YOGA AND GERIATRIC CARE: AN EVALUATION OF POSITIVE HEALTH INDICATORS

Thesis submitted by

MANJUNATH N. K.

Under the Guidance of

SHIRLEY TELLES M.B.B.S., M.Phil., Ph.D.
H.R. NAGENDRA M.E., Ph.D.

Towards the partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

October 2005

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(Deemed University)
BANGALORE – 560 019
INDIA

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C E R T I F I C A T E

This is to certify that Manjunath N. K. who has been given Ph.D. registration with effect from September 11, 2002 by the Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University under the Division of Yoga and Life Sciences has successfully completed the required 'training' in acquiring the relevant background knowledge in physiology, neurology and psychology related to Aging and geriatric medicine and Yoga and has completed the required 'course of research' for not less than two years to submit this thesis entitled "YOGA AND GERIATRIC CARE: AN EVALUATION OF POSITIVE HEALTH INDICATORS" as per the regulations of the University.

We also declare that the subject matter of my thesis entitled "YOGA AND GERIATRIC CARE: AN EVALUATION OF POSITIVE HEALTH INDICATORS" has not previously formed the basis of the award of any degree, diploma, associate ship, fellowship or similar titles.

Shirley Telles M.B.B.S., M.Phil., Ph.D.
Professor & Head
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H.R. Nagendra M.E., Ph.D.
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Date:
Place:

D E C L A R A T I O N

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA), Bangalore, under the guidance of Dr. Shirley Telles, Prof. & Head, Dept. of Biosciences and Dr. H.R. Nagendra, Vice Chancellor, Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Bangalore.

I also declare that the subject matter of my thesis entitled "YOGA AND GERIATRIC CARE: AN EVALUATION OF POSITIVE HEALTH INDICATORS" has not previously formed the basis of the award of any degree, diploma, associate ship, fellowship or similar titles.

Place: Bangalore **MANJUNATH N. K.**

Date: (Candidate)

A C K N O W L E D G E M E N T

I express my profound gratitude to my guide, Dr. Shirley Telles for the encouragement, guidance, and support. I am grateful to my co-guide Dr. H.R. Nagendra for providing me this opportunity and continued support and guidance. Their contribution in my development (both professionally and personally) can not be expressed in words.

My grateful acknowledgements are to Prof. Ramchandra Bhat, Prof. N.V.C. Swamy, Dr. R. Nagarathana, Sri T. Mohan and Smt. Subhadra Devi for their co-operation and timely guidance.

I thank Assistant Registrar Mr. Ravikumar Itgi, all the faculty members, and my friends Naveen, Raghuraj, Sarang Patil, Manoj Dash, and Sudha for their help at different stages of this work. I acknowledge with thanks Subramanya, Avinash, Meesha, Venkat Ramana, Sanjib, Sanjay, and other colleagues who greatly helped me during my thesis writing. I will be always grateful to Pujya Swami Visharadananda, whose teachings have helped to have clear and right perspective of Life.

I am indebted to my late father who has been the inspiration behind my hard work and all achievements, and my mother, wife and other family members whose love, support and dedication has made a major contribution in this endeavor.

I gratefully acknowledge the Department of Indian Systems of Medicine and Homeopathy, Ministry of Health and Family Welfare, Government of India, New Delhi, India, which funded this study by a research grant. I also acknowledge the support and co-operation of the following institutions in the study: Asaktha Poshaka Sabha, Bangalore, India and The Government Ayurveda Medical College, Bangalore, India.

More than anything, my sincere gratitude to all the elderly subjects whose participation alone made this study possible.

Bangalore
Date: **MANJUNATH N.K.**

LIST OF TABLES

LIST OF FIGURES

A B S T R A C T

Background

There have been no randomized controlled trials to evaluate Yoga or Ayurveda for the promotion of positive health in a geriatric population measuring various indicators of aging.

Aims

The present trial was conducted to evaluate the effects of Yoga and of Ayurveda as compared with a Wait-list Control group of older persons. The assessments included (i) general health measures, (ii) neurological and (iii) psychological variables.

Methods

After screening ninety persons of both sexes over sixty years of age, staying in an old age home, sixty-nine persons were selected for the trial. They were randomized as three groups, Yoga, Ayurveda and a Wait-list Control group. Assessments of all three groups were made at baseline and after three and six months. The assessments were of three categories i.e., (i) measures of general health and of (ii) neurological and (iii) psychological status. The Yoga group practiced a combination of Yoga techniques including physical postures, breathing exercises, guided relaxation and a devotional session, for sixty minutes a day, six days a week. The Ayurveda group received a special preparation called *rasayana kalpa,* given as ten grams, twice a day. The Wait-list Control group was given no specific intervention and continued with their routine activities. The data were analyzed using repeated measures ANOVA and paired t-test for

comparisons between (i) baseline and three months and (ii) baseline and six months.

Results

At the end of three months the Yoga group showed an improvement in minute ventilation, aspects of memory based on the Wechsler memory scale (e.g., semantic memory and primary and working short-term memory). There was also an improvement in depression scores and self-rated quality of sleep. The Ayurveda group showed an improvement in minute ventilation. The scores for short term primary memory were also improved in both the Ayurveda and the Wait-list Control groups. The Wait-list Control group also showed two changes suggestive of a deterioration viz., a decrease in right hand grip strength and an increase in skin conductance (as sympathetic dominance is a known consequence of aging).

At the end of six months the Yoga group showed an improvement in forced vital capacity, minute ventilation, autonomic status, scores for gait and balance, and mobility (based on a "timed-up-and-go test"). There were also improvements in various aspects of memory based on the Wechsler memory scale such as semantic memory, primary and working short-term memory and episodic memory. The depression scores and self rated quality of sleep also improved. The Ayurveda group showed an improvement in maximum voluntary ventilation and in mobility based on the "timed-up-and-go test". The Wait-list Control group showed signs of deterioration at six months based on a decrease in forced vital capacity, mid-arm circumference and in scores for episodic memory.

The results mentioned above were all significant at the .05 level (t-test for paired data). Those results which were not significant have not been mentioned. The differences between groups was significant (based on Repeated Measures ANOVA) for: forced vital capacity, hand grip strength, skin conductance, ability to balance, mobility, depression scores and associate memory as well as primary and working short term memory.

Summary and Discussion

A sixty minute Yoga module practiced over a six month period brought about significant benefits in older persons with respect to their gait, balance, mobility, memory, mental state, self-rated quality of sleep, lung functions and reduced psychophysiological arousal. The Ayurveda group showed improvements in lung functions and mobility but not in other measures. In contrast, the Wait-list Control group showed deterioration in lung functions, muscle mass and episodic memory.

With respect to changes in lung functions the Yoga group, there was an increase in FVC and minute ventilation. In an earlier study, an increase in the lung capacity following Yoga practice was attributed to an increased development of respiratory musculature.

Following Yoga there was a decrease in heart rate and in the power of the Low Frequency band of the Heart Rate Variability (HRV) spectrum while the High Frequency band of HRV increased. These changes suggested an increase in cardiac vagal and decrease in cardiac sympathetic discharge. The gait, ability to balance and mobility all improved following Yoga. While the exact basis is not known the improvement may be related to factors such as better visuo-motor co-ordination, postural re-adjustment and improved proprioception. It is possible that the semantic memory, primary and working short-term memory and episodic memory improved since reduced anxiety facilitates remembering, and the anxiety reducing effects of Yoga may have been the basis for these changes. Also, the practice of Yoga has already been shown to induce “a state of alertful rest” and reduced distractibility.

The changes in mood with a decrease in scores indicating depression following Yoga may be related to multiple factors. For example, physical activity is known to increase endorphin secretion, while guided relaxation was shown to reduce the secretion of hormones related to stress. Since Yoga incorporates both physical activity and relaxation, these factors may have contributed to the positive affect following Yoga. The Yoga group showed improvements in several aspects of their self-rated quality of sleep such as a decrease in time taken to fall asleep, an increase in the number of hours slept each night, and an increase in the feeling of being rested in the morning. Once again these benefits may be attributed to the increase in physical activity and relaxation associated with Yoga.

The group who received the Ayurveda intervention showed an increase in minute ventilation and Maximum Voluntary Ventilation at the end of six months. The underlying mechanisms cannot be speculated upon as the physiological effects of the individual components as well as of the combination used in the Ayurveda preparation have not been studied. The Ayurveda group also showed an increase in their mobility. The rationale for this effect also, at this stage, cannot be understood for the reasons given above.

In contrast to the Yoga and Ayurveda groups, the Wait-list Control group showed a decrease in mid-arm circumference which suggests a decrease in muscle mass and hand grip strength which indicates muscle endurance. This group showed an increase in skin conductance suggestive of increased sudomotor sympathetic activity and possibly of physiological activation. Finally this group showed a decrease in the scores of episodic memory. These findings suggest that in the absence of an intervention, the Wait-list Control group actually showed deterioration in different aspects of functioning.

Aging is a universal human experience which refers to progressive changes during the life span that often, but not always reduces an individual's viability. An analysis based on global demographic estimates undertaken by the "Population Division of the Department of Economic and Social Affairs of the United Nations (UN) Secretariat" has provided percentage distribution by age and in different geographic locations (Shrestha, 2000). Based on this survey, the life expectancy at birth in South Central Asia in the year 2000 for both sexes was shown as sixty-four years (males 63.1 years and females 64.9 years). In North America, however, a higher life expectancy at birth was reported for both sexes in 2000, viz., 77.6 years (males 74.4 years and females 80.7 years). In South Central Asia in contrast, the definition of an aged person was similar to that reported elsewhere (Indira, 1999) and this was a person aged over 60 years.

As age advances a number of physical and mental changes occur very often, though they are not inevitable. While there are different ways of categorizing the changes, the following categorization directly indicates how the changes would impact health. There are three main categories of changes: [1] changes in the indicators of general health (this would include pulmonary functions, anthropometric measurements, muscle power and endurance), [2] changes in neurological variables (including autonomic variables, measures of gait and balance, memory and audiometric measurements of hearing, and [3] changes in measures which have a psychological basis (for e.g., the mental state and quality of sleep). Each of these changes has been detailed below:

1.1 CHANGES IN THE INDICATORS OF GENERAL HEALTH:

1.1.1 Changes in the respiratory system: Many structural and functional changes have been reported to occur with aging, which influence the lung and chest wall function, gas exchange, and ventilatory control (Johnson, 2003). The most dominant changes include a stiffening of the chest wall (Rizzato & Marazzini, 1970; Morris, Koski, & Johnson, 1971), an apparent loss of respiratory muscle strength (Black & Hyatt, 1969), and a loss of elastic recoil of the lung tissue (Islam, 1980). Age associated changes in the respiratory system which may alter gas exchange include loss of elastic recoil (as mentioned above), a decreased surface area of the lung (Thurlbeck, 1980), decreased pulmonary capillary blood volume (Crapo, Morris, & Gardner, 1982), increased dead space ventilation (Martin, Das, & Young, 1979) and decreased distensibility of the pulmonary arterial vasculature (Reeves, Dempsey, & Grover, 1989). Whether the healthy elderly adult has an altered ventilatory control at rest remains controversial (Rubin, Tack, & Cherniak, 1982). However, till now most studies examined the adequacy of ventilatory response to exercise in later life and found it quite similar to that of young adults i.e., arterial PO_2 remains similar to the resting value and CO_2 elimination is reduced below resting values (Johnson & Dempsey, 1991).

1.1.2 Anthropometric measurements: The link between obesity, inparticular central adiposity and hypertension and hyperlipidemia is well established. While average central adiposity as indicated by the waist-hip-ratio, continues to increase with increasing age, the average body mass index does not change much after the age of 65 years.

1.1.3 **Muscle strength** increases through childhood, adolescence, peaks in the mid twenties, declines moderately until the age of fifty after which a greater decrement is seen (Larson, 1982). By contrast, after the age of sixty, muscle mass declines each year by 0.5 percent and one percent in men and women respectively.

1.2 CHANGES IN NEUROLOGICAL MEASURES:

1.2.1 Autonomic nervous system: In humans the effects of aging have been better studied in relation to the sympathetic nervous system. Sympathetic neural activity may be measured in a number of ways such as by the measurements of plasma nor-adrenaline, assessment of nor-adrenaline spill-over, and direct recordings of either muscle or skin sympathetic nerve activity in peripheral nerves using microneurographic techniques. In older people plasma nor-adrenaline levels are higher, but this is not due to impaired clearance. There is an increase in muscle sympathetic nerve activity, but the increase is not generalized as nor-adrenalin spill–over studies indicate a preferential rise in sympathetic outflow to the heart. The reasons for both the increase and the differential changes are not clear. They are unlikely to result from impaired baroreflexes alone and may reflect impaired sensitivity of target organs to the effects of nor-adrenaline, resulting from mechanisms ranging from reduced sensitivity of the adrenoceptors to impairment of post receptor signal induction. Thus, a variety of changes at neural and non-neural sites may reduce sensitivity to sympathetic stimulation in older people. This is supported by the fact that spectral analysis of the heart rhythm of older subjects (i.e., 60-75 yrs) indicated reduced spectral power at all frequencies, including the low frequency band associated with sympathetic nervous system influence on the heart (Esler, 1995).

1.2.2 Balance, Gait and Mobility

1.2.2.1 Balance: In the absence of age-associated diseases known to impair balance, only modest balance decrements can be demonstrated between 70 and 80 plus years (Wolfson, Whipple, & Derby, 1992). By contrast, in a study of nursing home subjects with recurring falls, half of the subjects had profound deficits of their postural responses as well as impaired gait and lower extremity strength compared to the controls (Wolfson, Whipple, Amerman, & Kleinberg, 1986). Balance may be defined in terms of measurable components which are needed to perform daily activities. For these purposes balance is divided into the following five components along with their measures: (1) standing (sway); (2) ability to use sensory input (loss of balance with limited sensory input); (3) limits of stability (functional base of support); (4) response to external perturbations (loss of balance); and (5) stance with a narrowed base of support (single stance time).

These five categories reflect qualitatively different components but in reality, movement is integrated and often requires more than one component. Coming to each of the components, there is a three percent difference in the antero-posterior sway amplitude of older subjects (average age 76 years ± 5 years) and younger subjects (average age 35 years ± 12 yrs) (Wolfson, Whipple, & Derby, 1992). The sway differences between old and young people increases when visual input or tactile–proprioceptive input is blocked or inaccurate. This suggests that in older people processing of sensory information into a postural response requires additional input, i.e., visual or tactile–proprioceptive feedback in addition to vestibular input. Standing requires the body mass to be vertically aligned over a support zone (this is the limit of stability in each foot). The functional base of support is a measure of this zone of stability in the antero-posterior plane. It is measured using a forced platform to ascertain the percentage of foot length used to uphold body weight with forward and backward body leaning. The functional base of support is relatively stable until sixty years of age, following which it decreases to forty percent of foot length at the age of eighty years (King, Judge, & Wolfson, 1994). The responses to destabilizing forces are different in old and young subjects, with older people showing more losses of balance than young people. Finally the one legged stance is necessary for turning and leaning used in routine activities. The ability to maintain the one legged stance for a period of time is unchanged from the twenties to the fifties, decreases to twenty-two seconds during the sixties to fourteen seconds during the seventies (Bohannon, Larkin, Cook, Gear, & Singer, 1984).

1.2.2.2 Gait: The gait velocity remains relatively constant until sixty years and thereafter slows by fifteen percent per decade. A decrease in walking speed is accompanied by diminished stride length and single support time (i.e., one foot on the ground) and increased double support time (i.e., both feet on the ground) (Murray, Kory, & Clarkson, 1969; Imms & Edholm, 1979). These decrements indicate a significant but modest decrease in these quantitative indices of gait. It is also interesting to note that the walking speed varies with the level of activity. A study of nursing home residents demonstrated a strong correlation between abnormal gait (stride length, walking speed, quantitative assessment) and the occurrence of falls (Wolfson, Whipple, Amerman, & Tobin, 1990).

1.2.3 Memory: Cognitive psychology has conceptualized human memory both in terms of systems and processes (Shanks, 1997). A systems-based concept of memory described five forms of memory, given below (Tulving, 1993). The five forms are: (i) procedural memory referring to memory for skills; (ii) perceptual representation of systems involved in the identification of objects and underlying the phenomenon of perceptual 'priming'; (iii) semantic memory concerning acquisition and use of general knowledge; (iv) short term memory involving retrieval of information from consciousness and (v) episodic memory which refers to memory for personal events encoded in a special temporo-spatial context. This ordering of memory systems corresponds to their presumed developmental sequence in both a phylogenetic and an ontogenetic sense. Procedural memory is thought of as the earliest system to develop, while, episodic memory is thought to be the latest. Another way of subdividing human memory is the distinction between explicit and implicit memory (Graf & Schacter, 1985). In this view, explicit memory involves conscious recollection of information, an example being episodic memory. In contrast, implicit memory does not require deliberate retrieval of an episode, an example being perceptual priming. The systems-oriented view of memory as well as explicit and implicit memory has been mentioned above. According to the process-oriented view, differences of the type between explicit and implicit memory may be explained by the different processes which individuals use while performing different memory tasks. This may be data driven processing versus conceptually driven processing; conscious recollection versus familiarity. Each of the five forms of memory according to the 'systems-view' will be discussed below with a special emphasis on the changes which occur with age.

1.2.3.1 Procedural memory underlies acquisition of skills and those aspects of knowledge which are not directly accessible to consciousness, but whose presence is indirectly shown by action, e.g., walking or cycling. It is commonly believed that procedural memory is largely unaffected by age, especially when contrasted with explicit memory (Light & LaVoie, 1993). However, age deficits have been reported in partial word identification (Hashtroudi, Chrosniak, & Schwartz, 1991), the pursuit rotor task (Ruch, 1934) and in learning to read inverted sentences (Mochvitch, Winocur, & McLachlan 1986).

1.2.3.2 Perceptual representation system of memory: In the perceptual representation system of memory, the emphasis is on physical characteristics of the item. For example, in word stem completion, subjects are required to complete a word stem (e.g., TRU_ _) with the first word that comes to mind, e.g., truck or trunk. In contrast, tests based on concepts rather than perceptual representations rely on the semantic meaning of the items. An example of this is the question "Which small blood vessel supplies oxygen and nutrients to cell tissue?". Understanding the concept and semantic meaning would elicit a correct response (i.e., 'capillaries'). In a recent meta-analysis of the literature, LaVoie & Light (1994) evaluated age differences on a number of perceptually based priming tests and concluded that there were small, but statistically reliable age differences in this class of tests.

1.2.3.3 Semantic memory or generic memory refers to our general knowledge of the world. It includes meanings about words, concepts and symbols, their association as well as rules for using these concepts and symbols. The information is stored without reference to the temporal and spatial context present at the time of its storage. Semantic memory also involves knowledge of ones' own memory proficiency and processes. In general, age differences in semantic memory tasks tend to be negligible. With respect to changes in semantic memory with age, it is unlikely that age related deficits in accessing semantic memory information are because of an actual loss of representations of the names or words, as they are stable across the adult life span. Instead, age deficits in retrieving semantic information may be related to problems in accessing lexical information rapidly.

1.2.3.4 Short Term memory: Short term memory is of two types: primary memory and working memory. For both of them the items which are to be remembered reside in consciousness. However, they differ in one aspect. In primary memory, the items are kept passively, whereas items in working memory are manipulated in some way (Baddeley, 1986). The digit span test of the Wechsler Adult Intelligence Scale provides an example of this. Forward digit span requires individuals to recall a series of digits in the same order as they were presented. Hence, subjects need only to rehearse the items passively and this task is a measure of primary memory. In contrast, backward digit span requires subjects to recall a series of digits in the reverse order. Hence, individuals have not only to remember the digits, they also have to manipulate them, i.e., arrange them in reverse order. Hence, this task is an index of working memory. Evidence regarding the existence of age-associated performance decrements in primary memory is mixed. For example, there is a report showing that primary memory abilities decline across the adult's life span (Botwinick & Storandt, 1974). However, it has also been found that the ability to store information temporarily is not affected by aging (Craik & Rabinowitz, 1984). In contrast to this debate about age-related changes in primary memory, it is generally accepted that when the material to be remembered has to be manipulated in some way (i.e., working memory) there are substantial age differences in functioning.

1.2.3.5 Episodic memory: Episodic memory involves retrieval of information which is acquired in a particular place at a particular time. Episodic memory draws on a wide network of brain structures, which include the hippocampal formation and related cortical structures, diencephalon, anterior cingulate gyrus, precuneus, prefrontal cortex, and cerebellum (Cabeza, Grady, & Nyberg, 1997). Hence, the susceptibility of episodic memory to aging may be due to the fact that changes at multiple sites in a large distributed network are capable of disrupting performance. It is important to note that age associated episodic memory deficits appear to be equally large in traditional laboratory-based tasks (e.g., word recall, paired-associate learning) and tasks that approximate more closely the memory demands of every day life (e.g., face recognition, text recall).

1.2.4 Hearing: Presbyacusis is the term used to describe the clinical manifestations of aging of the auditory system, characterized by bilaterally symmetrical loss of hearing in older people. Presbyacusis may begin insidiously; usually the higher frequencies are involved first. However, with progression the frequency of the upper range of human speech are affected particularly interfering with consonant discrimination (Gulya, 2003).

Four types of presbyacusis have been identified. These are: sensory, neural, metabolic and mechanical. Sensory presbyacusis is defined audiometrically by a bilaterally symmetric, abruptly dropping, pure-tone threshold curve with excellent speech discrimination. Audiometrically, neural presbyacusis manifests as a loss of speech discrimination out of proportion to the loss of pure-tone threshold. In metabolic presbyacusis the audiogram typically has a flat configuration and speech discrimination scores remain normal until the pure-tone threshold exceeds 50 dB.

Conductive presbyacusis, also called as cochlear presbyacusis describes a downward-sloping threshold curve associated with speech discrimination scores that are inversely proportional to the steepness of the slope of the curve. Although pure forms of the four types of presbyacusis are described above, various combinations can occur and result in differing audiometric configurations.

1.3 CHANGES IN MEASURES WHICH HAVE A PSYCHOLOGICAL BASIS:

1.3.1 Depression: In 1996, Beckman cited fifteen prevalence studies of depression in the primary care of people over the age of 55 years. For depressive illness the weighted average was 1.7 percent (range 0.4 – 10.2). In older people depression and physical illness may occur together. It is also interesting that some biological changes associated with aging are similar to those seen in depression. Hence both normal aging and depression are associated with decreased brain concentration of serotonin and dopamine, nor-adrenaline and their metabolites and increased monoamine oxidase B activity (Veith & Raskind, 1988).

