interventions for ambulatory people with multiple sclerosis, *BMC neurology*, 2009, 9:34 doi:10.1186/1471-2377-9-34

33. Sherley telles et al, Effect of one week of yoga on function and severity in rheumatoid arthritis, BMC research notes, 2011, 4:11 8
34. Sarita kanojia et al, Effect of yoga on autonomic functions and psychological status during both phases of menstrual cycle in young healthy females, journal of clinical and diagnostic research, 2013 oct, volume 7.
35. T.Prabhakar reddy et al, Effect of yoga training on handgrip, respiratory pressures and pulmonary function, British journal of sports medicine, 2010.078725.225
36. Dr.AS Boreman et al, Effect of yogic asana in the handgrip strength in school boys, international journal of yogic, human movement and sports sciences, 2016; 1(1): 05-08
37. Vijaya kavuri et al, Remedial yoga module remarkably improves symptoms in the irritable bowel syndrome patients: A 12 week randomized controlled trial, European journal of integrative medicine 7 2015, 595-608
38. Yu yaginuma et al, can hand grip strength improve following low body mass index based lower body exercises, Bio research open access, volume 6, 2017.
39. Giampaoli S, Ferrucci L, Cecchi F, et al. Hand-grip strength predicts incident disability in non-disabled older men. *Age Ageing*. 1999;28:283–288.
40. Rantanen T, Guralnik JM, Foley D, et al. Midlife hand grip strength as a predictor of old age disability. *JAMA*. 1999;281:558–560.
41. Kuh D, Bassey J, Hardy R, et al. Birth weight, childhood size, and muscle strength in adults life: evidence from a Birth Cohort Study. *Am J Epidemiol*.2002;156:627–633.

42. Sayer AA, Syddall HE, Gilbody HJ, et al. Does sarcopenia originate in elderly life? Findings from the Hertfordshire Cohort Study. *J Gerontol A Biol Sci Med Sci*. 2004;59:M930–M934.
43. Bunout D, Barrera G, de la Maza P, et al. Effects of nutritional supplementation and resistance training on muscle strength in free living elders. Results of one year follow. *J Nutr Health Aging*. 2004;8:68–75.
44. Ozaki H, Loenneke JP, Buckner SL, et al. Muscle growth across a variety of exercise modalities and intensities: contributions of mechanical and metabolic stimuli. *Med Hypotheses*. 2016;88:22–26.
45. Rafaela avila matioli et al, Association between handgrip strength and physical activity in hypertensive elderly individuals, dx.doi.10.1590/1809-9823.2015.14178
46. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exercise* 2007;39(8):1423-34.
47. Xue-Ping Chen, You-Mei Lu et al, Intervention study of finger movement exercise and finger weight lift training for improvement of handgrip strength among the very elderly, *International journal of nursing sciences-I*, 2014 165-170
48. Aayer AA, Syddall HE, Martin HJ, Dennison EM, Roberts HC, Cooper C. Is grip strength associated with health-related quality of life? Findings from the Hertfordshire Cohort Study. *Age Aging* 2006;35(4):409e15.

49. Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. *J Geriatr Phys Ther* 2008;31(1):3e10.
50. Frederiksen H, Hjelmberg J, Mortensen J, McGue M, Vaupel JW, Christensen K. Age trajectories of grip strength: cross-sectional and longitudinal data among 8,342 Danes aged 46 to 102. *Ann Epidemiol* 2006;16(7):554e62.
51. Ling CHY, Taekema D, Anton JM, Draen D, Gussekloo J, Westendorp RGJ, et al. Handgrip strength and mortality in the oldest old population: the leiden 85-plus study. *Can Med Assoc J* 2010;182(5):429e35.
52. Lin Xu et al, Effect of handgrip on coronary artery disease and Myocardial infarction; a Mendelian Randomised study, *Nature*, 19 apr, 2017.
53. Matteini, A. M. *et al.* GWAS analysis of handgrip and lower body strength in older adults in the CHARGE consortium. *Aging Cell*, doi:10.1111/accel.12468 (2016).
54. Ruiz, J. R. *et al.* Association between muscular strength and mortality in men: prospective cohort study. *BMJ* **337**, a439–a439, doi:10.1136/bmj.a439 (2008).
55. U. S. Ray, K. S. Hegde, and W. Selvamurthy, “Improvement in muscular efficiency as related to a standard task after yogic exercises in middle aged men,” *Indian Journal of Medical Research*, vol. 83, pp. 343–348, 1986.
56. U. S. Ray, B. Sinha, O. S. Tomer, A. Pathak, T. Dasgupta, and W. Selvamurthy, “Aerobic capacity & perceived exertion after practice of *hatha yogic* exercises,” *Indian Journal of Medical Research*, vol. 114, pp. 215–221, 2001.
57. U. S. Ray, K. S. Hegde, and W. Selvamurthy, “Effects of yogic *asanas* and physical exercises on body Flexibility in middle aged men,” *Yoga Review*, vol. 3, p. 76,