1.3.2 Insomnia: Sleep disturbance is one of the most common problems encountered by a geriatrician. Although many sleep disorders are encountered in older people, the most common complaint likely to be seen will be insomnia. Numerous physiological factors operate to reduce the depth, quality, and length of nocturnal sleep in older people. These normal age-associated changes include: loss of deep (stages 3 and 4) sleep; an increased proportion of total sleep spent in Stage 1 (transitional) sleep; and increased frequency of brief arousals lasting less than 15 seconds. Rapid eye movement sleep may change only minimally with age. It has been suggested that the pattern for elderly people to become sleepy earlier in the evening and awaken during the night may actually reflect an age associated change in what may be termed a "phase advance" of the circadian sleep-wake cycle. It is also relevant to note that the prevalence of specific sleep disorders such as sleep apnea increases with age and also many medical illnesses which disturb sleep are more common in aged populations. These factors combine to predispose an elderly person to insomnia.

In the paragraphs mentioned above, changes in the number of variables which occur in the human life span and especially in aging, have been given. These variables are the pulmonary functions, anthropometric measures, muscle strength, gait and balance, memory, hearing, mental state and the quality of sleep. The variables listed above were selected as they form part of a battery for the short term measurement of the rate of human aging (Comfort, 1969). In recent years, there has been a concept of successful or healthy aging, where successful aging has three main components. These are: (i) a low probability of disease and disease related disability, (ii) a high capacity for cognitive and physical functioning and (iii) an active engagement with life including interpersonal relations and productive activities.

According to gerontological experts, the health care and self-care strategies likely to be affected in facilitating the transition from usual to successful aging are interdisciplinary approaches that include behavioral, biomedical, nutritional and other interventions (Committee on a National Research Agenda on Aging, 1991). There have been attempts to study the effects of behavioral and lifestyle interventions in aging. These will be described below:

Transcendental meditation (TM) is a widespread technique, as over a million individuals have learnt the TM program over the past forty years. (Schneider, Alexander, Salerno, Robinson, Fields, & Nidich, 2002). The beneficial effects of practicing TM on the physiological and cognitive correlates of aging have been described. With respect to the physiological correlates, long term (i.e., over five years meditation experience) TM practitioners had a mean biological age twelve years younger than their mean chronological age based on indices, such as, auditory discrimination, near-point vision accommodation and systolic blood pressure (Wallace, Dillbeck, Jacobe, & Harrington, 1982). Also, TM appears to produce long term changes in cognitive functions which appear to be opposite in direction to those associated with aging (Schneider, 2002). These TM induced changes include enhanced short term and long term memory and organization of memory evidenced in learning tasks, incremental gains in fluid intelligence over a two-four year period, improved perceptual flexibility, and an increased perceptual motor speed. In addition the TM program was shown to have beneficial effects on chronic diseases and health patterns associated with aging.

Tai Chi Chuan (TCC) is an ancient Chinese martial art which involves an integration of mind and body in slow circular movements and changes in the center of gravity. The joint proprioception and balance control during weight shifting were compared for four groups (Tsang & Hui-Chuan, 2004). These were (i) experienced elderly Tai Chi practitioners, (ii) experienced elderly golfers, (iii) healthy elderly subjects and (iv) young university students. Both experienced Tai Chi practitioners and golfers had better knee joint proprioception and limits of stability when compared to elderly control subjects. Also, these measures were comparable to those of young students. The effects of TCC have also been studied on autonomic nervous system modulation in older adults (Lu & Kuo, 2003).

Twenty Tai Chi practitioners and twenty controls were compared with respect to the stationary state spectral heart rate variability (HRV) measures and the changes in HRV measures that were studied after classical TCC practice. The results showed that the short term effect of the TCC was to enhance the vagal modulation and tilt the sympathovagal balance towards decreased sympathetic modulation. In yet another study (Li, Fisher, Harmer, Irbe, Tearse, & Weimer, 2004), the effectiveness of Tai Chi on self rated sleep quality and day time sleepiness was evaluated in older adults. Tai Chi participants reported improvements in specific aspects of sleep such as sleep quality, sleep onset latency, sleep duration, sleep efficiency and sleep disturbance. Hence a six month, low to moderate intensity Tai Chi program appeared to be an effective non-pharmacological approach for sleep disturbances.

In the studies on TM and TCC mentioned above, each study examined a different variable. This was not the case in another study which determined the psychological, behavioral, cognitive and cardio-respiratory changes with up to fourteen months of aerobic exercise training in older persons (Blumenthal, Emery, Madden, Coleman, Riddle, Schniebolk, Cobb, Sullivan, & Higginbotham, 1991; Blumenthal, Emery, Madden, Schniebolk, Riddle, Cobb, Higginbotham, & Coleman, 1991). For the first four months of the study, 101 older men and women were randomly assigned to one of three conditions viz., aerobic exercise, yoga and a wait-list control group. After four months, all subjects completed four months of aerobic exercise and they were then given the option of an additional six months of aerobic exercise. Assessments were made initially, after four months, after eight months and at the end of fourteen months. The assessments included the peak oxygen consumption, carbon dioxide elimination, end-tidal gas concentrations, questionnaires for anxiety, depression and overall mood, motor function, memory as well as range of tests for perception and motor functions. The results showed that there was a 10-15 percent improvement in peak oxygen consumption after four months of aerobic exercise and 1-6 percent improvement in aerobic power with additional exercise training. With respect to the psychological, behavioral and cognitive changes, there were relatively few improvements in cognitive performance associated with aerobic exercise although subjects who maintained their exercise participation for fourteen months experienced improvements in some psychiatric symptoms. The most important points to be noted in this study were that no details have been given of what the yoga practices involved. The second important point is that although a range of variables were measured, apart from the assessments of different aspects on memory and depression, the variables were indicators of levels of functioning but not of the rate of aging, as has been mentioned above (Comfort, 1969).

Hence the present prospective, single blind, randomized control trial was designed to evaluate the effects of two complimentary ancient Indian sciences viz., Yoga and Ayurveda in older persons.

In the present study a comprehensive battery of tests was designed which included different variables taken from the standard battery and which came under three broad categories: (i) General health measures, (ii) Neurological variables and (iii) Psychological measures.

2.0 AIMS AND RELEVANCE OF THE STUDY

2.1 AIMS OF THE STUDY

The present study was designed to evaluate the effects of Yoga and of Ayurveda on persons over the age of sixty years. The effects measured were of three categories:

(i) Measures of general health such as pulmonary functions, anthropometric measures, and muscle strength

(ii) Neurological measures such as autonomic status, gait and balance, memory and hearing

(iii) Psychological measures such as mental state and quality of sleep.

2.2 RELEVANCE OF THE STUDY

There is an increase in the proportion of old people in India. The latest statistics have shown that people over the age of sixty have increased from 55.3 million to 75.9 million in the last ten years. This trend is likely to continue in the future. Hence the health of the older people is assuming greater importance and it is desirable to scientifically evaluate traditional methods which have been described as promoting positive health and which may hence also be considered likely to facilitate healthy aging.

3.1.1 Background and Scope

Memory is the most fascinating and complex function which allows every individual to use prior experiences to appreciate the familiar, to be alert to the novel and to plan effectively for the future as a projection from the past.

The process of memory involves encoding, storage and retrieval of information and cognitive processes (Crooks & Stein, 1991). Encoding is the process of receiving sensory input and transforming it into a form, or code which can be stored. Storage involves actually putting coded information into memory bank and retrieval is gaining access to stored, coded information when it is needed. Good memory results from deeper and elaborate processing of perceptual input.

Though there are similarities between the modern and ancient concepts of memory, there is a vast difference between them in their deeper understanding. Hence, this literary research is an attempt to study those facets of memory which are defined in ancient Indian literature.

It is worth noting that all ancient scriptures such as the *Vedas, Upaniṣads, Sūtras* etc., were originally not in written form but memorized and transmitted from teacher to pupil by word of mouth. The Vedic corpus is what has been dubbed a mnemonic literature and examples of such expositions are *Dharmaśāstras.* Even today, this culture has been evidenced by spiritual scholars who can recite from memory, one or more *saṁhitās* (sections of the Vedas) or the entire *purāṇas* (large collections of mythological descriptions) each comprising of thousands of verses. This extraordinary ability has been attributed not only to their style of learning but also to the special and subtle features of the mind which have been detailed below.

According to *Yoga Vāsiṣṭha* (Atreya & Samvid, 1993) a philosophical ground text on yoga, attributed to *Maharṣi Vāsiṣṭha*, the mind is the basic fabric of creation. Various manifest and unmanifest layers of mind constitute this creation. Mind has been said to have four facets i.e., *Manas, Buddhi, Ahaṅkāra* and *Citta. Manas* is often correlated with the mind. It has been defined as '*Saṅkalpavikalpātmaka Manaḥ'*, the resolved and ever changing processes are often referred to as *manas. Buddhi* (intellect) sorts out the information which is newly acquired, analyzes and forwards it for further action. The intellect with its power of discrimination sorts out the thoughts and connects all other thoughts which are related to a subject. This process involves concentration. The third facet of mind is the *citta* which has been regarded as the storehouse of all past impressions called *saṁskāras* and newly generated impressions called *vāsanās.* At the background of all these states of mind is the *ahaṅkāra,* the 'I' - principle which governs all actions performed by every individual. These four facets put together constitute the *Antaḥkaraṇa* (inner tools of perception).

Thus, all actions performed by an individual are governed by the *saṁskāras.* As long as the *saṁskāras* are present, the seed for activity remains. Therefore, the ancient scriptures proclaim that the spiritual evolution completes only when all *saṁskāras* are cleared. They remain as obstacles to liberation. Sage

Patañjali describes the final goal of every being is to transcend in the plane of spiritual evolution to reach the final state which is featured by absolute bliss with no past impressions (*saṁskāras*) i.e., *Nirbīja Samādhi* (Prabhavananda, 2002).

This analogy illustrates the fact that the concept of memory is not as simple as retrieval of information as per the present day understanding, but has deeper expressions and implications. Memory plays a very important role in everyone's life. As much it is important for a spiritual seeker to clear the past impressions to attain liberation, equally important is the proper perception and cognition for an individual at a mundane level for better functioning. Apart from several external factors which can influence the memorizing capacity of an individual, the aging process which is an intrinsic factor, has been said to have a negative impact on memory. Hence a detailed understanding about the concept of memory and different means to overcome the probable consequences of aging on memory is required. This would help elderly individuals to prevent and manage problems related to the decline in memory as the aging process continues.

Hence the present literary research had the following aims and objectives:

3.1.2 Aims and Objectives

(i) To compile and understand the concept of memory according to ancient Indian scriptures

(ii) To identify the factors which can influence the process of memory

(iii) To explore the possibilities of developing the memory

(iv) To study the effects of aging on memory

3.1.3 Methodology

3.1.3.1 Source material

This literary research is based on the information collected from (i) ancient Indian scriptures, as well as (ii) the experts in the field of yoga and spiritual lore. The following traditional scriptures and yogic and spiritual literature were reviewed:

***(1) Major Upaniṣads**:* (i*) Kena Upaniṣat (ii) Kaṭha Upaniṣat (iii) Māṇḍūkya Upaniṣat (iv) Taittirīya Upaniṣat and (v) Chāndogya Upaniṣat*

(2) Ancient yogic texts: *(i) Yoga Vāsiṣṭha (ii) Patañjali's Yoga Sūtras, Vyāsa Bhāṣya on Patañjali Yoga Sūtras (iii) Bhagavadgītā, and (iv) Haṭha Yoga Pradīpikā.*

(3) Darśanas (sytems of philosophies): *(i) Sāṅkhya (ii) Nyāya (iii) Vaiśeśika (iv)Pūrva Mīmāmsā (v)Uttara Mīmāmsā*

(4) Saṁhitās: (i) *Ṛgveda Saṁhitā* (ii) *Caraka Saṁhitā*

(5) Other classical texts: *Tarka Saṅgraha*, *Pāṇini Sūtras*, and *Nyāya Śāstra* (*prakaraṇa granthas*), and *sūtras* of *Śaṅkarācārya*, *Aruṇa Praśna* of *Yajurveda*, *Amarakośa, Parijātakośa* and *Sāhitya Darpaṇa.*

3.1.3.2 Methods

The classical and authentic information derived from the verses and the commentaries and descriptions about different aspects of memory, from the above mentioned sources was first systematically compiled and then was sorted according to the defined structure of the sections. The relevant references are cited in the body of the text as well as in the reference section.

3.1.4 The Concept of Memory according to Ancient Indian Scriptures

The concept of memory in yoga and spiritual lore takes into consideration the holistic perspective of an individual. The traditional approach adopts the five-layered existence of man (Gambhirananda, 1998). The first, and the most gross is the physical frame, i.e., the *Annamaya kośa* (physical sheath). The second (life energy body) is the *Prāṇamaya kośa* characterized by predominance of *prāṇa*, the life principle. The next sheaths in the order of subtlety are: *Manomaya kośa* (mental sheath), *Vijñānamaya kośa* (intellectual sheath), and *Ānandamaya Kośa* (sheath of bliss). As the sheaths become subtler, the freedom of operation increases, bondage decreases, and bliss associated with it multiplies. While in *Manomaya kośa* the creative power predominates, in *Vijñānamaya kośa* it is the power to discern and discriminate. Bliss is embodied in *Ānandamaya kośa*, the highest stage of evolution. In his journey towards Ultimate, man crosses these sheaths of existence one by one. Through analysis known as *Pañca kośa viveka* (knowing through experience of the five sheaths of existence) and the associated practices called *Tapas*, an individual is transformed by getting relieved from the bondages and constrictions of each sheath. This is one of the ways of reaching the ultimate goal described in the *Upaniṣads* (Gambhirananda, 1998).

In *Annamaya kośa* (physical layer of existence) memory has been regarded as the functional aspect of brain according to present day neuroscience. But the spiritual texts take different stand point with respect to the concept of memory at physical level. The normal mind with limited memories can only create a world from experience as in the dream state. But subtler and deeper memories can create an even more 'real' world. It is the mind that can create and destroy the whole world says *Yoga Vāsiṣṭha.* The whole Universe is pervaded by Brahman. Emerging from Brahman, the mind by its power shows up as Universe. Thus the whole creation is a construct of mind. There have been great Yoga masters who have shown up amazing abilities to memorise, passing through the limitations of time and space, associated with such memories to change their physical existence, allow the body to disappear, create a new body, multiple existence etc. all coming under the name of *sidhis* or supernatural powers. Thus even the brain a physical store house of memory has been believed to be a construct of mind.

Based on the wisdom of *Upaniṣads* described above it is evident that a total understanding of memory should take the entire existence of human system into consideration, and not limit itself to the physical body alone. Hence this brings us to a holistic concept of memory.

In *Prāṇamaya kośa* memories are concerned with the vegetative and instinctual activities. They are stored at the grosser level (instincts) but overpowered by subtler stores of memory and by higher *saṁskāras*.

In *manomaya kośa*, memory is classified as *vāsanā* (superficial) and *saṁskāra* (deep rooted). The former is due to habituation while *saṁskāras* are associated with emotions. As mentioned earlier, it is the mind that can create and destroy the whole world and the whole creation is a construct of mind.

In *Vijñānamaya kośa*, memory is based on analysis, discrimination and understanding. Individual's understandings also expand and become increasingly comprehensive and his ability to remember increases. Deepest of the memories is in *Ānandamaya Kośa*, with the most comprehensive and total memory of the entire creation. The very tendency to think, act and enjoy is again the subtlest of the memory layers. They are called *vāsanās* (tendency). When even this tendency vanishes, mastery emerges which is a state of highest freedom.

3.1.4.1 Etymology of the word memory in *Saṁskṛta*

In yogic and spiritual literature the *Saṁskṛta* words such as *Smṛti, Smaraṇa* and *Medhā* have been synonymously used for memory in different contexts. The word *Smṛti* is derived from the root *smṛ* with *lyut* as a suffix. *Smṛti* is defined as '*Saṁskāra janya jñānam Smṛtiḥ*'.

The information derived from the past imprints (*saṁskāras*) is called as *Smṛti*.

Smaraṇa is the process of remembering. It has been described in the *vedāṅgas* (Madhavananda, 1989) as:

मनो बुद्धिरहङ्कारः चित्तं करणमान्तरम् ।
संशयो निश्चयो गर्वः स्मरणम् विषया इमे ॥ वेदान्त परिभाषा ॥

Mano buddhirahaṅkāraḥ cittaṁ karaṇamāntaram।
Saṁśayo niścayo garvaḥ smaraṇam viṣayā ime. (vedānta paribhāṣā)

Mental state is of four kinds: doubt, certitude, egoism and memory. Owing to this diversity of states, the mind, though one, is designated as the *manas*, the intellect, the ego and the *citta*. So it has been said: "The *manas*, the intellect, the ego and the *citta* constitute the internal instrument (mind). Doubt, certitude, egoism and memory – these are (respectively) their objects."

Another word which is synonymously used for memory is *Medhā*.

Medhā is described as the process of memorizing with special attention and intention.

धीः धारणावती मेधा ॥ अमरकोश ॥१।१५७ ॥

Dhīḥ dhāraṇāvatī medhā. (Amarakośa)..1.157..

Holding the information with special intention is called *Medhā*.

Smṛti is common to all, while *Medhā* is a special ability.

3.1.4.2 Definition of *Smṛti*

Smṛti has been defined as the process of retrieving information from the past imprints (*saṁskāras)*. The *vaiśeśika* system of philosophy defines *Smṛti* as:

आत्ममनसोः सम्योग विशेषत् संस्कारवच्च स्मृतिः ॥ कणादसूत्रं ॥

Ātmamanasoḥ samyoga viśeṣat saṁskāravacca smṛtiḥ . (Kaṇādasūtraṁ)

The *saṁskāra* which arises because of the special conjunction between Ātmā (Soul) and the *manas* (mind) is termed as *Smṛti* .

Where as sage Patañjali defines *Smṛti* as:

अनुभूतविषयासंप्रमोषः स्मृतिः ॥ प. यो. सू. १. ११ ॥

Anubhūtaviṣayāsampramoṣaḥ smṛtiḥ. (PYS: 1.11)

Memory is the absence of loss (i.e., retention) of the experienced objects (Taimini, 1986). The mental process in recalling a past experience is a peculiar one. That is the reason why memory has been classified as a type of *citta-vṛtti (*modification of the mind*).* The other modifications in summary are:

प्रमाणविपर्ययविकल्पनिद्रास्मृतयः ॥ प. यो. सू. १. ६ ॥

Pramāṇa-viparyaya-vikalpa-nidrā-smṛtayaḥ | PYS: 1.6 ||

The right knowledge, wrong knowledge, fiction, sleep and memory.

Memory is defined as the retention of the past experience in the mind. But it is to be noted that these experiences are retained in the mind as mere impressions (*Saṁskāra*) and as long as they are present in their potential form, as mere impression it is not considered as a *citta-vṛtti*. It is only when the potential impressions are converted into their active state in the form of mental images that they can properly be considered as a *citta vṛtti.* Hence *Smṛti* comprises all those images which are modifications of the mind, which are produced without any kind of direct contact with the outer world. They are the results of the independent activity of the lower mind using the sensuous perceptions which have been gathered before and stored in the mind are reproduced based on the need.

3.1.4.3 Classification of *Smṛti*

According to *Tarka Saṅgraha* (Athalye & Bodas,1974), *Smṛti* has been divided into two types:

स्मृतिरपि द्विविधा यथार्थायथार्था च।
प्रमाजन्या यथार्था। अप्रमाजन्या अयथार्था॥३४॥
Smṛtirapi dvividhā yathārthāyathārthā ca.
Pramājanyā yathārthā| Apramājanyā ayathārthā ..34..

Recollection is of two folds; *yathārthā* which is true and *ayathārthā* which is false.Pramājanyā is born out of valid knowledge while the apramājanyā is born of false cognition which is erroneous.

Vyāsa Bhaṣya on *Patañjali's Yoga Sūtras* describes the following types of memories:

(i) *bhāvita-smartavyā* (produced memorablia) and (ii) *abhāvita – smartavyā* (un-produced memorablia) (Usharbudh Arya, 1986).

In dream, comes the produced memories and in waking, the unproduced memories. All these memories (the remembrances) rise from the experience of citta vṛttis i.e., real cognition (*pramāṇa*), perversive cognition (*viparyaya*), fiction (*vikalpa*), sleep (*nidrā*) and memory (*Smṛti*).

Smṛti has also been classified as one of the states of consciousness in the vedāntic philosophy. The Consciousness is classified into four divisions. *Pramā* = conscience (pure subjective consciousness); *Pramātā* = cognitive Consciousness or the perceiver (the lower subjective manifestation); *Pramāṇa* = the instrumental or the cognitional consciousness (lower self or Citta); *Prameya* = cognizable consciousness (the gross mind). Here the *Pramāṇa* and the *Prameya* are the material aspects of consciousness; and the other two are the spiritual aspects. Intelligence is the productive faculty (*Abhijñā-pratyakṣa*). Memory is the reproductive faculty (*pratyabhijñā-pratyakṣa*) of the *vedānta darśana*. Produced memorablia is the *prātibhāsika–sattā* (the visionary phenomenon or the creation of the mind); and the unproduced memorablia is the *vyavahārika - sattā* (the wordly phenomenon or the creation of God). The *vedānta – darśana* does not take notice of this unproduced memorablia, because the pure subjective state has been dealt with in it. The aim of this yoga –s*ūtra* is to teach the process and the characters of the suppressive habit after gradual destruction of the exhibitive ones, so this science begins with the unproduced memorablia.

The *Aitereya Upaniṣad* describes *smṛti* as one of the facets of consciousness.

यदेतद्धृदयं मनश्चैतत्। संज्ञानमाज्ञानं विज्ञानं प्रज्ञानं मेधा दृष्टिधृतिर्मतिर्मनीषा जूतिः स्मृतिः संकल्पः क्रतुरसुः कामो वश इति। सर्वाण्येवैतानि प्रज्ञानस्य नामधेयानि भवन्ति॥ ऐतरेय उपनिषद् ३.१.२. ॥

Yadetaddhṛdayaṁ manaścaitat, Sañjñānamājñānaṁ vijñānaṁ prajñānaṁ medhā dṛṣṭidhṛtirmatirmanīṣā jūtiḥ smṛtiḥ saṅkalpaḥ krarasuḥ kāmo vaśa iti . Sarvāṇyevaitāni prajñānasya nāmadheyāni bhavanti (Ait. U. 3.1.2.)

It is this heart (intellect) and this mind that were stated earlier. It is sentience, rulership, secular knowledge, presence of mind, retentiveness, sense-perception, fortitude, thinking, genius, mental suffering, memory, ascertainment, resolution, life-activities, hankering, passion, and such others. All these verily are the names of Consciousness.

In summery, though the classification of memory is not clear in the ancient yoga texts, on the basis of their origen they can be broadly identified as (i) Saṁskārajanya – that which arises out of saṁskāras, and (ii) Manojanya – that which arises from the mind.

3.1.5 The process of memory

As described earlier, according to the present day understanding the process of memory involves encoding, storage and retrieval of information and cognitive processes. Similar description has been given in the *saṁhitās*. It starts with perception (receiving information from the sense organs (*indriyas*)). Any information thus received will be analyzed and stored for further recollection.

Perception is called as *grahaṇa* in *Saṁskrita*, which means to perceive.

The *Nyāya* School of thought described the process of perception as:

इन्द्रियार्थसन्नि कर्षोत्पन्नम् ज्ञानमव्यभिचारि व्यवसायात्मकम् प्रत्यक्षम्। न्यायसूत्रम्॥ २।३।२।२१॥

Indriyārthasanni karṣotpannam jñānamavyabhicāri vyavasāyātmakam pratyakṣam. (Nyāyasūtrām)2.3.2.21..

Perception is that knowledge which arises from the contact of a sense with its object and which is determinate, unnamable and non-erratic.

In *Nyāya*, the process of acquiring new information has been decribed as follows: when an object (pot) comes in contact with the sense organ (eyes), an image of the object is carried to the mind which conveys it to the soul. Thus the process is pot- sense organ – mind - *ātman.*

The *saṁhitās* have described this process in greater detail and with better clarity. The definition of perception according to *Caraka saṁhitā* (Sharma & Dash, 1985) is:

आत्मेन्द्रियमनोर्थानां सन्निकर्षात् प्रवर्तते।
व्यक्ता तदात्वे या बुद्धिः प्रत्यक्षं सा निरुच्यते॥ सू ।स्था॥११।२०॥

Ātmendriyamanorthānāṁ sannkarṣāt pravartate
Vyaktā tadātve yā buddhiḥ pratyakṣaṁ sā nirucyate .. sū. sthā..11.20..

A mental faculty instantineously manifested (in a particular form) as a result of the proximity of the soul, sense faculties, mind and the objects is known as *pratyakṣa* (perception or direction observation).

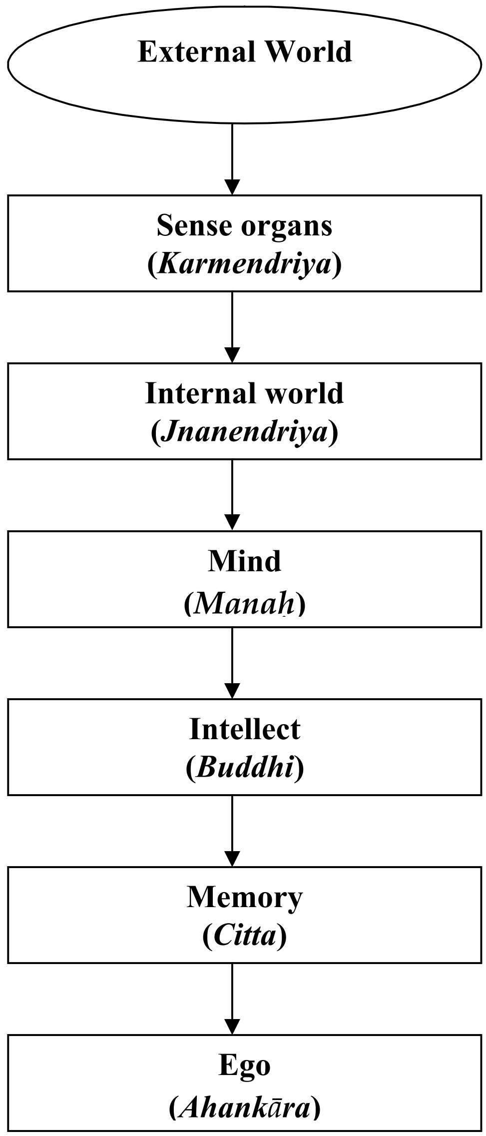
Hence the instruments of knowledge are mind, intellect and cognitive and connotive organs. Their association with the doer (emperical soul) results in action, sensation and understanding. The emperical soul alone (in the absence of instruments of knowledge) does neither initiate action nor enjoy the fruit of action. Combination of all these factors is responsible for the manifestation of everything and without that nothing exists. This concept is well-explained in the *śloka* mentioned bellow:

करणानि मनो बुद्धिर्बुद्धिकर्मेन्द्रियाणि च ।
कर्तुः संयोगजं कर्म वेदना बुद्धिरेव च ॥ शा ।स्था ॥१ ।५६ ॥
नैकः प्रवर्तते कर्तुं भूतात्मा नाश्नुते फलम् ।
संयोगाद्वर्तते सर्वं तमृते नास्ति किञ्चन ॥ शा ।स्था ॥१ ।५७ ॥

Karaṇāni mano buddhirbuddhikarmendriyāṇi ca,
Kartu samyogajam karma vedanā buddhireva ca.. śā.sthā..1.57..
Naika pravartate kartum bhūtasmā nākṣrute phalam,
Samyogādvartate sarvam tamrute nāsti kiṇcana.. śā.sthā..1.58..

The process of aquiring new information involves the perception, which is dependent on the harmoneous functioning of the sense organs, the mind, intellect and cognitive faculties. Deeper the perception, longer the imprints remaining for retrieval, also regular use can result in better storage. Information, thus, stored can be retrieved for use through appropriate cues. This proces has been schematically represented in Fig. 3.1.5

Fig 3.1.5: schematic representation of the process of remembering



3.1.6 Factors influencing *Smṛti*

3.1.6.1 Factors influencing perception

The emperical soul is endowed with the power of perception. It perceives things when it is associatd with the mind, intellect and sense faculties. If these instruments of perception are either absent (not in association with the emperical soul) or impeded, then there will be no perception. One cannot get the real reflected picture of an image from a mirror which is covered with dirt or from water which is muddy. Similar is the case when the mind etc. get afflicted. The *śloka* mentioned below from *Caraka saṁhitā* (Sharma & Dash, 1985) illustrates this process in a nut shell:

आत्मा ज्ञः करणैर्योगाज् ज्ञानं त्वस्य प्रवर्तते ।
करणानामवैमल्यादयोगाद्वा न वर्तते ॥ शा ।स्था ॥५४ ॥
पश्यतोऽपि यथाऽऽदर्शे संक्लिष्टे नास्ति दर्शनम् ।
तत्त्वं जले वा कलुषे चेतस्युपहते तथा ॥ शा ।स्था ॥५५ ॥

Ātmā jñaḥ karaṇairyogāj jñānaṁ tvasya pravartate,
Karaṇānāmavaimalyādayogādvā na vartate.. śā.sthā..54..
Paśyato'pi yathā''darśe saṅkliṣṭe nāsti darśanam,
Tatvaṁ jale vā kaluṣe cetasyupahate tathā.. śā.sthā.. 55..

3.1.6.2 Influence of Guṇas on Memory

तत्त्वज्ञाने स्मृतिर्यस्य रजोमोहावृतात्मनः ।
ब्रश्यते स स्मृतिब्रम्श स्मर्तव्यं हि स्मृतौ स्थितम् ॥ शा ।स्था ॥१ ॥१०१ ॥

Tattvajñāne smṛtiryasya rajomohāvṛtātmanaḥ,
Braśyate sa smṛtibramśa smartavyaṁ hi smṛtau sthitam.. śā.sthā..1.101..

If memory is impaired due to a person being overcome by rajas and tamas, this is known as the impairment of memory. Normally memory contains everything memorable (Sharma & Dash, 1985).

3.1.6.3 Influence of Food on memory

The process of recollection has been believed to involve the proper functioning of the physical body, the strength of which is dependent on the consumption of food followed by the presence of vital force (*prāṇa*) and the association of the mind with the object of perception or the recollection and the involvement of the emperical soul.

Chāndogya Upaniṣad (Swahananda, 1984) has decribed the role of food in recollection. While describing the composition of human body the teacher says that the mind (*manaḥ*) is made of food (*annamayam*), vital force (*prāṇah*) is made of water (*apomayah*) and speech (*vāk*) is made of fire (*tejomayī*). To illustrate this the teacher asks the student not to eat food for fifteen days but tells him to drink as much water he wants. After fifteen days when the student returns he asks him to recite the mantras from *Ṛgveda, Sāmaveda* and *Yajurveda*, but the student replies that they indeed are not flashing to his mind. This shows that the ability to recollect depends on the consumption of food and fasting has a detrimental effect on memory.

3.1.6.4 Influence of *Kleśas* on memory

Sage Patañjali has classified *Smṛti* as one of the *citta vṛttis* (modifications of the mind). The *citta vṛttis* are the binding factors which causes trauma of the mind. They are also the causitive factors for the generation of *kleśas* (afflictions). The *saṁskṛta* word *kleśa* means affliction, pain, or misery. But the deeper meaning describes it as what causes pain, afflictions or misery. They are:

अविद्याऽस्मितारागद्वेषाभिनिवेशाः क्लेशाः ॥ प. यो. सू. : 2.3 ॥

Avidyā'smitā-rāga-dveṣābhiniveśāḥ kleśāḥ. (PYS: 2.3)

The lack of awareness of reality (*Avidyā*), the sense of 'I' am ness (*Asmita*), attractions (*Rāga*), repulsions (*Dveṣa*) and strong desire for life (*Abhiniveṣa*) are the great afflictions or causes of all miseries in life (Taimini, 1986).

Avidyā has been described as the root cause for the manifestation of other four *kleśās*. A detailed picture reveals the fact that the nature of the other four *kleśās* will show not only that they can grow only on the soil of *Avidyā* but also that the five *kleśas* form a connected series of causes and effects. The states in which *kleśas* may exist can be classified as (i) dormant, (ii) attenuated, (iii) alternating and (iv) expanded. In dormant condition the *kleśas* are present in latent form. In attenuated condition they are very feeble. They are not active but can become active with mild stimulation. In the fully expanded condition the *kleśa* is fully in operative condition. The alternating condition is that one in which two opposite tendencies overpower each other as in the case of the feelings of attraction and repulsion alternate, though fundamentally they are based on attachment.

It is in the case of advanced yogīs that the *kleśas* are present in the dormant form. In the case of ordinary people, the *kleśas* are present in the other three conditions, depending upon external circumstances. Overall, the *kleśas* and *vṛttis* influence each other. One such example of the influence of *kleśas* on memory which can be illustrated well through the *śloka* from *bhagavadgītā*:

ध्यायतो विषयान् पुंसः सङ्गस्तेषूपजायते ।
सङ्गात् सञ्जायते कामः कामात् क्रोधोऽभिजायते ॥ गीताः २ . ६२ ॥
क्रोधाद् भवति संमोहः संमोहात् स्मृतिविभ्रमः ।
स्मृतिभ्रंशाद् बुद्धिनाशो बुद्धिनाशात् प्रणश्यति ॥ गीताः २ .६३ ॥

Dhyāyato viṣayān puṁsaḥ saṅgasteṣūpajāyate,
Saṅgāt sañjāyate kāmaḥ kāmāt krodho'bhijāyate. (Gītā:2.62)
Krodhād bhavati sammohaḥ sammohāt smṛtivibhramaḥ,
Smṛtibhraṁśād buddhināśo buddhināśāt praṇaśyati. (Gītā:2.63)

Brooding on the object of senses, a man develops attachment for them; from attachment springs up desire (unfulfilled) ensues anger. From anger arises delusion, from delusion; confusion of memory; from confusion of memory, loss of reasoning; and from loss of reasoning (discrimination), he goes to complete ruin (Tapasyananda, 1982).

3.1.7 Memory and spiritual evolution:

Since *Citta vṛttis* and *kleśas* acts as barriers or obstacles for spiritual evolution of an individual, sage *Patañjali* has advocated *aṣṭāṅga yoga* (eight limb path) for gaining mastery over *citta vṛttis* , for attenuating *kleśas,* and to attain *samādhi. Hence he defines yoga as the process of gainingmastery over the mind.*

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योगश्चित्त वृत्ति निरोधः ॥ प. यो. सू.: १.२ ॥

Yogaś citta -vṛtti –nirodhaḥ. (PYS: 1.2)

Yoga is the inhibition of the modifications of the mind.

समाधिभावनार्थः क्लेशतनूकरणार्थश्च ॥ प. यो. सू.: २ .२ ॥

Samādhibhāvanārthaḥ kleśatanūkaraṇārthaśca.(PYS: 2.2)

Yoga is practised for attenuating kleśas and bringing about *samādhi* (Taimini, 1986) and the features of such a *sādhaka* are described in the *Haṭhayogapradīpikā* (Mukthibodhananda, 2001) as:

चित्तं न सुप्तं नोजाग्रत्स्मृतिविस्मृतिवर्जितम् ।
न चास्तमेति नोदेति यस्यासौ मुक्त एव सः ॥ ह. यो. प्र. ४. ११० ॥

***Cittaṁ na suptaṁ no jāgrat smṛtivismṛtivarjitam* |**
***na cāstameti nodeti yasyāsau mukta eva saḥ* . (H.Y.P.: 4.110)**

He whose *Citta* (mind) is neither asleep nor awake, has neither memory nor forgetfulness and is neither unconscious nor conscious- he is liberated indeed.

श्रद्धावीर्यस्मृतिसमाधिप्रज्ञापूर्वक इतरेषाम् ॥ प. यो. सू.: १.२० ॥

Śraddhāvīryasmṛtisamādhiprajñāpūrvaka itareṣām. (PYS: 1.20)

This is preceded by Faith, Courge, Retentive Power, Spiritual Absorption and Intellective Vision in the case of others.

This (Ultra-Cognitive–spiritual–absorption) being dependent upon the systematic process happens to the Yogis. Faith means the vehement aspiration of the mind. It indeed sustains the Yogī like a benevolent mother. Courage, in fact, is born in that Faithful aspirant seeking after the Intellective distinguishing power. Retentive Power comes to the fully courageous; further, on the acquisition of the Retentive Power the mind being freed from disturbance, becomes Spiritually Absorbed. The Intellective vision, by which the yogi understands the Substance in reality, comes to the Spiritually Absorbed mind. By the practice of these (Faith, etc.) and from the non-attachment towards the respective objects thereof, comes the Ultra- Cognitive –Spiritual-Absorption.

The very tendency to think, act and enjoy (*Jñātṛtva, Kartṛtva and Bhoktṛtva*) is again the subtlest of the memory layers. They are called *vāsanās* (tendencies). When even this tendency vanishes, mastery emerges which is a state of highest freedom - mokṣa beyond all forms, Yoga Vāsiṣṭha (Atreya & Samvid, 1993) beautifully mentions.

वासन तनवम् राम मोक्ष इत्यभिधीयते ॥ यो ।व ॥११ ।७० ।१ ॥

Vāsana tanavam Rāma mokṣa ityabhidhīyate..y.va.11.70.1..

Thinning of vāsanās, O Rāma, is verily the *Mokśa.*

Thus, memory plays an important role in spiritual evolution. It acts as an obstacle according sage *Patañjali* and availing the benefits of the same, an individual can attain *Samādhi* and ultimately reach *Mokṣa.*

3.1.8 Techniques to improve memory

The concept of memory development in yoga and spiritual lore takes into consideration the holistic perspective of an individual. This traditional approach to improve memory involves techniques based on the five-layered existence of man (ref) . As described elsewhere, the first is the *Annamaya kośa* (physical frame). The second is the *Prāṇamaya kośa* (layer of life energy). The next sheaths in the order of subtlety are: *Manomaya kośa* (layer of mind), *Vijñānamaya kośa* (layer of intellect), and *Ānandamaya Kośa* (layer of bliss). As the sheaths become subtler, the freedom of operation in living beings increases, bondage decreases, and bliss associated with it multiplies. While in *Manomaya kośa* the creative power predominates, in *Vijñānamaya kośa* it is the power to discern and discriminate. Bliss is embodied in *Ānandamaya kośa*, the highest stage of evolution.

In *manomaya kośa***,** memory is classified as *vāsanā* (superficial) and *saṁskāra* (deep rooted). Hence memory development is targeted at two levels:

3.1.8.1 Mental level: The mind is a collection of thoughts. Unconnected thoughts called *cañcalatā*, and a random, haphazard mind-set is the basis for deterioration. The first step in gaining mastery over the mind is to systematically train and develop the power of concentration, to think about a given subject. All thoughts in the mind get channellized in concentration. This is the work of the intellect. The next step to concentration is *Dhāraṇā*, focusing of the mind on a single thought. Effortless *dhāraṇā*, is *dhyāna,* meditation. All these stages, *Dhāraṇā*,, *Dhyāna* and the next step, *Samādhi*, (superconsciousness, merger of *tripuṭi*, the seer-seen-process of seeing) helps in developing at the mental level.

There is a basic difference between memory development techniques at the intellectual and mind levels. In the former, understanding is the key to memory. At the mind level, memorization takes place through dwelling on a single thought by repetition of the same thought several times and by relaxed, effortless process of *Dhyāna.*

If one could get into *Samādhi* voluntarily, photographic memory could be the result. After *Samādhi* is the process of *Samyama.* By performing *Samyama*, a triplet of *Dhāraṇā* - *Dhyāna* – *Samādhi*, *Patañjali* mentions that one can unravel the knowledge hidden deep within the subtler layers of the memory.

Techniques of yoga include the practice of various meditation techniques - Transcendental Meditation, meditation on the syllable 'OM', relaxation techniques such as Yoga Nidrā, deep relaxation technique and focusing and de-focusing practices such as Trāṭaka to help in *Dhāraṇā* and *Dhyāna* leading to *Samādhi.* Yoga games and songs help in enhancing the memory at this level.

3.1.8.2 Emotions level: Repeating a thought in the mind many times is how an attachment develops. This is the beginning of all emotions and feelings. Emotion can influence strong memories (*saṁskāras*), at deep subconscious levels invoking the right emotion is the best way to memorize. The stronger the emotion, the deeper the imprint. For memory development at emotional level, yoga offers *Bhakti Yoga* (the science of emotions' culture) gives the right direction of growth i.e., to move from gross violent emotion to softer, ennobling emotions. The memory imprints of strong violent emotional reactions have to be replaced with memories of elevating subtler emotions. To move from *kāma* (desire) to *prema* (selfless love) and to *Bhakti* (devotion) by adding *tyāga* (sacrifice) and surrender. The art of *Bhakti* is the memory to invoke and instill different *Bhāvas* or feelings. Devotional sessions, songs, skits, dramas, humors, stories and anecdotes, are the tools used in yoga to develop memory at the emotional level.

In *Vijñānamaya kośa*, memory is based on analysis, discrimination and understanding. Individual's understandings also expand and become increasingly comprehensive and the ability to remember increases. The technique for memory development at this stage is the *Jñāna* yoga triplet, *Śravaṇa-manana-nididhyāsana*: hearing (or reading) about the higher and more comprehensive perspectives of the whole creation - analyzing the same through logic with an open mind without bias, disbelief or blind belief, intense search within finding the root of all thoughts are staying between two thoughts. The result of this is a sudden opening of our memories, an activation of the dormant knowledge hidden within. The *Upaniṣads* proclaim that each individual is potentially divine. All knowledge is within. However, a loss of memory of the same has taken place. Hence, we think we are limited. Through techniques of *Jñāna* Yoga, by conducting experiments in the laboratory of the self, memories will comeback to the surface and the recall of the subtlest knowledge takes place. *Patañjali* states that in that stage the awareness blossoms and a total awareness emerges (Taimini, 1986). He called it

ऋतम्भरा तत्र प्रज्ञा ॥ प।यो।सु १।४८ ॥

Ṛtambharā Tatra Prajñā .(P.Y.S:1.48).

These techniques of *Jñāna* yoga thus develop memory open and broad vistas of the inner world or the multilayered existence of the world.

Deepest of the memories is in *Ānandamaya Kośa*, with the most comprehensive and total memory of the entire creation. *Jñāna* or the wisdom of discrimination with an understanding of the totality is the most important adjunct to memory development at *Ānandamaya kośa* level. The highest memory development involves being able to retain that wisdom, to maintain a continuous stream of awareness at all points of time and under all situations, and to be in tune with creation. For the most elevated the memory of *Ātmā* abounds to such an extent that they never lose awareness of that *Ānanda*, a state of total expansiveness and blissful awareness, a state of silence within.

That is the highest or the most holistic memory achievement. To the extent that such masters become embodied with bliss itself (*Ānandamaya kośa*). A periodic dip into this oceanic memory of bliss is the enlivening nectar of all our lives even the most mundane, says the *TaittirīyaUpaniṣad* (Gambhirananda, 2002).

To live in tune with this knowledge base, to have the recall of this state is the real memory development. The *Bhagavadgītā* (Tapasyananda, 1982) says:

योगस्थः कुरु कर्माणि सङ्गं त्यक्त्वा धनञ्जय ॥ गीताः २. ४८ ॥

Yogasthaḥ kuru karmāṇi saṅgaṁ tyaktvā dhanañjaya . (Gītā: 2.48)

Act in tune with this total awareness (memory of the highest state of *Ānanda*) relinquishing all attachments. At all other levels the memory is limited. The memory there is called *saṁskāra* or *vāsanā*.

Slowly as one progresses, this bliss percolates, into hours of sleep and the constrictions, limitations and loss of awareness during sleep get replaced by an inner light. The blissful awareness dominates the regions of dream and deep sleep.