- 1983.Khalid A Alahmari, S. Paul Silvian, Ravi Shankar Reddy, Venkata Nagaraj Kakaraparthi, Irshad Ahmad and Mohammad Mahtab Alam, Hand grip strength determination for healthy males in Saudi Arabia: A study of the relationship with age, body mass index, hand length and forearm circumference using a hand-held dynamometer, *Journal of International Medical Research* 2017, Vol. 45(2) 540–548
58. Dr. Harbans Lal Godara, Effect of Yogic Exercises on the Physical Fitness Components of Handball Players, *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, Volume 5 Issue V, May 2017
59. Dr Madanmohan MD, Effect of yogic practices on different systems of human body, *International Journal of Traditional and Complementary Medicine*, 2016; Vol. 1(1): 0031-0043
60. Silventoinen K, Magnusson PK, Tynelius P, et al. Association of body size and muscle strength with incidence of coronary heart disease and cerebrovascular diseases: a population-based cohort study of one million Swedish men. *Int J Epidemiol* 2009; 38: 110–118.
61. Cooper R, Kuh D, Cooper C, et al. Objective measures of physical capability and subsequent health: a systematic review. *Age Ageing* 2011; 40: 14–23.
62. Hebert LE, Scherr PA, McCann JJ, et al. Change in direct measures of physical performance among persons with Alzheimer’s disease. *Aging Ment Health* 2008; 12: 729–734.
63. Cawthon PM, Fullman RL, Marshall L, et al. Physical performance and risk of hip fractures in older men. *J Bone Miner Res* 2008; 23: 1037–1044.

64. Sirola J, Rikkinen T, Tuppurainen M, et al. Grip strength may facilitate fracture prediction in perimenopausal women with normal BMD: a 15-year population-based study. *Calcif Tissue Int* 2008; 83: 93–100.
65. Cooper R, Kuh D and Hardy R. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. *BMJ* 2010; 341: c4467.
66. Sasaki H, Kasagi F, Yamada M, et al. Grip strength predicts cause-specific mortality in middle-aged and elderly persons. *Am J Med* 2007; 120: 337–342.
67. Fallahi AA and Jadidian AA. The effect of hand dimensions, hand shape and some anthropometric characteristics on handgrip strength in male grip athletes and nonathletes. *J Hum Kinet* 2011; 29: 151–159.
68. Leong DP, Teo KK, Rangarajan S, et al. Reference ranges of handgrip strength from 125,462 healthy adults in 21 countries: a prospective urban rural epidemiologic (PURE) study. *J Cachexia Sarcopenia Muscle* 2016; 7: 535–546.
69. Helen C Roberts et al, A review of measurement of grip strength in clinical and epidemiological studies: towards a standardized approach, age and ageing, 2011; 40: 423-429.
70. Joris JW Ploegmakers et al, Grip strength is strongly associated with height, weight and gender in childhood; a cross sectional study of 2241 children and adolescents providing reference values, *Journal of physiotherapy* 2013, vol 59.
71. Onderkarakock et al, Effect of handgrip strength in different sports, *international journal of sport studies*. Vol.,5(10),1132-1136,2015