स यदा तेजसाऽभिभूतो भवति ।
अत्रैष देवः स्वप्नान्न पश्यत्यथ तदैतस्मिञ्शरीरे
एतत्सुखं भवति ॥ प्रश्न उ. ४.६ ॥

Sa yadā tejasā 'bhibhūto bhavati|
Atraiṣa devaḥ svapnānna paśyatha Tadaitaasmiṅ śarīre
etatsukhaṁ bhavati (Praśna U.: 4.6)

When that deity ,(the mind), becomes overwhelmed by (the solar) rays (called bile), then in this state, the deity does not see dreams. Then, at that time, there occurs this happiness in this body. Until it is all one ocean of memory of blissful awareness all through.

The *saṁhitās* have described several techniques to improve memory at the physical level. Eight separate methods have been detailed in *Caraka Saṁhitā* – for improving memory (Sharma & Dash, 1985):

वक्ष्यन्ते कारणान्यष्टौ स्मृति यैरुपजायते ।
निमित्तरुपग्रहणात् साद्रश्यात् सविपर्ययात् ॥ शा ।स्था ॥१ ।१४८ ॥
सत्त्वानुबन्धादभ्यासाज्ज्ञानयोगात् पुनः श्रुतात् ।
द्रष्टश्रुतनुभूतानां स्मरणात् स्मृतिरुच्य ॥ शा ।स्था ॥१ ।१४९ ॥

Vakṣyante kāraṇānyaṣṭau smṛtiryairupajāyate.
Nimittarupagrahaṇāt sādrśyāt saviparyayāt. śā.sthā..1.148.
Sattvānubandhādabhyāsājjñānayogāt punaḥ śrutāt
Draṣṭaśrutanubhūtānāṁ smaraṇāt smṛtirucya. śā.sthā..1. 149.

Memory is nothing but the remembrance of things directly perceived, heard (from scriptures) or experienced earlier. Hence the following are the eight factors that bring about a good memory:

1. Knowledge of cause (of a thing and event etc.)
2. Knowledge of form (e.g. based on an earlier experience)
3. Knowledge of similarity. (e.g. on seeing a son one remember his father having similar form)
4. Knowledge of contrast (e.g. having seen an ugly form one remembers a beautiful form)
5. Concentration of mind
6. Repetition
7. Attainment of metaphysical knowledge, and
8. Subsequent partial communication of an event.

The above mentioned techniques would improve the memorizing and retrieving capacity of an individual based on the following methods:

a) Deepening perception: Unless all channels of contact with the external world (namely the five sensory pathways) are functioning optimally, some aspects of perception will be lost or blunted. The first step, then is to increase the sensitivity of the pathways. Stimulations (through *kriyās*) and relaxation (*śavāsana*, *prāṇāyāmas*,) and indeed any yoga practice can do this.

b) Reducing distractibility/increasing the attention span: Yogic exercises aim at reaching (ultimately) a state of mental transcendence. One of the aspect of this state is to have the ability to alter one's mental functions at will. Even if this super-awareness stage is not attained, some measure of mental control is certain, which allows a person to direct his attention to the materials which has to be memorized to the exclusion of other thoughts.

c) Shifting useful memories from useless for our overall development: Memory development should ideally help us to reach the very source of our thoughts and our existence (in yogic lore *Ānandamaya kośa*). One of the ways in which this can occur is if constructive, useful memories are retained, whereas purposeless ones, which generate displeasure and ill will, erased.

This should help the individual to grow and hence aid in building a positive environment, and a harmonious society.

3.1.9 Influence of aging on memory

According to ancient scriptures, advancement in age has been positively correlated with higher planes of sādhanā, provided, an individual sincerely attempts to grow in the plane of spiritual evolution. That is the way one gets liberated from the cycles of birth and death. Otherwise, the factors influencing memory take an upper hand and the individual loses the descrimination as already discussed elsewhere.

The process of involution is well-described in *Kaṭhaopaniṣad* (Chinmayananda, 2002) as:

यच्छेद् वाङ्मनसी प्राज्ञस्तद् यच्छेज्ज्ञान आत्मनि ।
ज्ञानमात्मनि महति नियच्छेत् तद् यच्छेच्छान्त आत्मनि ॥ कठोपनिषद् १.३.१३ ॥

Yacched vāṅ manasī prajñastad yacchaejjñāna ātmani,
Jñānamātmani mahati niyacchet tad yacchecchānta ātmani.

(Kaṭha. U. 1.3.13).

A wise person makes all his organs go back into the mind, the mind into the enlightening intellect, the enlightening intellect into the Collective Intellect [i.e., the Great Self, Hiraṇyagarbha], and all Collective Intellect into the Pure Self.

This is possible only when an individual is with his true Self.

यस्तु विज्ञानवान्भवति युक्तेन मनसा सदा ।
तस्येन्द्रियणी वश्यानि सदश्वा इव सारथेः ॥ कठोपनिषद्: १.३.६ ॥
Yastu vijñānavānbhavati yuktena manasā sadā,
Tasyendriyaṇī vaśyāni sadaśvā iva sāratheḥ.. (Kaṭha U.: 1.3.6).

When a person has a discriminating intellect and has that intellect always joined to a mind that is under control, and his senses are also under control, then he is like a charioteer who has well-trained horses to handle.

यस्तु विज्ञानवान्भवति समनस्कः सदा शुचिः ।
स तु तत्पदमाप्नोति यस्माद् भूयो न जायते ॥ कठोपनिषद्: १.३.८ ॥
Yastu vijñānavānbhavati samanaskaḥ sadā śuciḥ,
***Sa tu tatpadamāpnoti yasmād bhūyo na jāyate.* (*Kaṭha U.:* 1.3.8)**

The person who has a discriminating intellect and also has a controlled mind is always pure [in thought, speech, and action]. Such a person is sure to attain his goal [of Self -knowledge]. [Having once attained that goal]he will not be born again[i.e., be subject to birth and death again].

Those who are covered by *avidyā* (ignornce), would face difficulties in all aspects of life, the reason behind it is illustrated through the śloka mentioned below:

यस्त्वविज्ञानवान्भवत्ययुक्तेन मनसा सदा ।
तस्येन्द्रियाण्यवश्यानि दुष्टाश्वा इव सारथेः ॥कठोपनिषद्: १.३.५ ॥

Yastvavijñānavānbhavatyayuktena manasā sadā,
Tasyendriyāṇyavaśyāni duṣṭāśvā iva sāratheḥ. (Kaṭha U.: 1.3.5)

If the intellect is incapable of discriminating between right and wrong and is also connected with an uncontrolled mind, it is like a charioteer who has to deal with uncontrollable,vicious horses.

Ultimately, he whose intellect, like a good charioteer, takes him along the right path, whose mind is under the control of the intellect, and who, by virtue of such a combination, can direct his senses as he thinks best, he can go to the other side of the world where he attains the highest goal, union with the Cosmic Self.

विज्ञानसारथिर्यस्तु मनः प्रग्रहवान्नरः।
सोऽध्वनः पारमप्नोति तद्विष्णोः परमं पदम्॥ कठोपनिषद्: १.३.९॥

Vijñānasārathiryastu manaḥpragrahavānnaraḥ,
So'dhvanaḥ pāramapnoti tadviṣṇoḥ paramaṁ padam. (*Kaṭha U. : 1.3.9)*

तां योगमिति मन्यन्ते स्थिरामिन्द्रियधारणाम्।
अप्रमत्तस्तदा भवति योगो हि प्रभवाप्ययौ॥ कठोपनिषद्: २.३.११॥

Tāṁ yogamiti manyante sthirāmindriyadhāraṇām,
Apramattastadā bhavati yogo hi prabhavāpyayau. (Kaṭha U.: 2.3.11)

According to the yogins, the state in which all the organs are at complete rest is yoga. In fact, a yogin never makes a mistake [for instance, he is not attracted by sense pleasures because he is one with the Self]. But this yogic state may have its fall just as it has its rise.

Power of memory for salvation:

एतत्तदेकमयनं मुक्तैर्मोक्षस्य दर्शितम्।
तत्त्वस्मृतिबलं येन गता न पुनरागताः॥ शा।स्था॥१।१५०॥

Etattadekamayanaṁ muktairmokṣasya darśitam.
Tattvasmṛtibalaṁ yena gatā na punarāgatāḥ.. śā.sthā..1.150..

अयनं पुनराख्यातमेतद्योगस्य योगिभिः ॥
संख्यातधर्मैः सांख्यैश्च मुक्तैर्मोक्षस्य चायनम् ॥ शा । स्था ॥१ ।१५१ ॥

Ayanaṁ punarākhyātametadyogasya yogibhiḥ.
Saṅkhyātadharmaiḥ sāṅkhyaiśca muktairmokṣasya cāyanam..
śā.sthā..1.151..

The power of metaphysical memory constitutes the best way of liberation,as shown by the liberated ones. Persons following this waydo not come back to wordly traps. This is again the best way to the attainment of yoga (communion with God) as well as mokṣa (salvation). This is what the *yogins*, the virtuous ones, the followers of the *Sāṁkhya* system,and the liberayed ones say.

In summary the ancient descriptions suggest that the spiritual growth should be the final goal of an individual. During this process different faculties such as perception, memory etc. have to be used optimally to hasten this process.

3.1.10 MEMORY ACCORDING TO PRESENT DAY NEUROSCIENCE

3.1.10.1 Definition of memory

Memory is defined as the process or processes of storing and preserving newly acquired information for later recall. Otherwise it's also referred to the process of recalling a specific experience or the total collection of remembered experiences stored in an individual's brain (Crooks & Stein, 1991).

3.1.10.2 Process of memory

Memory involves three processes viz., **encoding, storage and retrieval**.

Encoding involves perceiving a particular stimulus and then translating or coding the information so that it can be stored easily. This involves establishing associations or links between the new facts and what is already known.

Storage is the process by which encoded material is retained over time in an individual's brain's 'memory bank'. The efficiency of storage depends on the effort put into encoding or organizing the incoming information.

Retrieval is the final step in the process of remembering. Retrieval depends on encoding and storage. The efficiency in encoding and storage determines the ability to retrieval.

3.1.10.3 Types of memory

Atkinson and Shiffrin (1968) have described three distinct memory systems that allow an individual to process, store, and recall information.

(i) ***Sensory memory*****:** This system involves no active organization or encoding of information. The information which first comes through the senses will be stored for a fleeting moment. This information would never enter the conscious awareness because of its transitory nature.

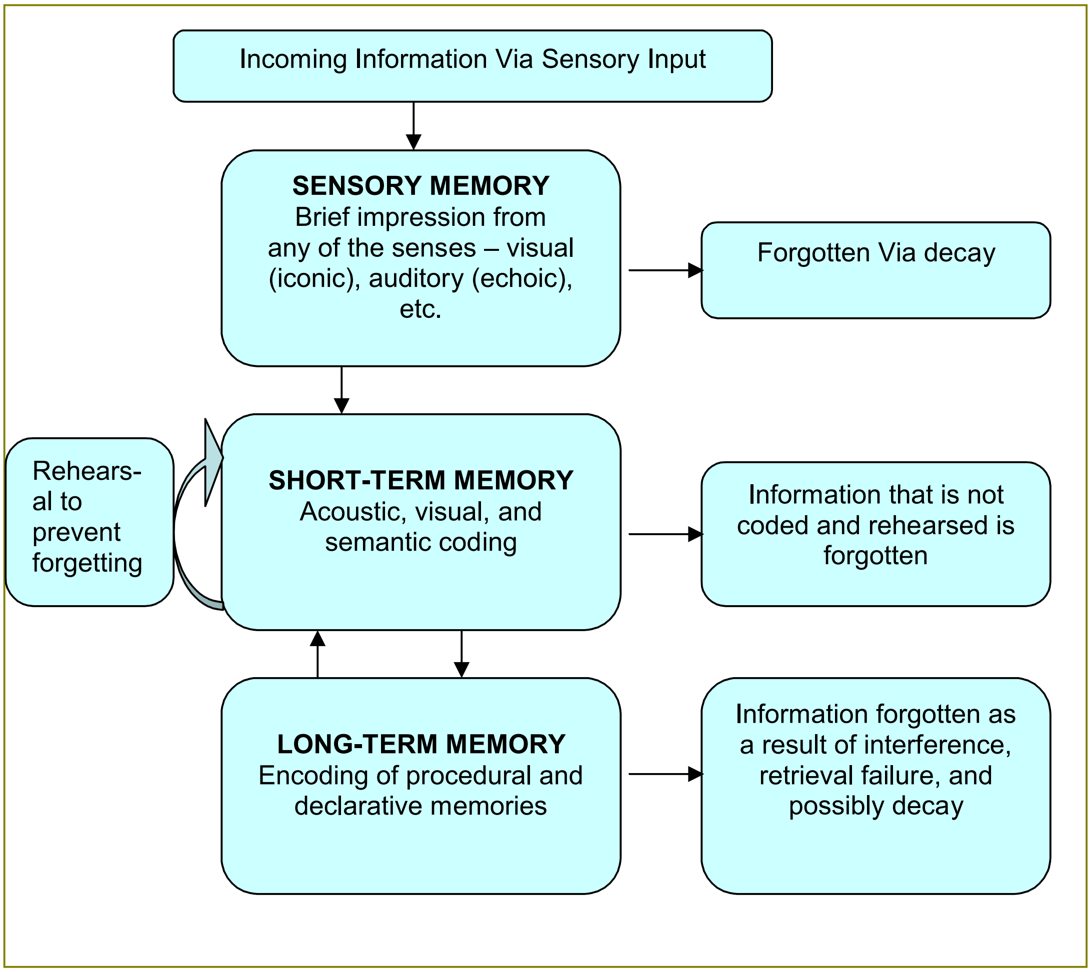
(ii) ***Short term memory:*** This comprises immediate recollection of stimuli soon after one perceives it. This system allows temporary storage of information. Unless one repeatedly reinstate the information it will probably be retained only momentarily, perhaps for no more than twenty seconds (Brown, 1958; Muter, 1980).

(iii) ***Long-term memory*** implies what generally memory means. Any information transferred from short-term memory to long-term memory may remain in storage for minutes, hours, days, perhaps even a lifetime. The retrieval of information from long-term memory involves the passage of short-term memory too.

Figure 3.1.10.3 illustrates schematically how information flows into and among these three memory systems.

A systems-based concept of memory described five forms of memory, (Tulving, 1983). The five forms are: (i) *procedural memory* referring to memory for skills; (ii) *perceptual representation of systems* involved in the identification of objects and underlying the phenomenon of perceptual ‘priming’; (iii) *semantic memory* concerning acquisition and use of general knowledge; (iv) *short term memory* involving retrieval of information from consciousness and (v) *episodic memory* which refers to memory for personal events encoded in a special temporo-spatial context. This ordering of memory systems corresponds to their presumed developmental sequence in both a phylogenetic and an ontogenetic sense. Procedural memory is thought of as the earliest system to develop, while, episodic memory is thought to be the latest. Another way of subdividing human memory is the distinction between explicit and implicit memory (Graf & Schacter, 1985). In this view, explicit memory involves conscious recollection of information, an example being episodic memory. In contrast, implicit memory does not require deliberate retrieval of an episode, an example being perceptual priming. The systems-oriented view of memory as well as explicit and implicit memory has been mentioned above. According to the process-oriented view, differences of the type between explicit and implicit memory may be explained by the different processes which individuals use while performing different memory tasks. This may be data driven processing versus conceptually driven processing; conscious recollection versus familiarity.

Figure 3.1.10.3: Schematic representation of how information flows into and among these three memory systems



3.1.10.4 The process of forgetting

The process of forgetting can be attributed to (i) Decay of the memory trace, (ii) Problems with interfering material, (iii) A breakdown in the retrieval process, (iv) Emotional and motivational conditions and (v) Organic factors.

3.1.10.4A Decay of memory trace: Fading away of a memory trace (the neurochemical and/ or anatomical changes in the brain which encode memories) has been speculated to be responsible for the process of forgetting. However, a number of psychologists believe that decay is partially responsible for forgetting. Decay may be responsible to loose information in the short-term memory, but that any information in long-term memory is stored permanently and failure to recall it is due to a retrieval difficulty (Tulving, 1977).

*3.1.10.4*B *Interference*: There is evidence that forgetting is probably influenced by the experiences that occur either before or after learning something new interferes with existing memories. The possible two types of interference are: Retroactive and Proactive.

Retroactive (or backward) interference occurs when later event interferes with recall of earlier information. In Proactive (or forward) interference earlier learning interferes with later learning.

3.1.10.4C Retrieval failure: Failure to recall information may be due to inaccessibility because either it is poorly encoded in the first place or because of inadequate retrieval cues. Forgetting long-term memories often reflect a failure of retrieval cues rather than decay or interference.

3.1.10.4D Motivated forgetting: Some times the long-term memories are forgotten once they are no more required to be remembered. People often push certain kinds of memories out of conscious awareness because they are too embarrassing, frightening, painful or degrading to recall.

3.1.10.4E Organic causes: Forgetting is not usually caused by organic pathology. However, certain physical illnesses or accidents can alter the physiology of the brain. Memory deficits caused by organic factors may be of three kinds: amnesia caused by disease (impaired brain circulation, Alzheimer’s disease, etc.);

retrograde amnesia (loss of recall for events occurring just before a brain trauma); and anterograde amnesia (inability to recall information processed after brain damage).

3.1.10.5 The physical basis of memory

3.1.10.5A Memory and the brain

The ability to recall is linked with most of the higher brain functions which place man at the top of the evolutionary scale. For example, perception is a complex ability which first of all involves receiving sensory information (i.e. sensation). However, much more than that is needed for perception, since it involves the significance of that sensory information, and for this we often draw upon our stored facts (i.e. memories). This can be easily understood with an example. The ways in which the brain undergoes change to make remembering take place, are amazing. Broadly, two types of changes can occur:

SHORT TERM MEMORY	LONG TERM MEMORY
1. Information is retained long enough for the mind to grasp it.	**1.** Information is stored for retrieval much later.
2. Is represented by a dynamic change in activity of neurons (the function changes)	**2.** Is represented by a structural change in neurons (the actual structure changes)

:

3.1.10.5B Parts of the human brain involved in memory

Remembering' is linked with the activities of the different parts of the Central Nervous System.

(i) Cerebral Cortex: From a comparative examination of the nervous systems of different organisms from fish, right up to man, it is easily apparent that the limbic system (which governs our emotions and instincts) remains roughly the same. However, in Man and in some extent in monkeys there is a tremendous ' mushrooming' of the cerebral cortex which surrounds the limbic system. Since the cerebral cortex is the real ' seat' of higher faculties - intelligence, creativity, what difference does this make to behavior?

It is easy to understand that in all species the behavior is a product of instincts and of reasoning. Hence, while instinctual behavior is common throughout (from insects up to Man) the ability to learn rises sharply with Man. Complex reasoning appears to be linked to the expanded cerebral cortex. Behavior in Man can be largely modified by thinking, reasoning, and memories.

Parts of the cerebral cortex involved in learning and memory:

An early psychologist, Karl Lashley (1950) in his paper "In search of the engram" described engram as another word for memory trace. He conducted experiments on rats, surgically removing portions of the cerebral cortex and checking whether they were still able to learn to find their way in a maze (i.e. maze learning). He concluded that the part of the cortex which was removed was of no importance. All parts had equipotentiality. However, what was important was the volume of cortex removed. This was based on observation that after a particular percentage of cortex was removed, the rats made significantly more errors.

a) Temporal lobe: The Canadian neurosurgeon, Wilder Penfield, electrically stimulated the brains of conscious epileptic patients to check for any abnormal brain tissue, and the functions which its removal might endanger. The patients were under local anaesthesia and were thus conscious throughout the procedure. When Penfield probed a region of the temporal lobe, one patient heard a voice singing, and remembered the name of the song, another saw himself talking to his friends somewhere else. Hence this part seems to be related to long term memories.

b) Frontal cortex: This has been imaginatively called the 'character cortex' because it determines the code of conduct and ethics. It is also important for our creativity, ability for abstraction, and anticipation. Experiments on chimpanzees showed that removal of this part of the cortex caused a deficit in the ability to learn a particular task. This task involved showing the chimp a peanut, then placing the peanut under one of two identical cups. After this, an opaque screen was lowered for a few minutes between the animal and the cups. Finally the screen was lifted and the animal was allowed to look for the peanut. A normal chimp would unerringly select the correct cup. However, after frontal lobectomy, the brief interval during which the screen was lowered was sufficient for the chimp to forget which the correct cup was, and hence the chimp would inevitably make errors.

These experiments showed that the frontal lobe is important for facts to be stored for future retrieval. Nowadays, two factors are specially important.

This part of the brain is believed to help in channelising the attention, hence the frontal lobectomised animal has increased distractibility or a reduced attention span. Also the frontal cortex may be playing a role in erasing redundant information, hence after frontal lobectomy we can imagine that a "chaotic overcrowding" of information occurs.

(ii) Hippocampus: The name hippocampus is derived from its curving shape, which reminded some early neuroanatomist of a sea horse, and another of a ram's horn. The link between this part of the brain and the memory was dramatically established by the unfortunate removal of the hippocampus on both sides, as a therapeutic intervention in a patient, who had intractable epilepsy. This resulted in an almost total loss of recent memory, while long term memory was intact. Hence the hippocampus appears to be important for the imprinting of permanent memory, but, not storage of long term memory.

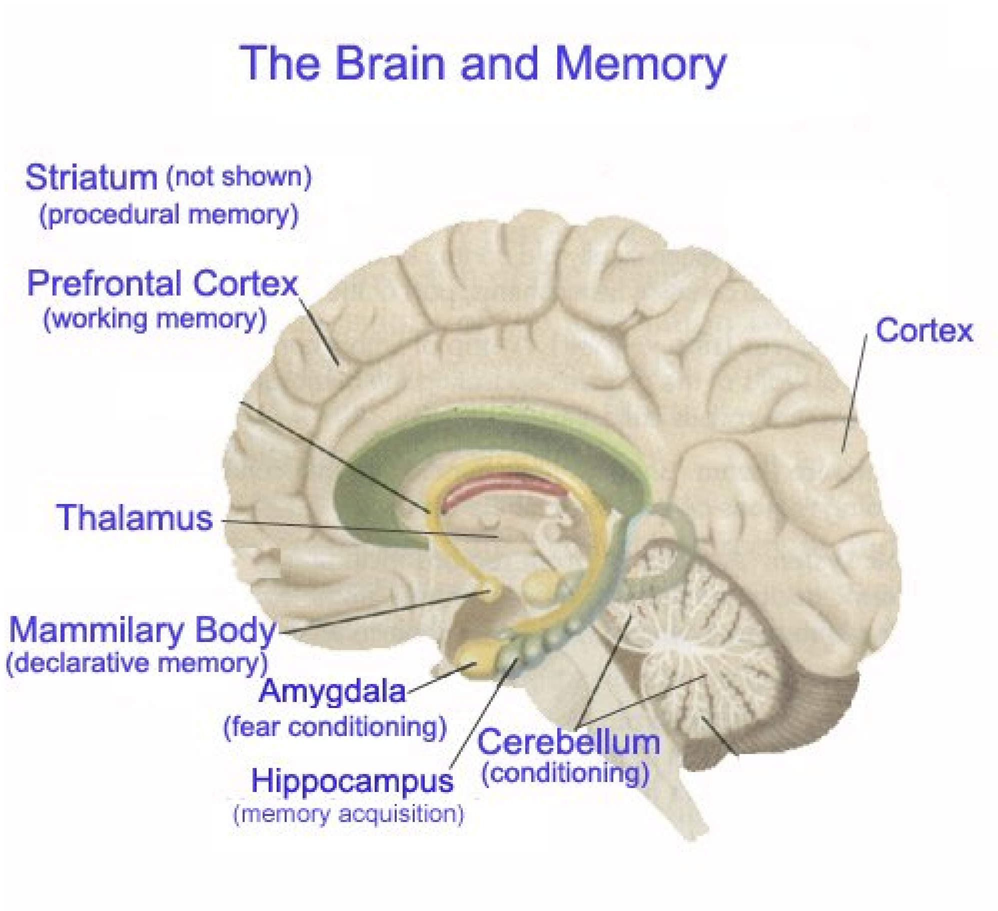
(iii) Parts of the Basal Cholinergic Forebrain System, and the Amygdala:

It is well known that as we grow older, we often get more forgetful. Our distant memories remain remarkably clear and can be recalled in great detail, however, more recent memories are compromised. The aging process (and the pathological process in senile dementia) is known to involve certain regions, especially the basal forebrain system of the brain which may be related to memory deficits. The amygdala is part of the brain related to emotional responses.

(iv) Mammilary Bodies (Hypothalamus): The hypothalamus controls all the essential functions and determines homeostasis (internal balance). In Korsakoff's psychosis (a permanent memory defect resulting from vitamin B deficiency) post mortem studies showed pathological changes in the hypothalamic mammilary bodies.

(v) Reticular Activating System

This network of the neurons and their fibers extends throughout the brainstem. The most rostral part (midbrain) has been the zone of consciousness, as any injury here causes coma. This Part of the midbrain plays a vital role in attention.



3.1.10.5C Memory and changes in nerve cells:

Distinct changes can be observed in nerve cells during the process of remembering. They are:

(i) Changes in their activity pattern

(ii) Changes in their shape/form

(iii) Chemical changes

(i) Activity pattern: In 1970s, Bliss and Lomo in London reported studies in the intact, anaesthesised rabbit. They recorded the nerve cell response to a single current shock, and then they gave a brief stimulus of shocks at high frequency. They recorded the response to a single shock again, and found that the response was much greater than that obtained initially. This phenomenon is called long term potentiation (LTP). Nerve cells communicate with one another at sites of close proximity called synapses. Some views suggested that LTP involved the pre-synaptic nerve cell (by releasing more of the messenger chemical, the neurotransmitter). Other views suggest that the post synaptic nerve cell changes (increased receptor binding sites, for example).

(ii) Changes in form/structure: Nerve cells change considerably with every experience. In a nerve cell, the dendrites are the receptive zone. Electrical signals are summed up and integrated here, so that the nerve cell produces its own message (as an electric signal). This electric signal is sent along its axon (the conducting zone) to reach some other nerve cell.

It has been shown experimentally that when rats are trained to perform a task their receptive zone (i.e., dendrites) increases. There is a huge increase in the dendritic branching. Also, on dendrites there are minute conical projections (spines) which are the actual site of synaptic contact with learning, spines increase in number. Hence, after learning a nerve cell has a far greater area to receive signals. Also after learning a nerve cell has a far greater area to receive signals (i.e., it is more receptive and sensitive) then when it was "naive".

Eric Kandel and colleagues at Colombia University have worked out the mechanism for two phenomena at a microscopic level. The two phenomena are:

1. Habituation: Decrease in behavioral response during repeated presentation of a stimulus.

2. Sensitization: The enhancement of a reflex response by the introduction of a strong or noxious stimulus.

c) Chemical changes in neurons with learning and memory.

In 1962, James McConnell trained planaria, (small flatworms), to turn away from light. Taking advantage of the cannibalistic properties of these worms, he cut up the trained worms and fed them to untrained worms. He wanted to check if this group will learn their task more quickly than another group fed untrained planaria. When he observed similar results, he reasoned that memory must be stored chemically and can be transferred. Hence, it is evident from the description given above that specific regions of the brain are involved in learning and memory. There is evidence that learning produces change in the activity patterns of the neurons in their structure, and also in their chemical constituents.

In summery, evidence from several sources indicates that structural changes take place in the synapses between neurons when long term-term *memories are coded. Changes in dendrites branching of certain groups of neurons have been shown to result from specific kinds of training. Extensive evidence suggests that memories are, in the main, represented by large networks of neurons distributed over broad portion of cortex. The hippocampus and amygdala are necessary for memory consolidation, particularly when it involves the transfer of declarative information from short-term memory to long-term memory. The thalamus also appears to be involved in memory consolidation.*

3.1.10.6 Techniques to improve memory

Many memory experts draw an analogy between long term memory and set of file cabinets or the card catalog in a library. Encoding information for storage is like numbering books or files, storing them in specified places, and using index cards to provide cues or access codes. The better we organize our file systems, the more quickly access information and the longer we can remember it. Therefore a key to efficient long term memory is meaningful organization of material. A number of memory systems or mnemonic device can help to do this (Bower, 1970; Nield, 1987). The appropriateness or effectiveness of various mnemonic devices outlined here varies from task to task.

(i) Clustering: is a mnemonic device that involves grouping items into categories (Bousfield, 1953; Buschke, 1977; Forrester & King, 1971; Thompson et al., 1972) For example, to memorize the following shopping list:

Cheese	Candle	Banana
Corn	Green beans	Apple

Biscuits	Broom	Carrot
Grapes	Milk	Shampoo

These 12 items, if treated separately, include about five too many chunks for your short term memory. Thus you can probably forget trying to hold them in STM by repeatedly rehearsing the list all the way to the grocery store. If you treat the item as separate, without trying to organize the list in some meaningful way, your LTM recall is also likely to prove inadequate for the task. A far easier method is to cluster or group the items under four subcategories; dairy items, fruits, vegetables, and house hold products. Remembering four categories each with three items is a much more manageable task.

(ii) Method of Loci: The method of loci, developed by the early Greeks, involves forming mental associations between items one wish to recall and specific locations along a designated route one might travel (loci means locations or places in Latin).

(iii) Narrative Story: Another way to remember information is to organize it into a narrative (Wall & Routowicz, 1987). The story does not need to be particularly logical or plausible; it simply has to place items within a meaningful frame work. For example, suppose you want to remember the five explanations for why we forget, interference, organic amnesia, decay of the memory trace, retrieval failure, and motivated forgetting. The following narrative provides one possible way to encode this information.

(iv) The Peg-Word System: The peg-word system involves first learning a series of words that correspond to a sequence of number. Each word and corresponding number represents a peg in the system.

For example: One is a bun

Three is a tree

These associations would facilitate one to remember number of articles/things in an easy manner.

(v) Acrostics are sentences in which the first letter of each word serves as a cue for recalling specific information.

(vi) Acronyms are another memory system. Meaningful arrangements of letters that provide cues for the recall of material constitute acronyms.

3.1.11 Conclusion

The above compilation suggests that the defination of memory and process involved it are in line with that of the present day neuroscience. Though, it is evident that memory declines with aging (above sixty years), the ancient scriptures looks at it in a different viewpoint. Spiritual evolution should accompany aging according to scriptures. It is the goal and special abilities, such as memory would facilitate this process.

3.2.1 **General:**

Aging is a progressive, predictable process that involves the evolution and maturation of living organisms. Aging is inevitable, but the rate of aging varies greatly among individuals. This process in the human being results from the complex interplay of physiological, psychological and social factors (Rao, 1994). Different terms are used to indicate this process. The term ‘longevity’ refers to ‘given the current environment and culture, how long can an individual expect to live?’, while the term ‘life span’ suggests the maximum time a person could live, given favorable living conditions (Medina, 1996). Hence, the average life span (or life expectancy) has been described as the age at which fifty percent of a given population survives, and the maximum life span potential is the longest any member of the population lives. The average life span of humans has increased dramatically, yet the maximum life span potential has remained essentially constant at 90-100 years.

The word *senescence* is derived from the Latin word *senex*, meaning "old man" or "old age". *Cellular senescence* is a phenomena where isolated cells demonstrate a limited ability to divide in culture. *Organismal senescence* is the aging of organisms. Organismal aging is generally characterized by the declining ability to respond to stress, increasing homeostatic imbalance and increased risk of disease. Because of this, death is the ultimate consequence of aging.

Aging, in the sense of senescence, is a progressive loss of adaptability of an individual organism as time passess. As an individual grows older the ability to react adaptively to challenges from the external (injury and infection) or internal environment (arterial occlusion and malignant cell clones) declines. Since the homeostatic mechanisms become less sensitive, less well sustained, sooner or later everyone encounters a challenge which they are unable to deal with effectively and the person dies. Hence the rise of death rate with age has been recognized as the hallmark of senescence.

The branch of medicine that is concerned with the aging process; the prevention, diagnosis, and treatment of health problems in the aged; and the social and economic conditions which influences the health care of the elderly is called geriatric medicine. Arbitrarily, an aged or elderly population is defined as persons aged sixty/sixty-five years or older.

3.2.1.1 Demographic profile of the elderly in developed and developing countries:

The world's elderly population is currently growing at a rate of 2.4 per cent per year, considerably faster than the global total population. One of the major features of demographic transition in the world has been the considerable increase in the absolute and relative numbers of elderly people. Elderly populations of developing countries are now growing more rapidly than those in industrialized nations (Shrestha, 2000) due to the decline in fertility rates combined with an increased life expectancy of people achieved through medical interventions, behavioral and other life style modifications (Kalache, & Keller, 2003). In 1975 the majority of the world's elderly resided in more developed regions. However, more than fifty-nine percent of the persons aged sixty-five years and older now live in developing countries. In the coming decades, the distribution of the world's elderly will continue to shift considerably, with a growing proportion residing in developing countries (sixty-seven percent by 2020) (Shrestha, 2000). The United Nations defines a country as 'aging' where the proportion of people over sixty reaches seven percent. It is anticipated that by 2020 there will be a global elderly population of 698 million, more than double the current size of the entire North American population, so that the proportion of elderly in the worlds' population will increase from 5.3 percent to 9.6 percent.

3.2.1.2 Regional dimensions:

Asia has the highest number of elderly persons i.e., 217 million. China alone has 87 million people (6.8 percent of its population), and this is expected to increase to 167 million (11.5 percent) by 2020. All developing regions have elderly populations that are less than seven percent of their total population. Asia, Latin America and the Caribbean have the highest proportion of elderly people at 6.4 percent and 5.4 percent respectively (Shrestha, 2000). Among developed countries, Japan has the highest number of elderly persons. The proportion of population aged sixty five and older, in selected regions across different years is given below:

Table L1. Dynamics of Population Aging in the Modern World
Observed and Forecasted of the Elderly (65+years) in Selected Areas, Regions and Countries of the World: 1950, 2000 and 2050.

Major Areas, region and country	1950	2000	2050
World	5.20%	6.9%	19.30%
Africa	3.20%	3.30%	6.90%
Latin America and the Caribbean	3.70%	5.40%	16.90%
China	4.50%	6.90%	22.70%
India	3.30%	5.00%	14.80%
Japan	4.90%	17.20%	36.40%
Europe	8.20%	14.70%	29.20%
Italy	8.30%	18.10%	35.90%
Germany	9.70%	16.40%	31.00%
Sweden	10.30%	17.40%	30.40%
U.S.A.	8.30%	12.30%	21.10%

Source: United Nations World Population Prospects: The 1998 revision, Volume 1: comprehensive tables (New York: United Nations Secretariat, 1998).

3.2.1.3 Life expectancy:

As mentioned elsewhere, the average life span (or life expectancy) is the age at which fifty percent of a given population survives, and maximum life span potential is the longest any member of the population lives. The average life expectancy at birth in the less developed regions stands at sixty-five years, seventeen percent lower than the average of seventy-six years in more developed countries. On an aggregate regional basis among developing regions, life expectancy at birth is highest in two regions: Latin America and the Caribbean and Asia and the trends are projected to remain so beyond 2020 (Shrestha, 2000). The average life expectancy of Japan has reached eighty years, the highest level of any major country of the world and several other developed nations (Australia, Sweden, Canada, and Switzerland) have achieved levels of seventy-nine years, women outlive men by five to seven years in every developed nation. Maintaining an earlier trend, but exacerbated by the HIV/AIDS epidemic, the lowest life expectancy continues to be in Africa. However, world wide women are expected to live longer than men.

3.2.1.4 The major cause of death:

The cause of death in the developed countries has shifted from infectious and parasitic diseases to chronic, degenerative diseases such as cardiovascular disease and cancer. In the developing regions the focus is still on infectious and parasitic diseases (Preston, & Martin, 1994) but the prevalence of degenerative diseases has been progressively increasing.

3.2.1.5 Demographic profile of elderly in India:

India is a subcontinent that carries fewer than fifteen percent of the world's population. However, this is gradually undergoing a demographic transition, with decline in fertility and mortality rates as a result of many factors including specific developmental programs (Das, & Kapur, 1995) resulting in a progressive increase in the number of elderly persons. The life expectancy was around thirty-two years in 1947; improvement in public health, and medical services has led to the substantial control of infectious diseases which translated into a significant decrease in mortality rates. Life expectancy at birth has increased steadily. Improved sanitation, better maternal health and improvement in child care facilities have reduced infant mortality rate significantly. Acceptance of family planning measures reduced fertility rates. In the year 2000 the crude birth rate was around twenty-five percent while the crude death rate was less than nine percent. The shape of the population pyramid has changed from a wide-base-narrow-tip to a barrel shaped form. In modern India, for all practical purposes people above sixty years are considered to be ‘senior citizens’. In academic research, retirement age is often taken as an index of aged status and hence a chronological age of 60 years is considered as the beginning of old age (Indira, 1999).

According to the definition of the United Nations a country is said to be 'aging' where the proportion of people over sixty reaches seven percent. India (by the year 2000) has already exceeded that proportion (7.7 percent) and is expected to reach 12.6 percent by 2025.

3.2.1.6 Present scenario and future projection:

The Indian aged population is currently the second largest in the world. The absolute number of ‘over sixty’ population in India would increase from seventy-six million in 2001 to one hundred and thirty seven million by 2021.

The old age dependency ratio has increased from 9.8 percent in 1951 to 11.9 percent in 1981 and further to 12.6 in the year 2001. This suggests that the burden of a larger group of older people will have to be borne by a relatively smaller working group of younger adults. Tables L2 and L3 give details about the changes that have taken place in the last few decades with respect to the percentage of population aged sixty plus years based on their place of residence and the sex ratio (Sharma, & Xenos, 1992).

Table L2: Percentage decadal increase in the population aged 60 years and over

Years	Population Aged 60 +		
	Rural	Urban	Total
1951-1961	22.66	26.28	23.25
1961-1971	30.03	45.17	32.39
1971-1981	25.93	50.75	29.97
1981-1991	23.28	52.71	28.94
1991-2001	29.56	68.61	38.46

Table L3: Growth of elderly population aged 60 and over, by sex, in India 1901-2001

Year	Population 60+ (in millions)		
	Person	Males	Females
1901	12.06	5.50	6.56
1911	13.17	6.18	6.99
1921	13.48	6.48	7.00
1931	14.21	6.94	7.27
1941	18.04	8.89	9.15
1951	19.61	9.67	9.94
1961	24.71	12.36	12.35
1971	32.70	16.87	15.83
1981	43.98	22.49	21.49
1991	55.3	28.23	27.07
2001	75.93	38.22	37.71

Source: Sharma, S.P. & Peter Xenos. 'Aging in India: Demographic Background and analysis based on census materials', Office of the Registrar General and Census Commissioner, India. New Delhi, 1992.

These findings suggest that the population aged sixty years is progressively increasing in urban areas compared to rural areas and there will be more women than men aged seventy years in rural areas compared to urban areas. The distribution of widowed persons aged sixty plus years based on place of residence and sex suggests that females continue to dominate the numbers and the rural population would have more widowed men and women compared to the urban population. The working group in the elderly belonging to both sexes is increasing and the trends are expected to continue further. In men, the working class from 8.4

million has gone up to 14.3 million by 2001 and a similar trend is observed in women.

3.2.1.7 Health status of the elderly in India:

The leading cause of death in the elderly has been changing from infectious diseases to non-communicable diseases. Presently cardiovascular diseases are the major contributors (Roy, 1992). According to an Indian Council for Medical Research report, the number of blind persons among older population was around eleven million in 1996, and eighty percent of them were due to cataract (Angra, Murthy, Gupta, & Angra, 1997). Nearly sixty percent of the older population has reported hearing loss. The consequences of these problems are not limited to physical disability, but also impinge on economic, social and psychological domains of the affected individual's life (Kacker, 1997). Hypertension, diabetes and stroke are the other prevalent health problems in the elderly (Dalal, 1997). Age related changes in the immune system have rendered people susceptible to a variety of tumors. Though tuberculosis related mortality has declined, the prevalence rate is still higher in old age (Dey, & Chaudhury, 1997). Disabilities arising from aging assume greater significance as a large segment of this population still remains below poverty line. A recent report suggests that there were seventeen million disabled people in India in 2001. The prevalence of mental morbidity among the elderly was estimated at 8.9 percent. The risk of specific psychiatric illness has been shown to increase with age (Rao, & Madhavan, 1983). Senile dementia of the Alzheimer type has been increasing and the neurotic disorders and late life depression represent the bulk of total mental morbidity (Rao, 1997). The major psychosocial problems faced by the elderly population are the following: (i) isolation from the main stream of life, (ii) loss of independence, (iii) inability to socialize, (iv) tendency to be pitied by others and (v) easily distractible thought processes. A recent survey states that ninety-three percent of the elderly population has emotional stress, eighty percent are depressed, ninety percent feel lonely and eighty percent feel that they are neglected. Old women face more poverty and poor health compared to men and are more vulnerable (Vineetha, 2000).

3.2.2 Theories of Aging:

The aging process has been ascribed to different mechanisms by multiple theories such as free radical damage (Harman, 1994), a decline in immune surveillance (Walford, 1969), molecular cross linking (Bjorksten, 1968), a decline in the level of melatonin secretion (Roiter, & Robinson, 1995), neuroendocrine substratum of gonadal failure (Stumpf, & Sar, 1976) and senescence of genes in the DNA (Hayflick, 1987).

According to the free radical damage theory, aging is described as an integrated phenomenon. Although the causes of aging are heterogeneous and incompletely understood (Harman, 1991), some common principles have been suggested. Cannon (1939) proposed integration as one such principle. This integration or interconnectedness of physiological systems may underlie and explain theories of aging that have been advanced (Bjorksten, 1968; Hayflick, 1987; Medvedev, 1990; Warner, Butler, Sprott, & Schneider, 1987). This theory suggests that damage due to ubiquitous oxygen-free radicals (e.g., superoxide) and non-radical oxidants (e.g., hydrogen-peroxide) is a fundamental physiological process of aging related deterioration. Moreover, it has been suggested that free radical activity or oxidative stress may be accelerated by psychosocial stress (Adachi, Kawamura, Takemoto, 1993; Scarpellini, Sbracia, & Scarpellini, 1994; Schneider, Nidich, Salerno, Sharma, Robinson, Nidich, & Alexander, 1998).

The decline in immune surveillance theory suggests that as age advances the humoral as well as cell-mediated immunity declines. Also, it has been shown that the anti body response will be impaired particularly in response to tetanus toxoid and influenza viral antigens (Kishimoto, Tomino, Mitsuya, Fujiwara, & Tsuda, 1980; Barker, Mullooly, 1980).

The theory of neuroendocrine mechanisms describes the influence of neuroendocrine control of the gonads, adrenal and thyroid glands on the aging process. Accordingly the hall mark of aging has been proposed as 'menopause/ andropause'. A depletion of the nerve growth factor (NGF) has been proposed to play a central role in aging of the central nervous system (Heffi, Hartikka, & Knuel, 1989). NGF is produced by the cholinergic neurons arising from the nuclei in the basal forebrain which has efferents to the hypothalamus, hippocampus, limbic system and the cerebral cortex (Stanley, 1994). In senile dementia of the Alzheimer type these neurons have shown signs of degeneration. Also, with advancing age the levels of dehydroepiandrosterone (DHEA) and melatonin steadily decline. The decline in melatonin has also been regarded as a triggering factor for senescence (Roiter & Robinson, 1995).

Senescence of genes in the DNA has been postulated as a probable cause of aging. Alexis Carrel, the father of tissue culture, formulated the first paradigm of modern gerontology. He hypothesized that cells can be immortal if given an ideal environment which was later disproved by Hayflick (1987). Hayflick stated that aging is an intrinsic cellular process. A programmed synthesis of a senescence factor occurs as the cells age. This factor inhibits DNA repair and replication (Rener, & Nordone, 1980). Later Smith and Lumpkin (1980) proposed the loss of gene repression activity as a theory of cellular senescence.

3.2.3 Concept of Healthy Aging:

Human aging is a highly complex and variable experience that is influenced by numerous factors, intrinsic and extrinsic to the individual. Healthy aging is described as a state of low risk and high function in contrast to usual aging which is a non-pathologic state but at high risk (Rowe, & Kahn, 1987). It was reported that healthy aging has three main components: (a) a low probability of disease and disease-related disability, (b) a high capacity for cognitive and physical functioning, and (c) an active engagement with life including interpersonal relations and productive activity (Rowe, & Kahn, 2000)

The usual aging and the problems associated with it are may be preventable and even reversible. Recent research indicated that with appropriate interventions, many processes associated with aging can be slowed, or even reversed. For example, carbohydrate intolerance, osteoporosis and high blood pressure, all correlates of usual aging, can be modified by behavioral and life style interventions such as exercise, diet, and stress reduction (Schneider, Alexander, Salerno, Robinson, Fields, & Nidich, 2002). Similarly, neurobehavioral aging, including cognitive decline was said to be not inevitable (Finch, 1987). According to gerontological experts, the health care and self care strategies likely to be effective in facilitating the transition from usual to successful aging are interdisciplinary approaches that include behavioral, nutritional, biomedical and other interventions (Committee on a National Research Agenda on Aging–Division of Health Promotion and Disease Prevention, 1991; Rowe, 1991; Steel, 1997; Swan, 1999).