72. Ana paula shirotori, et al, evaluation protocols for handgrip strength in individuals with rheumatoid arthritis: a systematic review, *rev bras reumatologia*,2014;54(2): 140-147.
73. Mathiowetz M. Comparison of rolyan and jamar dynmaometers for measuring grip strength. *Occ Ther Int.* 2002;9:201-209.
74. Schmidt et al, Interobserver reproductivity of the assessment of severity of complaints, grip strength, and pressure pain threshold in patinets with lateral epicoldylitis. *Arch Phys Med Rehabil.* 2002;83:1145-50.
75. Karkkainen M et al, Physical tests for patient selection for bone mineral density measurements in postmenopausal women. *Bone.* 2009;44(4):660-665.
76. Sasaki et al, Grip strength predicts cause – specific mortality in middle –aged and elderly persons, *American journal of medicine*, 2007 Apr;120(4):337-42
77. Adult grip strength norms for the Baseline digital dynamometer, Chelsey L. Meek, The University of Toledo Digital Repository, 2015
78. Ling CH et al, Handgrip strength and moratlity in the oldest old population: the Leiden 85 – plus study, *Canadian medical association journal*, 2010.
79. Yogic SV: (The complete Sequence of 48 yogic exercises) by Dhirendra Brahmachari. Practice 12 – 21.
80. Walker A, A European perspective on quality of life in old age. *Eur. J. Ageing.* 2005;2:2-12.
81. Netuveli et al, Quality of life in older ages, *Br. Med. Bull.* 2008;85:113-126.
82. Tosato M et al, The ageing process and potential interventions to extend life expectance, *Clin. Interv. Aging*, 2007;2:401-412.

83. Sayer A. A et al, Is grip strength associated with health related quality of life? Findings from the Hertfordshire cohort study, *Age ageing*, 2006;35:409-415.
84. Rijk J.M et al, Prognostic value of hand grip strength in people aged 60 years and older: A systematic review and meta-analysis. *Geriatr. Gerontol. Int.* 2016;16:5-20.
85. Taekema D. G et al, Hand grip strength as a predictor of functional, psychological and social health. A prospective population based study among the oldest old. *Age ageing*. 2010;39:331-337.
86. Cesari M et al, Biomarkers of sarcopenia in clinical trials-recommendation from the international working group on sarcopenia. *Sarcopenia muscle*, 2012;3:181-190.
87. Sallinen J et al, Hand grip strength cut-points to screen older people at risk for mobility limitation, *Geriatr. Soc*, 2010;58:1721-1726.
88. Di Monaco M et al, Prevalence of sarcopenia and its association with osteoporosis in 313 older women following a hip fracture. *Geriatr.* 2011;52:71-74.
89. Di Monaco et al, A skeletal muscle mass, fat mass and hip bone mineral density in elderly women with hip fracture. *Metab.* 2007;25:237-242.
90. Venkatesh R. Rathod et al, Effect of 4 month yoga training on hand grip strength and hand grip endurance in children at Nagpur, *International journal of medical science and public health*, April, 8, 2016.
91. Hernandez C.J et al, A theoretical analysis of the relative influences of peak BMD, age-related bone loss and menopause on the development of osteoporosis. *Osteoporos. Int.* 2003;14:843-847.

92. Russo C. R et al, Aging bone in men and women: Beyond changes in bone mineral density. *Osteoporos. Int.* 2003;14:531-538.
93. Kirchengast S et al, Sex-specific associations between soft tissue body composition and bone mineral density among older adults. *Ann. Hum. Biol.* 2012;39:206-213.
94. Kroger H et al, The association of levels of and decline in grip strength in old age with trajectories of life course occupational position. *PLoS One*, 2016;11:e015585444.

10.0 ANNEXURES

10.1 INFORMED CONSENT FORM

Title of the study: “Improvement in handgrip strength in normal volunteers following selective sukshma vyayam practices – A pilot randomized control trial”

Name of the Participant :

Name of the Principal Investigator : Dr. S. Madankumar

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 the study.

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.

11. 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.

12. I have understood that my identity will be kept confidential if my data are publicly presented.

13. I have had my questions answered to my satisfaction.

14. 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__