3.2.3.1 Complementary and Alternative systems of healing and healthy aging:

As mentioned elsewhere, the process of aging includes both physiological and psychosocial components. It appears that health care strategies that effectively (i) reduce the chronic consequences of psychosocial stress and oxidative stress, (ii) improve internal stress resistance and recovery, and (iii) improve and simultaneously promote balance and homeostasis among integrated physiological systems can be used as important measures for minimizing usual aging and achieve successful aging. Such strategies are now employed using Complementary and Alternative Medicine (CAM) for geriatric care. The most commonly used CAM by the older adults have been reported as chiropractic medicine, herbal remedies, relaxation techniques, megavitamins and religious or spiritual healing (Foster, Phillips, Hamel, & Eisenberg, 2000). Another report describes the use of herbal remedies (ginkgo biloba and ginseng), vitamins, music therapy, touch massage therapy, and neurofeedback in older adults with implications for improved cognitive functions (Adams, Gatchel, & Gentry, 2001). However, it is interesting to note that the use of CAM among the aged is dependent on education (those with higher education use CAM more often) and gender (females use more CAM than men) (Astin, 1992).

3.2.4 Health Problems in the Elderly

3.2.4.1 General:

In most of the developing world a decreasing mortality rate, healthier life styles and advances in medical technology and in public health have prolonged the life span but not the health span of an individual. This has contributed to an increasing number of individuals with chronic conditions especially in the elderly. Despite improvements in health measures, however, some leading causes of extreme concern for the elderly have not changed appreciably in the past few decades. In fact these problems are attributing to the high mortality rate in the elderly. The major diseases whose prevalence and severity have been increasing with advancing age include coronary heart disease, stroke, cancer, dementia, osteoporosis, and musculoskeletal disorders (Alliance for Aging Research & American Federation for Aging Research, 1995; Perry, 1999).

Another natural consequence of aging is diminished perceptual sensitivity especially visual and auditory perceptions (Medina, 1996). Also, aging has been accompanied by a well documented increase in the incidence of infectious diseases (Fein, 1999; Gavazzi & Krause, 2002) due to immune senescence (Miller, 1996). The state of dysregulated immune function following aging contributes to increased susceptibility of elderly persons to infection and possibly to autoimmune disease and cancer (Pawelec & Solana, 1997).

3.2.4.2 Physical problems:

Age related changes in the skin resulting in wrinkling and sagging are due to changes in the epidermis, decreased connective tissue collagen and brittle elastin fibers. Also, the reduced activity of the sweat and sebaceous glands makes the skin dry and rough (Whitbourne, year). These changes have been shown to heighten the risk of medical problems such as dermatitis and pruritis (Klingman, 1989). Chatterjee and Choudhuree (1991) have shown that hand grip strength is negatively correlated with age in the elderly. Falls in older people are an important but often overlooked problem. One third of people aged over sixty-five years and older fall each year and half of those in their eighties fall at least once a year (Campbell, Reinken, & Allan, 1981). Falls are the most common cause of injury in the elderly and may result in institutionalization and disability (Tinetti & Williams, 1997; Donald & Bulpitt, 1999). The most common precipitating factors include gait and balance disorders, weakness, dizziness, visual impairment, confusion and postural hypotension (Rubenstein, Josephson, & Osterweil, 1996). The normal gait and balance involves a network of neural connections and centers regulated by peripheral and internal feedback mechanisms. Aging can lead to six physical changes that affect the basic gait and balance: (i) stiffening of connective tissue, (ii) decreased muscle strength, (iii) prolonged reaction time, (iv) decreased visual acuity and depth perception, (v) impaired proprioceptive sensation and (vi) increased postural sway (Rubenstein & Trueblood, 2004). Hence individuals with gait and balance disorders will have one or more of the following problems: pain, joint movement limitation, muscle weakness, spasticity, loss of sensory input or a dysfunction in central processing. The osteoporotic changes in the bones make elderly individuals more prone fractures (Ricklefs & Finch, 1995).

3.2.4.3 Psychological problems:

Depression and cognitive impairment are the most important mental health problems in an elderly population. Both conditions have severe consequences including diminished quality of life, functional decline, increased use of services and high mortality rates (Macdonald, 1997). Depression has been found to be associated with the presence of one or more chronic diseases (Schwab, Traven, & Warheit, 1978) as well as disability including days in bed and days away from normal activities (Murrel, Himmelfarb, & Wright, 1983). Insomnia is another associated problem in the elderly. In a National Institute of Aging study over 9,000 persons aged 65 and above belonging to both sexes reported at least one chronic sleep problem (Foley, Monjan, Brown, Simonsick, Wallace, & Blazer, 1995). Several processes may interfere with sleep and wakefulness in the elderly (Bliwise, 1993; Neubauer, Smith, & Earley, 1999). Among them are acute and chronic medical illness, medication effects, psychiatric disorders, poor sleep habits and circadian rhythm shifts. Loss of sleep or chronic use of sedative medication may lead to falls and accidents.

Age related changes are seen in two brain areas associated with memory i.e., (i) the frontal lobe which controls certain executive memory processes and (ii) the hippocampus, leading to the deterioration of explicit memory capacities. Also, it is evident that both short-term and long-term memory changes as one gets older. Most of the problems are caused not by an irreversible loss of a specific fact, but from impaired retrieval mechanisms (Medina, 1996). Elderly persons are more prone to amnesia, a neurological syndrome characterized by a deficit in learning new information and this does not appear to be secondary to any other behavioral incapacity (Milner & Teuber, 1968). Another age-related neurodegenerative disorder which affects the process of memory is Alzheimer's disease. An elderly person with Alzheimer's disease has been shown to have an initial, profound amnesia for recently experienced events (Corkin, 1982) and dementia develops subsequently leading to multiple impairments in higher cognitive functions (Nebes, 1989). Anxiety is another major psychological problem associated with aging. The major cause of anxiety in the elderly can be attributed to the psychosocial problems affecting that age group i.e., (i) isolation from the mainstream of life, (ii) loss of independence, (iii) an inability to socialize, (iv) the tendency to be pitied by others and (v) easily distractible thought processes (Macdonald, 1997).

3.2.5 Use of Complimentary and Alternate Medicine in Geriatric Care:

3.2.5.1 Studies on the use of yoga in geriatric care:

3.2.5.1A General: Yoga is an ancient, Indian science which has evolved over thousands of years. It deals with the physical, mental, moral and spiritual wellbeing of an individual (Iyengar, 1968). The earliest systematic description of this practice was in the classic treatise the "Yoga Sutras" of Patanjali, dating back to 900 B.C.

(Taimini, 1986). This pragmatic description enumerates eight stages of yoga, which if practiced systematically allows one to attain a state of super consciousness (*Samadhi*). Yoga techniques include physical postures *(asanas)*, voluntarily regulated breathing *(pranayamas)*, internal cleansing techniques (*kriyas*) meditation, and philosophy.

According to Yoga philosophy, human life span has been divided into three stages (*avasthas*): (i) childhood (*balya*), (ii) adulthood (*prouda*) and (iii) old age (*vruddha*). A disciplined way of living and regular practice of yoga throughout the first two stages decides the nature of the last stage. *Hatha Yoga Pradipika*, an ancient yoga text prescribes several techniques to prevent and manage the problems related to aging and attain immortality (Mukthibodhananda, 2001).

The earliest studies on Yoga in the 1920s, evaluated the effects of specific practices using sophisticated methods of that time (e.g., X-rays) (Kuvalayananda, 1925). Subsequently, there were a series of studies on abilities of yogis to voluntarily regulate involuntary functions (Wenger, Bagchi, & Anand, 1961; Anand & Chhina, 1961; Anand Chhina, & Singh, 1961; Kothari, Bordia, & Gupta, 1973). However, the first widely publicized study was carried out on Transcendental meditation, which showed that this technique induces a 'fourth major state of consciousness', distinct from the wakeful state and two stages of sleep (Wallace, 1970; Wallace, Benson, & Wilson, 1971). Further research has increased the awareness that Yoga is a very useful mind-modifying technique with potential applications in the promotion of positive health, prevention and treatment of disease, as well as in rehabilitation.

Normal volunteers were shown to have a better sense of well-being following ten months of yoga physical postures (Ray, Mukhopadhyaya, Purkayastha, Asnani, Tomer, Prashad, Thakur, & Selvamurthy, 2001). Bera and Rajapurkar (1993) have shown that one year yoga training in school students can improve ideal body weight, bone density and cardiovascular endurance along with a significant reduction in fat fold and body circumference measurements. Another study reported the effects of a combination of practices (s*hanthi kriya*) on psychophysiological variables in eight middle aged healthy male volunteers. Following one month of training, there was a significant decrease in body weight, increased alpha activity of the brain, increased oral temperature and decreased respiratory rate suggesting that a combination of yoga practices including breathing and relaxation can induce a hypermetabolic state with calm mental state (Satyanarayana, Rajeswari, Rani, Krishna, & Rao, 1992).

Practicing yoga has also been shown to improve sensory perception in volunteers across diverse age groups. Some of these observations were based on studies of auditory evoked potentials, which demonstrated that specific components occurred sooner, following yoga practices such as *pranayamas* (Telles, Joseph, Venkatesh, & Desiraju, 1992) or meditations (Telles, Nagarathna, & Nagendra, 1994). There was also improved performance in the temporal (frequency) component of the critical flicker fusion frequency assessment (Ramana Vani, Nagarathna, Nagendra, & Telles, 1997; Manjunath & Telles, 1999). Another measure of visual perception which has been shown to improve following yoga was the perception of geometric illusion (Telles, Nagarathna, Ramana Vani, &

Nagendra, 1997). The error or degree of illusion was less following yoga training. Apart from sensory perception, motor skills also improved following yoga. Among these, a definite improvement was shown to occur in static motor performance or the ability to hold the hand steady (Telles, Hanumanthaiah, Nagarathna, & Nagendra, 1994). Tweezer dexterity, a measure of fine motor skills also improved, which further showed a positive correlation with motivation to learn yoga (Manjunath & Telles, 1999). Other abilities which were shown to improve following yoga are chiefly related to cognitive tasks, which includes spatial memory (Naveen, Nagarathna, Nagendra, & Telles, 1997), verbal memory (Manjunath & Telles, 2004), planning (Manjunath & Telles, 2001) (based on the Tower of London test), and maze learning (Telles, Vempati, & Reddy, 2000).

Yoga has also been used to improve the psychological wellbeing of an individual. The antidepressant effect of rhythmic hyperventilation at different rates of breathing (*Sudarshan Kriya Yoga* or SKY) was studied in a prospective, open, clinical trial (Janakiramaiah, Gangadhar, Naga Venkatesha Murthy, Harish, Subbakrishna, & Vedamurthachar, 2000). This study compared the benefits of SKY with two standard treatments, viz. electroconvulsive therapy and imipramine, on untreated depressives. Even though it is not possible to conduct a double blind trial using yoga as one of the interventions (Singh, Wisniewski, Britton, & Tattersfeld, 1990) the results suggested that SKY produced lesser benefits than electroconvulsive therapy but could be considered as a potential alternative to drugs in melancholia, as a first line of treatment.

3.2.5.1B Yoga and geriatric care: It is evident from the above mentioned literature that yoga can bring about psychophysiological effects as well as therapeutic benefits. However, the literature is very limited with respect to yoga and geriatric care. Few attempts have been made to understand the effects of yoga in an elderly population and the studies are reviewed below.

In a randomized control trial the long term effects of exercise were compared with yoga on the physiological (Blumenthal, Emery, Madden, Coleman, Riddle, Schniebolk, Cobb, Sullivan, & Higginbotham, 1991) and psychological (Blumenthal, Emery, Madden, Schniebolk, Walsh-Riddle, George, McKee, Higginbotham, Cobb, & Coleman, 1991) functioning of older men and women. One hundred and one older persons (fifty men and fifty-one women) aged above sixty years were randomly allocated to one of three conditions: aerobic exercise, yoga or a wait-list control group. They were assessed for their physiological and psychological functioning at baseline and after four months and following a semi-crossover design after eight months. This was followed by a six month optional exercise intervention given to all subjects and they were assessed again after fourteen months. For the first four months each group received their respective intervention (no intervention in the case of the wait-list control group). For the next four months all subjects from the three groups were given aerobic exercise and the last six months of aerobic exercise training was optional for the subjects of all three groups. Subjects in the aerobic exercise group practiced thirty minutes of continuous bicycle ergometry at an intensity equivalent to seventy percent maximum heart rate reserve determined at the time of an initial bicycle exercise test, and fifteen additional minutes of walking, mild jogging, and arm ergometry exercises. A ten minute warm-up period and five minute cool down period consisting of stretching and light calisthenics preceded followed each aerobic exercise session. The subjects of the yoga group participated in sixty minutes of non-aerobic yoga exercises two times per week. It has to be noted that the authors have used yoga as a control for group support, attention and social stimulation. The wait-list control group was given no intervention. The results after four months suggested that aerobic exercise improved peak VO_2 max and anaerobic threshold and reduced low density lipoprotein cholesterol. Also, the depression scores were reduced and the mood improved in men. The yoga and wait-list control groups showed no change. The results of the next four months during which all groups participated in aerobic exercise training showed that there was a significant improvement in peak VO_2 max and anaerobic threshold in all the groups along with an increase in low density lipoprotein. Since the last six months of aerobic training was optional, those who did participate showed lower sub-maximal heart rates and significantly longer times on the bicycle than the subjects who had not exercised. They also showed improvements in their lipid profile (increased levels of high-density lipoprotein).

Haber (1983) in an earlier study showed that yoga can be used as a preventive health care program for the elderly. Sixty-one white and forty-five low-income black elders at two community centers participated in a ten week yoga program. They were assessed at the end of the program and the results were compared with an equal number of control subjects assessed at their respective communities. Yoga was practiced under supervision once a week and rest of the days they were asked to practice on their own. The white elders who attended classes regularly and practiced yoga on their own on a daily basis showed improvements in their psychological well-being and lowered their systolic blood pressure compared to the control group. Black elders on the other hand attended the once-a-week classes regularly but did not practice on their own on a daily basis, and showed no improvement in psychological wellbeing nor did they reduce their systolic blood pressure. It was inferred that low income minority elders need more frequent contact. A subsequent study (Bowman, Clayton, Murray, Reed, Subhan, & Ford, 1997) evaluated the influence of yoga and aerobic exercise on the baroreflex sensitivity in twenty six elderly (age range 62-81 years) normotensive, healthy subjects. Following a six week intervention, the twelve elderly subjects of the yoga group showed a significant reduction in the heart rate, increase in the VO_2 max, and an increase in the alpha index of the baroreflex sensitivity at high frequency power. The fourteen elderly subjects of the aerobic exercise group showed a significant increase in the VO2 max alone. It was inferred that six weeks of yoga can induce signs of physiological rest in an elderly population.

The role of yoga in improving auditory perception in the elderly has not been studied. While the positive effects of yoga on the auditory perception are well documented (Telles, Joseph, Venkatesh, & Desiraju, 1992; Telles, Nagarathna, & Nagendra, 1994), a single randomized control trial investigated the role of two non-pharmacological interventions i.e., yoga and cognitive behavioral tinnitus coping training in the management of chronic tinnitus. Following three months of the respective interventions, the patients of the cognitive behavioral tinnitus coping training group expressed more satisfaction compared to the yoga group (Kroner-Herwig, Hebing, Van Rijn-Kalkmann, Frenzel, Schilkowsky, & Esser, 1995).

3.2.5.2 Studies on exercise and geriatric care:

Scientific studies which explored the influence of exercise on the health of an elderly population have suggested that exercise can improve measures of fitness in older adults, particularly strength and aerobic capacity (Buchner, Beresford, Larson, LaCroix, & Wagner, 1992). In a longitudinal study, 197 elderly women aged over 60 years belonging to two groups (regular exercise or a no intervention control group) were studied before and after a twelve month experimental period (Lord, Ward, & Williams, 1995). The intervention group participated in an one hour exercise session, two days per week for one year, while the control group continued with their regular activities. After twelve months of exercise training there was a significant improvement in reaction time, lower limb muscle strength and body sway measures which suggested an improved physical functioning in an elderly population. Cambell and others (1997) have studied the effectiveness of an individually tailored home based exercise program in reducing falls and injuries in elderly women aged above 80 years. In a one year follow up study, they have shown that a home based strength and balance retraining exercise program can improve the balance scores and the performance on a chair stand test compared to a control group who received social visits by a nurse four times a week. The positive effects of an exercise program on the physical health of an elderly population has been contradicted by another report (Reinsch, MacRae, & Lachenbruch, 1992) which showed no improvement in balance, strength or fear of falling in 230 elderly subjects who had undergone either a one year exercise program, cognitive behavioral training or remained as a control group.

The beneficial effects of an exercise program in an elderly population are not limited to the physical wellbeing alone but also extend to the psychological wellbeing.

Several studies have reported the positive effects of exercise on the depression scores in an elderly population compared with either a no-intervention control group or an established treatment modality. Hess-Homeler (1981) in her doctoral thesis reported that twenty volunteers from a community home, following an eight week exercise program (jogging or walking with the instructor, four times a week) have shown a significant reduction in the depression scores compared to cognitive therapy and no intervention control groups. A decade later McNeil and colleagues (1991) showed a clear trend of reduction in depression scores in thirty non-clinically depressed elderly people referred by religious and community organizations following a six week exercise program compared with a control intervention group (home visits by a psychology student for a 'health chat' twice a week) and a wait-list control group. A subsequent study by Singh and others (1997) on thirty-two elderly volunteers aged around seventy years who were assessed before and after ten weeks of an experimental period. They were divided into two groups, one received non-aerobic exercise (a progressive resistance training program) three times a week and the other group participated in seminars on health of elderly people twice a week. The non-aerobic exercise program group showed a significant reduction in depression scores. Hence, the authors inferred that an exercise program can be a beneficial addition to the regular activities of community dwelling elderly depressed individuals. In a quasi-experimental design, the effects of a ten week stretching exercise program on the physiological and psychological functioning of the community dwelling elderly women were evaluated (George & McKee, 1992). There were twenty-two subjects each in the experimental and control groups. The experimental group practiced stretching exercises for ten weeks while the control group received no intervention. The depression scores were significantly lower in the experimental group compared to the control group. Also, the total cholesterol, triglycerides and the percent of body fat reduced significantly following exercises. Exercise training for a longer duration (14 months) was shown to produce greater improvements among elderly with concomitant physical or emotional impairments (Blumenthal, Emery, Madden, Schniebolk, Walsh-Riddle, George, McKee, Higginbotham, Cobb, & Coleman, 1991). Another study investigated the feasibility and efficacy of unsupervised exercise as a long-term treatment for clinical depression in elderly patients. It has been shown that unsupervised exercise maintained its' antidepressant effect at twenty weeks in depressed elderly patients compared to control subjects (Lawlor & Hopker, 2001). In a meta-regression analysis of randomized control trials conducted to evaluate the effectiveness of exercise as an intervention in the management of depression, it was concluded that there is no association between the type of exercise and the variation in results between studies, indicating that aerobic and non-aerobic exercise have similar effects. However, the effects were also attributed to psychosocial factors, such as learning a new skill or socializing rather than to the exercise itself (Rubin, 1989). Though the mechanisms responsible for the reduction in depression symptoms and improved quality of sleep following exercise are not clearly understood, attempts have been made to explain them through the following mechanisms: (i) biological mechanisms, including alterations in central norepinephrine activity (Sothman & Ismail, 1984), reduced activity of the hypothalamo-pituitary-adrenocortical axis and increased secretion of beta endorphins by which exercise improves mood, but no empirical data are available to address these possibilities. (ii) Psychological mechanisms, including increased feelings of self-efficacy, improved self-concept and reduced dysfunctional or negative thought patterns were also hypothesized to be responsible for the positive effects of exercises (Blumenthal, Babyak, Moore, Craighead, Herman, Khatri, Waugh, Napolitano, Forman, Appelbaum, Doraiswamy, & Krishnan, 1999).

In a recent study conducted to evaluate the role of exercise therapy in improving the quality of sleep and to create a life style for the aging society, 11 elderly subjects suffering from insomnia were given a four week intervention of a short afternoon nap and evening 'stretch exercise' for thirty minutes. They were assessed for their sleep efficiency and general health before and after the intervention. Results suggest that following the stretch exercises preceded by a short afternoon nap, the sleep efficiency and the general health significantly improved (Tanaka, Taira, Arakawa, Urasaki, Yamamoto, Okuma, Uezu, Sugita, & Shirakawa, 2002). The authors inferred that proper awakening maintenance during the evening was effective in improving sleep quality. Another study conducted in fifteen elderly individuals (mean age ± SD, 73.1 ± 5.2 years) by the same authors suggested that exercise with moderate intensity including stretching and flexibility can reduce the time taken to fall asleep, and the time spent awake during the nights' sleep. In an earlier study (King, Oman, Brassington, Bliwise, & Haskell, 1997), forty-three elderly individuals were assessed before and after a sixteen week moderate intensity community based exercise training program (forty minutes endurance training program per week). An Equal number of subjects was studied as Wait-list controls. The sleep onset latency significantly reduced by 11.5 minutes, while the sleep duration increased by an average of 42 minutes following the intervention. The control group showed no significant change.

Physical activity was also shown to improve cognitive functions in older adults (Weuve, Kang, Manson, Breteler, Ware, & Grodstein, 2004). Accumulating evidence from both animal and human studies including small scale clinical trials, suggest that physical activity may reduce risk of poor cognition and early cognitive decline (Kramer, Hahn, Cohen, Banich, McAuley, Harrison, Chason, Vakil, Bardell, Boileau, & Colcombe, 1999; Colcombe & Kramer, 2003). Walking is one of the most common and among the most practical leisure time activity practiced by older adults (US Department of Health and Human Services, 1996). In a nurses' health study conducted over a period of 28 years the relation of long term regular physical activity to cognitive function was explored in 18,766 women aged between 70-81 years. Assessments were done using telephonic interviews which included tests for general cognition, verbal memory, category fluency and attention administered twice approximately two years apart. The results suggested an association between higher levels of activity with better cognitive performance. Participation in leisure activities has also been shown to reduce the risk of dementia in the elderly. In a prospective cohort (John & Harrison, 1997) 469 subjects older than 75 years of age residing in a community were studied. Their baseline cognitive status and presence or absence of any chronic medical illness was compared with the post assessment made after a follow-up period of 5.1 years. Results suggest that a one point increment in the cognitive activity score was significantly associated with a reduced risk of dementia. In another study, Faber and colleagues (1999) compared the effects of aerobic training and mental training on the cognitive functioning of thirty two healthy elderly individuals, who were assigned to one of the four groups: aerobic training, mental training, combined aerobic and mental training and a no intervention control group. Following two months of their respective training, there was a significant improvement in the logical memory, paired associate learning and memory quotient, while the control group showed no change either in physiological or in cognitive variables. Since the mean difference (pre and post training) in the memory quotient was significantly higher in the combined aerobic and mental training group compared to other two intervention groups, it was concluded that a combination of interventions would benefit more than individual interventions.

3.2.5.3 Studies on Tai Chi and geriatric care:

Wolf et al. (1996) have shown the positive effects of Tai Chi program compared to computerized balance training on specified indicators of frailty and the occurrence of falls in 200 elderly subjects aged above 70 years. Subjects were divided into two intervention groups and a control group. Following 15 weeks of Tai Chi practice subjects expressed less fear of falling compared to the control group and there was a significant reduction in the rate of falls by 47.5% in the Tai Chi group which suggested the use of Tai Chi as a preventive measure for reducing the incidence of falls in the elderly.

In another study, 110 healthy elderly community dwellers (mean age eighty years) were assessed to determine the effects of three months intensive balance or weight training followed by six months of low intensity Tai Chi training on balance and strength (Wolfson, Whipple, Derby, Judge, King, Amerman, Schmidt, & Smyers, 1996). After the preliminary three months training in balance, strength and balance strength interventions, all subjects received long term group Tai Chi intervention for one hour, once a week for six months. The results were suggestive of improved balance measures in the balance training group, while the balance and strength training did not show any interaction. Tai Chi training helped them to maintain the gains of earlier programs for six months without any decrement. The benefits of Tai Chi were not limited to physical wellbeing of the elderly. In another study, the effects of Tai Chi Chuan (TCC) on the autonomic nervous system modulations in twenty elderly practitioners of Tai Chi was compared with an equal number of control subjects (Lu & Kuo, 2003). The spectral analysis of the heart rate variability immediately after 30 minutes and 60 minutes of the practice suggested that there was a significant increase in the high frequency power from 22.8 to 28.2 at 30 minutes and further increased to 30.6 normalized units. In contrast, the low /high frequency ratio has decreased significantly. Also, the heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and pulse pressure have decreased significantly following the 60 minute practice. It was inferred that TCC enhances the vagal modulation in older persons and hence can be used as a health promoting form of calisthenics for older persons. Tai Chi has also been used to improve the quality of sleep and to reduce the depression scores in elderly individuals. Li and colleagues (2004), in a randomized control trial studied the role of Tai Chi on the self rated sleep quality in 118 older persons belonging to both sexes. The interventions were either Tai Chi or low-impact exercise practiced for sixty minutes for three times a week for 24 consecutive weeks. The Tai Chi participants reported significant improvements in five of the Pittsburg Sleep Quality Indices compared to the no intervention control group. The sleep onset latency has been shown to reduce by 18 minutes and sleep duration has increased by 48 minutes. Hence, it has been proposed that Tai Chi can be used as an effective non-pharmacological treatment modality to overcome sleep disturbances in the elderly.

3.2.5.4 Studies on Guided relaxation and geriatric care:

In a community based nursing study (Sloman, 2002), the effects of progressive muscle relaxation and guided imagery on anxiety, depression and quality of life in people with advanced cancer were studied. 56 cancer patients were randomly allocated to any of the four interventions viz., guided imagery, progressive muscle relaxation, combined treatment and a control group. There was a significant improvement in the depression scores and the quality of life of the three intervention groups while the control group showed no change. Another study compared the effects of individualized music with classical relaxation music on thirty nine elderly persons with Alzheimer's disease and related disorders (Gerdner, 2000). Following six weeks of respective interventions and on crossover after two weeks there was a significant reduction in agitation during and following individualized music compared to classical music.

3.2.5.5 Studies on Meditation and geriatric care:

3.2.5.5A Studies on the Transcendental Meditation (TM): The TM technique is described as a simple, natural, and effortless procedure practiced twice a day for 20 minutes while sitting comfortably with eyes closed (Roth, 1994). It requires no changes in beliefs, philosophy, religion, or lifestyle. Clinical reports indicate that this technique can easily be learned by individuals of any age, level of education, occupation, or cultural background (Alexander, 1993). During the practice of the TM technique, one's awareness gradually settles down to states of lesser excitation and is eventually experienced as remaining silently awake within itself. The attainment of this state, which is one of restful alertness, is reported by TM practitioners as an experience in which the ordinary thinking process is "transcended." This state also serves to distinguish the TM technique from other meditation and relaxation techniques that use contemplation and concentration and thus may increase mental activation (Orme-Johnson & Walton,1998).

Wallace and colleagues (1982) used a previously validated and standardized index of biological aging - the Morgan Adult Growth Examination (auditory discrimination, near-point vision accommodation, and systolic blood pressure) on 84 participants (mean age = 53 years). It was reported that long-term TM practitioners (> 5 years meditating) had a mean biological age 12 years younger than their mean chronological age. Short-term TM meditators were 5 years younger, and the non meditator controls were 2 years younger. TM groups differed significantly from age-matched controls. The study was controlled for the confounding effects of diet and exercise. Another study showed that both male (+23%) and female (+47%) TM participants had significantly higher levels of serum dehydroepiandrosterone sulfate (DHEAS), which has been shown to decline with age (Glaser, Brind, Vogelman, Eisner, Dillbeck, Wallace, Chopra, & Orentreich, 1992). In a prospective randomized controlled trial in the elderly (mean age = 81) by Alexander and colleagues (1989) it was shown that the TM group showed a mean reduction of blood pressure by 12 mm Hg over a 3-month period compared to modest change or no change for the mindfulness meditation and no-treatment control group. The survival rate was 100% for the TM group while the other groups showed 67% and 85% survival rates respectively. Schneider et al. (1995) conducted a randomized, controlled, single-blind clinical trial on 127 African Americans (average age 66 years) with mild hypertension. After a 3-month follow up period in a primary care, inner-city health center, TM intervention significantly reduced systolic blood pressure by 10.7 mm Hg and diastolic blood pressure by 6.4 mm Hg. compared to a lifestyle modification education control. A parallel progressive muscle relaxation (PMR) intervention lowered systolic blood pressure by 4.7 mmHg and diastolic blood pressure by 3.3 mmHg, but TM lowered blood pressure significantly more than PMR.

3.2.5.5B Studies on Mindfulness meditation: An attempt was made to study the impact of change in state of consciousness through specific mental techniques on extending the human life and to reverse age related declines. A randomized controlled trial compared the effects of mindfulness meditation, TM on the advanced elderly (mean age = 81 years). Over a 3-year period, the TM group improved most, followed by mindfulness training, and then by the no-treatment and relaxation groups for the following measures: paired associate learning, two measures of cognitive flexibility, systolic blood pressure, self-ratings of behavioral flexibility and aging, multiple indicators of treatment efficacy, and mental health after 18 months. After 3 years, survival rate for TM was 100% followed by mindfulness meditation (87.5%) in contrast to mental relaxation (65%) and no treatment (77%). The baseline survival rate for the 478 nonparticipating elderly was 62.5%. A separate study demonstrated the anti-depression effect of mindfulness meditation (Sun, Wu, & Chiu, 2004). In a single case study, a combination of mindfulness meditation and eye movement desensitization and reprocessing therapy was given to an elderly patient with depression, who also had trauma-derived fear of having to undergo a tracheotomy during his two weeks of hospitalization. Following the intervention the subject showed reduced symptoms of emotional distress as well as anxiety. Hence the authors have proposed the use of mindfulness meditation in specific psychotherapeutic situations in the elderly.

In summary the literature suggested the need for systematic randomized controlled trials in geriatric care with Yoga as an intervention.

3.2.5.6 Studies on Ayurveda and geriatric care:

Ayurveda (= the 'Science of Life' in Sanskrit) is also an ancient Indian discipline. It provides comprehensive knowledge about diverse aspects of health (Dev, 1999). Ayurveda considers geriatrics (*Rasayana tantra*) as one of the eight medical divisions. The classical Vedic medicine texts describe certain herbal preparations for specific diseases and other herbal preparations called *rasayanas*, which are proposed to promote general health by increasing resistance to disease, activating tissue repair mechanisms, and arresting or reversing deteriorative effects associated with aging (Sharma & Dash, 1998).

A particular rejuvenating preparation (*Rasayana Kalpa*) believed to promote positive health in older persons contains, among other constituents, the roots of *Withania Somnifera*. The roots of *Withania Somnifera* are traditionally used to promote physical and mental health, to provide defense against disease and adverse environmental factors and to arrest aging (Sharma & Dash, 1998). *Withania Somnifera* is also used to stabilize the mood in persons with behavioral disturbances. Based on this, the anxiolytic and antidepressive effects of the bioactive glycowithanolides isolated from *Withania Somnifera* roots were compared with those of the benzodiazepine, lorazepam and tricyclic antidepressant, imipramine, respectively, in rats. The herbal preparation exhibited an antidepressant effect comparable with that induced by imipramine, supporting the use of this preparation as a mood stabilizer (Bhattacharya, Bhattacharya, Sairam, & Ghosal, 2000).

3.2.5.6A Studies on herbal medicine and geriatric care:

The use of herbal medicine has been progressively increasing. Even though largest proportion of users are middle aged, it is inevitable that elderly individuals would increasingly try herbal treatment options, because herbal remedies are promoted as being effective for chronic diseases and devoid of adverse effects. *Hypericum perforatum* (St. John's Wort) has been successfully used as an antidepressant and was found to be superior compared to standard antidepressants such as imipramine, bromazepam, and diazepam (Linde, Ramirez, Mulrow, et al., 1996). The *Valeriana officinalis* (Valerian) roots are traditionally used for promoting sleep, but its influence on the sleep of the elderly is not conclusive (Stevinson & Ernst, 2000).

In summary, though there are very few studies available on the use of Ayurveda in geriatric care, other general studies suggested the possible potential benefits.

3.2.7 Summary of review of literature:

The studies cited above provide sufficient evidence to suggest that Yoga would be useful for the promotion of positive health in older persons. However, there have been no systematic trials evaluating the beneficial effects of Yoga in a geriatric population using a wide range of measures. Hence the present trial was planned using a randomized control design to evaluate the effects of Yoga and Ayurveda as compared with a Wait-list Control group on aspects of aging such as general health measures, neurological and psychological variables.

Living in an aging world requires

- ***Acknowledging older people as a valuable resource and combating aging***
- ***Enabling older people to be active participants in the development process***
- ***Providing adequate health care and health promotion for older people***
- ***Promoting intergenerational solidarity***

- The World Health Organization

4.0 GENERAL

In this thesis the changes in positive health indicators in elderly persons receiving two ancient Indian disciplines (Yoga and Āyurveda) as interventions have been evaluated and described.

4.1 SUBJECTS

4.1.1 General: 120 inmates of a residential home for the aged, over the age of sixty years belonging to both sexes were examined. Thirty of them were ill or bed-ridden. The remaining 90 persons were told about the trial, i.e., that participants would be randomly allocated to: Yoga, Äyurveda or Wait-list control groups. All of them expressed their willingness to participate in the trial and the signed informed consent of each subject was taken. 90 subjects who expressed their willingness to participate in the trial were screened using: the electrocardiogram (all leads), fasting blood glucose, Blood Pressure measurements (using sphygmomanometer), and routine clinical examination.

4.1.2 Source of subjects: The subjects recruited for the study were the inmates of Asaktha Poshaka Sabha (a residential home for the aged), V. V. Puram, Bangalore, South India **(see plate I)**. This residential home does not require the persons residing there to pay any money for their stay and other care including medical checkups and treatment.

4.1.3 Inclusion criteria: The subjects who had the following attributes were included in the study: (i) above the age of sixty years; (ii) belonging to both sexes; (iii) residing at the home for the aged for more than 6 months; (iv) healthy on a routine medical examination and on screening and (v) willing to participate in the trial by giving a signed informed consent.

4.1.4 Exclusion criteria: Subjects with the following conditions were excluded from the trial: (i) chronic ailments; (ii) disability or immobility; (iii) unwillingness to participate in the trial.

Following the detailed screening and routine clinical examination described above, subjects with the following health problems were excluded from the study: uncontrolled diabetes (seven participants), uncontrolled hypertension (four), neurological disorders (three), dementia (one), hearing impairment (five), and a detected case of non-infective Hansen's disease. Sixty nine subjects were included for the study after this screening.

4.2 DESIGN OF THE STUDY

Subjects were assessed at baseline and after three and six months of their respective interventions (Yoga, Äyurveda, or Wait-list control). See Fig. 4.2.A, B, and C.

Figure 4.2.A: Schematic representation of the design for the Ayurveda group

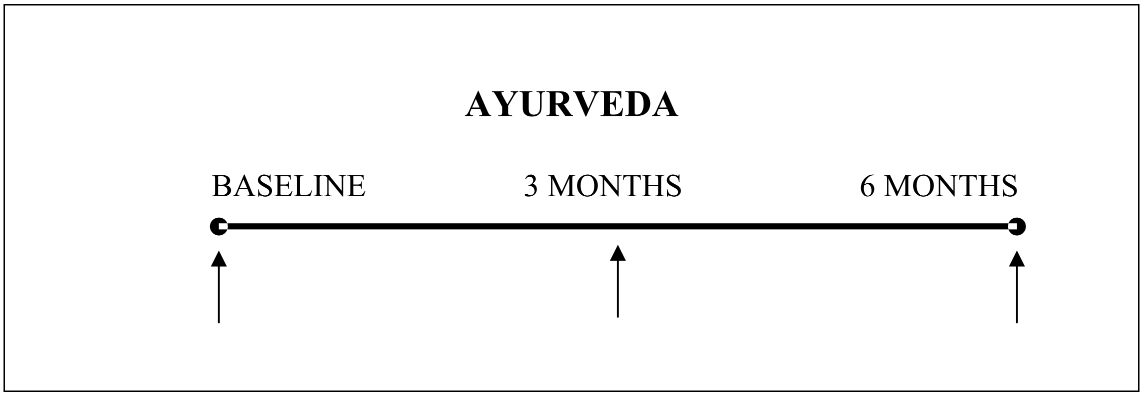


Figure 4.2.B: Schematic representation of the design for the Yoga group

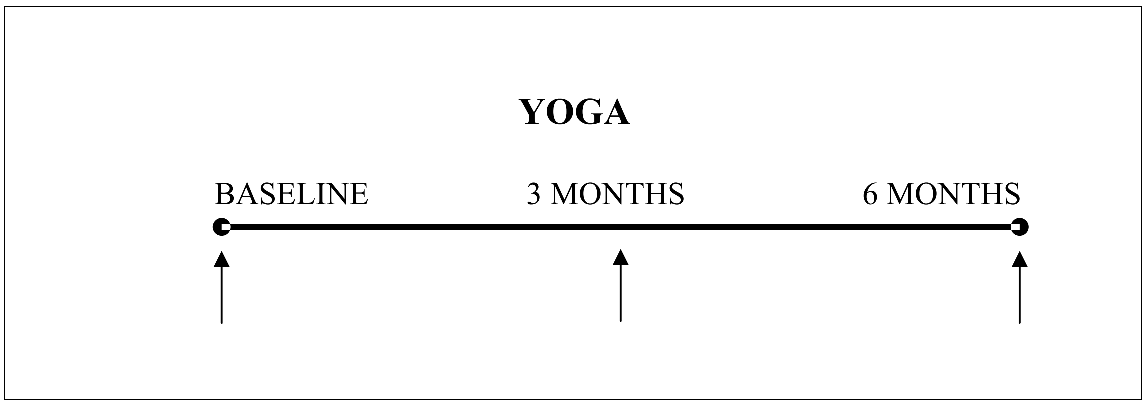
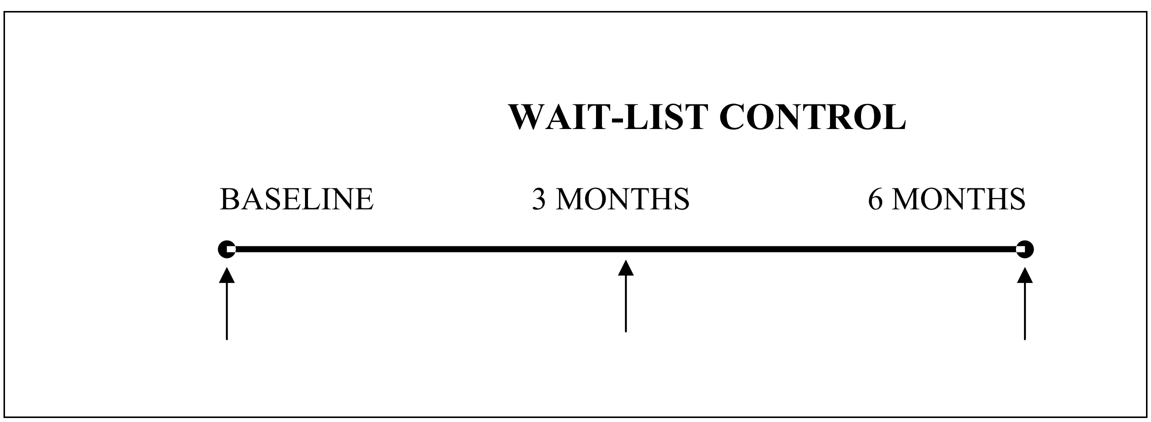


Figure 4.2.C: Schematic representation of the design for the Wait-list Control group



4.2.1 Randomization: The 69 subjects were stratified according to age [five-year intervals, e.g., between 60 and 65 years (lower limit), and between 90 and 95 years (upper limit)]. Within a particular five-year age range, subjects of each gender separately, were randomized as three groups by the investigator (i.e., Groups 1, 2 and 3) using a standard random number table (Zar, 1999). Allocation of a group to a particular intervention was carried out by the lottery method, as follows: The three interventions 'Yoga', 'Äyurveda' or 'Wait-list control' were written on three similar pieces of paper which were folded. A person who had no other part in the trial, picked up and opened the folded papers. The first intervention to be picked up was assigned to Group 1, and accordingly for Groups 2 and 3. Following stratified sampling and random allocation, there were twenty-three subjects in each group (including seven males in the Yoga group and six males each in Äyurveda and Wait-list control groups) with average ages (± S.D.) of 70.1 ± 8.3, 72.1 ± 9.0, and 72.3 ± 7.4 years, respectively. Further details of each subject such as their duration of stay in the home, reasons for staying in the home, and their general health status were noted and the details are given in Tables 4.2.1.1, 4.2.1.2 and 4.2.1.3 **(See Appendix 3)**.

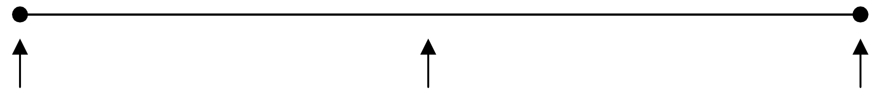
4.2.2 Ethical considerations: The protocol was approved by the Institutional Ethical Committee (IEC) of Swami Vivekānanda Yoga Research Foundation, Bangalore. The subjects were told about the aims and methods of the study and the informed consent was signed by all subjects (a sample copy is enclosed as Appendix-1). The variables measured in the present study are essentially noninvasive in nature.

4.3 VARIABLES STUDIED

All three groups were assessed at baseline, and after three and six months of their respective interventions (or no intervention in the case of the wait-list control group). In the present study a comprehensive battery of tests was designed which included different variables taken from the standard battery for the short term measurement of the rate of human aging (Comfort, 1969) and which came under three broad categories: (i) General health measures, (ii) Neurological variables and (iii) Psychological variables. The details about the rationale for using individual variables, their usefulness and limitations are given in Table 4.3. The variables studied at three and six months are schematically represented in Fig. 4.3.A and B respectively. Further details (tool used, range of operation, accuracy, units and the probable percentage of error of the tool used) of the first two categories of variables are given in Table 4.3A **(See Appendix 7)**.

It should be noted that in this thesis, the words ‘variable’ and ‘parameter’ have been used synonymously. Since parameters are described as ‘characteristics of distribution or relationships in the population which are estimated by statistical analysis of a sample of observations’, and variables as ‘measurements or attributes on which observations are made (Altman, Gore, Gardner, & Pocock, 1983) as far as possible the correct term has been used.

Fig. 4.3.A: Schematic representation of the variables studied at baseline and after three and six months



Baseline **Three months** **Six months**

Variables studied:

(i) **General health measures**
Pulmonary functions
Grip strength

(ii) **Autonomic variable**
Autonomic and respiratory variables
Wechsler memory scale

(iii) **Psychological variables:**
Geriatric depression scale
Sleep rating questionnaire

Fig. 4.3.B: Schematic representation of the variables studied at baseline and after six months

Baseline **Six months**

Variables studied:

(i) **General health measures:**
Anthropometric measurements

(ii) **Neurological variables:**
Audiometry
Heart rate variability
Tinetti balance and gait evaluation
Timed up and go

4.3.1 General Health Measures

The following variables were studied under this category: (i) Pulmonary functions, (ii) anthropometric measurements, and (iii) hand grip strength.

4.3.1.1 Pulmonary functions were assessed as there exists evidence that the lung functions are deranged due to aging (Medina, 1996). Pulmonary functions were studied using a computerized spirometer (Schiller Spirovit Sp-1, Switzerland) (**see plate II**). Subjects were asked to sit at ease. Relevant information i.e., name, age, gender, height (cm), and weight (kg) was noted and entered in the spirometer. Before each measurement the subjects were asked to breathe in and out through the mouth for three breaths. A disposable unit of the mouth piece of the spirometer was used. Instructions were given to hold the disposable mouth piece tight between the lips to avoid the leakage of air. A nose clip was used to ensure that they breathed through the mouth. Each subject was given a demonstration about how to breathe during the following measurements:

4.3.1.1A Forced Vital Capacity (FVC): Subjects were asked to take a deep inhalation followed by forceful exhalation. Since the greatest amount of air that can be expired after maximal inspiratory effort gives useful information about the strength of the respiratory muscles and other aspects of the pulmonary functions, it was clinically measured as an index of pulmonary function.

4.3.1.1B Slow Vital Capacity (SVC): Subjects were instructed to breathe normally for three rounds followed by a maximal inhalation and maximal exhalation. SVC also indicates the strength of respiratory muscle though there is no emphasis on speed of exhalation.

4.3.1.1C Maximum Voluntary Ventilation (MVV): Subjects were asked to breathe in and out rapidly for one minute (maximal rapid inhalation and exhalation). MVV measures the strength of the respiratory muscle in breathing in and out repeatedly to maximum for 30 seconds.

4.3.1.1D Minute Ventilation (MV): Subjects were asked to breathe normally for one minute. Minute Ventilation is a product of the tidal volume and the breath rate.

4.3.1.2 Anthropometric measurements: In the present study the following anthropometric measurements were included: (1) Body Mass Index (BMI), (2) Mid arm circumference, and (3) Waist-hip ratio.

4.3.1.2A Body Mass Index (BMI): The Body Mass Index or the Quetelet index was calculated from the equation: BMI = weight (kg)/square of the height (m). Body weight was measured with a beam balance accurate up to 100g to a maximum of 120kg. before eating and after voiding. The height was assessed with a measuring scale attached to a wall, perpendicular to the floor. The subjects were barefoot, standing with feet together and with head, shoulders, buttocks and heels touching the wall. The plane of the ear, mid-point of the hip bone and ankle was parallel, i.e., with the subject standing at attention. The height was then read from the measuring scale to the nearest centimeter.

Circumferences are important measurements that record the size of cross-sectional and circumferential dimensions of the body. Circumferences were measured using a measuring tape. The tape measure selected was inelastic (non-stretchable), and 0.7 cm wide. Recordings were made with the zero end of the tape held in the left hand and the remaining part of the tape held by the right hand. No tension was applied on the tape during measurements (Garrett & Kennedy, 1971).

4.3.1.2B Mid arm circumference: Mid-arm circumference is indicative of muscle mass and subcutaneous fat. The subject was asked to stand erect, with the arms hanging freely at the sides of the trunk and with the palms facing the thighs. To locate the mid point of the upper arm, the subjects' elbow was flexed to 90^0 with the palm facing upwards. The lateral tip of the acromion was located by palpating laterally along the superior surface of the spinous process of the scapula and the tip of the olecranon process was marked. The tape was placed connecting these two points and the mid point between them was marked. With the arm relaxed and the elbow extended and hanging by the side of the trunk and the palm facing the thigh, the tape was placed around the arm so that it was touching the skin, but not compressing it. The tape was placed perpendicular to the long axis of the arm at the marked mid point, and the circumference was recorded to the nearest centimeter.

4.3.1.2C Waist–hip ratio: The waist-hip circumference ratio is a measure of the distribution of subcutaneous and intra-abdominal fat. The ratio tends to increase with age and excess weight. To measure waist circumference, the subject was asked to stand erect with abdomen relaxed, the arms at the sides and the feet together. The measuring tape was placed around the bare abdomen just above the hip bone at the level of the natural waist which was the narrowest part of the torso. It was made sure that the tape was snug, but was not compressing the skin, and was in a horizontal plane. The subject was asked to relax, and on exhalation the measurement was taken to the nearest centimeter.

To measure hip circumference, the subject was asked to stand erect with arms at the sides and feet together. The measuring tape was placed in a horizontal plane around the buttocks where the circumference was maximum. The tape was in contact with the skin but did not indent it. The measurement was recorded to the nearest centimeter.

4.3.1.2D Hand grip strength: The Hand grip strength measures the muscle endurance during a sustained contraction. Hand grip strength was measured using a grip dynamometer (Anand Agencies, Pune). Subjects were tested in 6 trials, 3 for each hand alternately with 10 seconds gap between trials. During the assessment subjects were asked to keep their arm extended at shoulder level, horizontal to the ground (Raghuraj, Nagarathna, Nagendra, & Telles, 1997) and the maximum value obtained for each trail in Kilograms was recorded.

4.3.2 Neurological Variables

4.3.2.1 Autonomic and respiratory variables: It is now accepted that the autonomic nervous system can be controlled and its responses integrated and modified by the central nervous system. Compared to certain autonomic variables (namely, electrodermal activity and heart rate), respiration is a complex function, which includes striate and smooth muscle activity, ventilation, gas diffusion, pulmonary circulation, gas transport in the blood and mechanisms of breathing. However the autonomic and respiratory variables all commonly used, though their control mechanisms differ in psychophysiological investigation. A 4-channel polygraph

(Medicaid Systems, Chandigarh, India) was used to record the electrocardiogram (EKG), respiration, and skin conductance level (**see plate III**).

4.3.2.1A Skin Conductance Level (SCL): Skin conductance was recorded using Ag/AgCl disc electrodes with electrode gel (Medicon, Madras, India), placed in contact with the volar surfaces of the distal phalanges of the index and middle fingers of the left hand. A low-level DC preamplifier was used and a constant voltage of 0.5V was passed between the electrodes (Medicaid, Chandigarh, India).

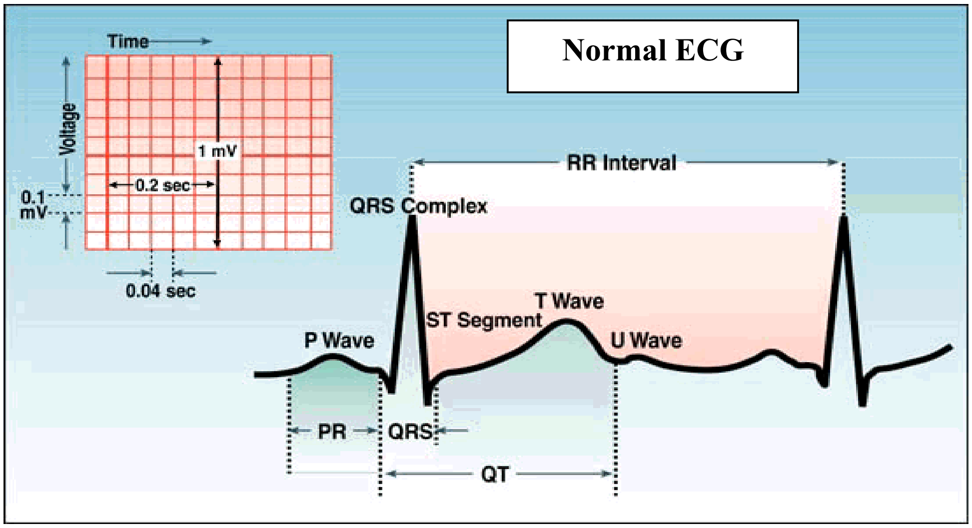
4.3.2.1B Breath Rate: Breath rate was recorded using a nasal thermistor clipped on to the more patent nostril. The nasal thermistor was connected to an AC amplifier and recordings were made with sensitivity set as required (Medicaid, Chandigarh, India).

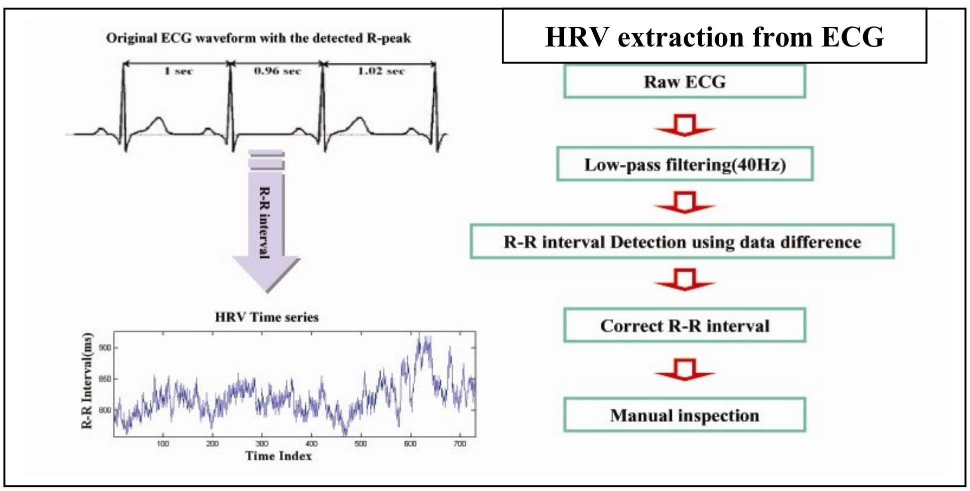
4.3.2.1C Electrocardiogram (EKG): The electrocardiogram was recorded using standard bipolar limb lead I configuration and an AC amplifier with 1.5 Hz high pass filter and 75 Hz low pass filter settings (Medicaid, Chandigarh, India).

4.3.2.1D Heart Rate Variability (HRV): The EKG was digitized using a 12 bit analog-to-digital converter (ADC) at a sampling rate of 500 Hz and stored on the hard disk of a PC (Pentium) for analysis. The R waves were detected to obtain a point event series of successive R-R intervals, from which the beat to beat heart series was computed (See Fig. 4.3.2.1D). The data recorded were visually inspected off-line and only noise free data were included for analysis. The following variables were measured

1. Low frequency (LF) power of HRV spectrum (normalized units)
2. High frequency (HF) power of HRV spectrum (normalized units)
3. Ratio of low and high frequency (LF/HF) powers

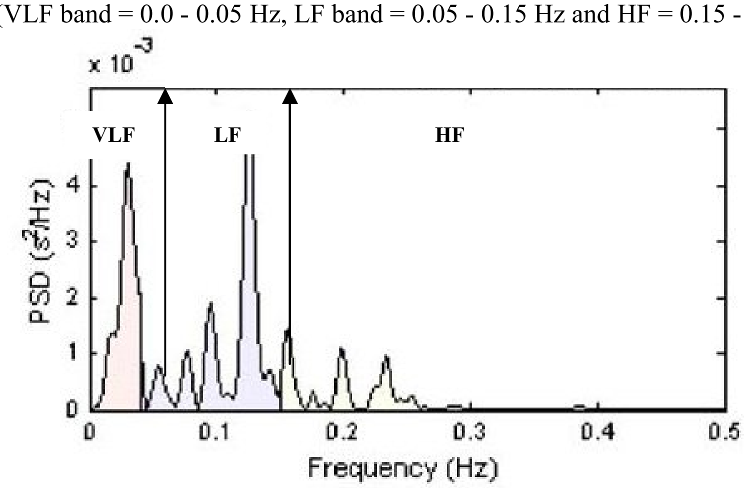
Fig. 4.3.2.1D: Heart rate variability spectrum (HRV)





Fast Fourier Transform analysis (FFT): HRV power spectrum

(VLF band = 0.0 - 0.05 Hz, LF band = 0.05 - 0.15 Hz and HF = 0.15 - 0.50 Hz)



4.3.2.2 Evaluation Gait, Balance and Mobility: For the elderly, walking without assistance requires the effective coordination of adequate sensation, musculoskeletal and motor control, and attention. As age advances beyond 70 years, the gait velocity (speed of walking) starts declining about 15 percent per decade for usual gait and 20 percent per decade for maximal gait (Medina, 1996). Balance may be defined in terms of measurable components which are needed to perform daily activities. The antero-posterior sway differences between old and young people increases when visual input or tactile–proprioceptive input is blocked or inaccurate (Wolfson, Whipple, & Derby, 1992). This suggests that in older people processing of sensory information into a postural response requires additional input, i.e., visual or tactile–proprioceptive feedback in addition to vestibular input.

4.3.2.2A The Tinetti balance and gait evaluation test: The Tinetti Balance and Gait test performs standardized evaluation of mobility and stability. Balance and gait are assessed and scored individually in a 16-item test. The Tinetti balance and gait evaluation test required the subject to be seated in a hard chair without arms as support. Different maneuvers related to balance (9 items) and gait (7 items) were tested as per the procedure required to evaluate individual items (Tinetti, 1986). Balance, the variable assessed first, was judged while sitting, arising, standing (immediate and prolonged), and turning. Additionally, maintenance of balance was tested against attempts at disruption (nudge) and without a horizon reference (eyes closed). These indicate body control and strength. In gait testing, right and left feet were evaluated separately for swing (step length) and clearance, and then compared. As per the maneuver each foot should completely clear the floor and should step completely ahead of the other foot. Comparisons included step symmetry and continuity. Additionally during walking, the path deviation, trunk stability, and stance (normal or wide-based) were also evaluated. A score of 22 or less (total 28) indicated the risk of fall.

The normal gait cycle is presented in Fig. 4.3.2.2A.

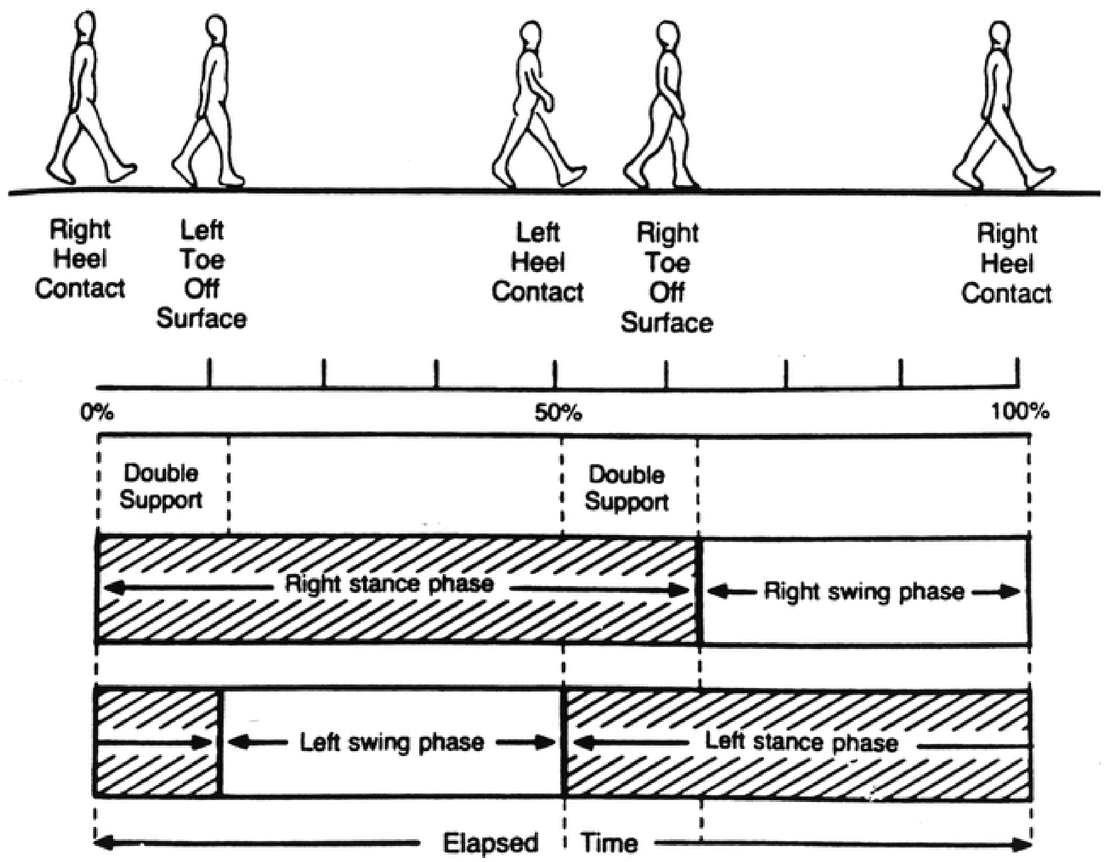
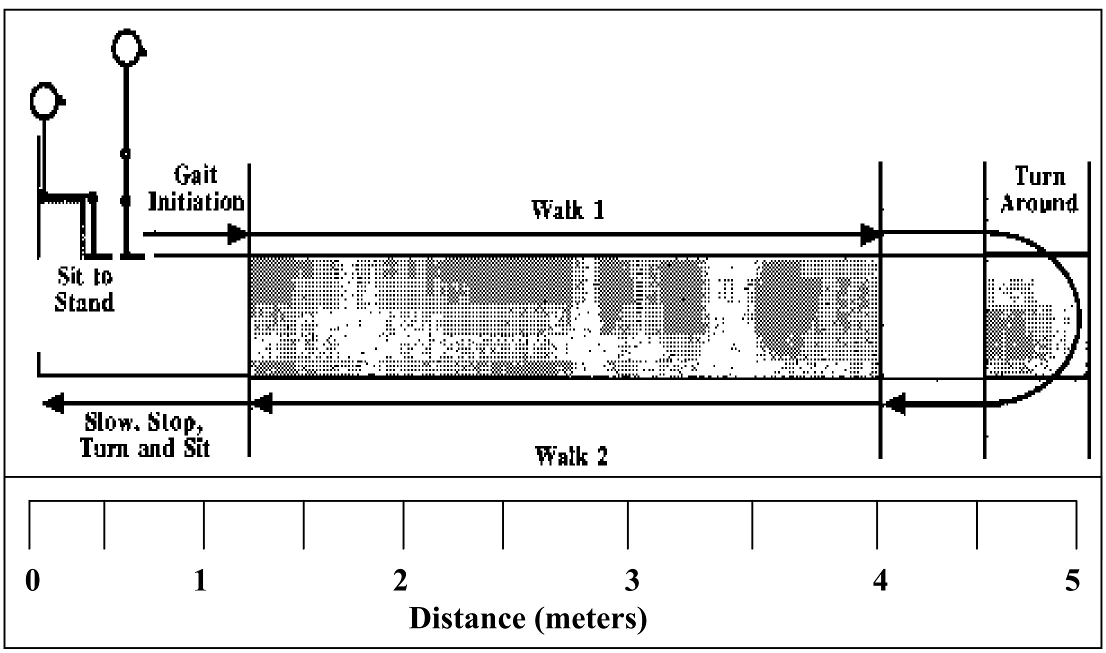


Fig. 4.3.2.2A: The normal gait cycle.

Reproduced from - Sudarsky, L. (1990). Gait disorders in the elderly. *New England Journal of Medicine*, 1441–1445. Copyright 1990, Massachusetts Medical Society.

4.3.2.2B Timed-up-and-go test: The timed up and go test measures basic mobility skills including a sequence of functional maneuvers used in everyday life. Subjects were asked to sit in a hard chair without arms for support. They were asked to get up from the chair and walk along a straight line for a distance of 5 meters at their usual pace and return to the sitting position. The time taken to get up from the chair, walk and return to the original position and the number of steps taken for the task were noted (Podsiadlo, & Richardson, 1991). The procedure of the test has been schematically represented in Fig. 4.3.2.2B

Fig. 4.3.2.2B: Schematic representation of the Timed-up-and-go test



4.3.2.3 Wechsler Memory Scale: Age related changes are seen in two brain areas associated with memory i.e., (i) The frontal lobe which controls certain executive memory processes and (ii) hippocampus leading to the deterioration of explicit memory capacities. Also, studies have shown that both short term and long term memories change as one gets older. Most of the problems are caused not by an irreversible loss of a specific fact, but from impaired retrieval mechanisms (Medina, 1996).

In the present study, the following components of memory were tested using the Wechsler memory scale i.e., (i) long-term memory and orientation, (ii) mental control, (iii) attention and concentration (digit span forward and backward), and (iv) associate learning. Assessments were made individually. Subjects were seated at ease. The answers were recorded on a separate sheet for each subject. Since the questionnaire was already evaluated for reliability and validity for Indian geriatric population the standardized English version of the questionnaire was administered in the present study.

4.3.2.4 Audiometry: The auditory acuity of the subjects was measured using a computerized audiometer (Elkon Private Ltd., Mumbai; model – EDA 3N3 PLUS) **(see plate II)**. This provided an objective measurement of the degree of deafness and of the tonal range most affected. Subjects were asked to sit in a sound dampened room. The audiometer was used to present subjects with pure tones of various frequencies through acoustically shielded ear phones. At different frequencies (ranging between 500 Hz and 12 KHz), the threshold intensity was determined and plotted on a graph as a percentage of normal hearing (Ganong, 1987).

To standardize the recording procedure and to eliminate probable differences in the frequencies heard at the testing site and a conventional speech and hearing laboratory, recordings were made first in an acoustically shielded cabin at the Richmond Clinic for Speech and Hearing, Bangalore. The same subject was then assessed in the laboratory where the study was being conducted and the hearing frequencies were compared. They were found to be comparable. Hence subsequent recordings were done at the recording site.

Subjects were assessed for the hearing threshold at the following different frequencies: (a) Low frequency (500Hz and 1.0 KHz) and (b) High frequency (6.0 KHz, 8.0 KHz and 12 KHz). The hearing threshold for each ear was determined by giving monaural tone stimuli through close fitting acoustically shielded earphones. For each frequency the intensity was raised from 10 dB to 100 dB with an increment of 10dB each time. Subjects were given a remote controlled button to press when they heard tones at different frequencies. The highest intensity detected by a subject was recorded as threshold intensity. False signaling was detected by doing the trial in the descending order.

4.3.3 Psychological Variables

4.3.3.1 Geriatric Depression Scale: As the population of people over the age of 65 years increases, more cases of late-life depression are likely to occur though depression is not a natural part of aging (Nelson, 2001). The depression symptom scores of all three groups were assessed using the short version of the Geriatric Depression Scale (GDS-S) (Sheikh, Yesavage, Raret, & Lum, 1986). This easily administered, self report inventory is a basic screening measure for depression in older adults. It consists of 15 questions to determine how subjects felt over the past week. Each item is presented in a dichotomous format. The score range was between 0 to 15, with 0 = no depressive symptoms. Based on the scores, subjects could be classified into three categories i.e., (1) scores between 0-5 as normal, (2) 6-10 as mildly depressed and (3) 11-15 as severely depressed. The questionnaire was administered individually at baseline, and after three and six months of the interventions (Yoga, Äyurveda, or Wait-list control).

Reliability and Validity of GDS-S: The original version of the geriatric depression scale (GDS) has 30 items (Segal, Coolidge, & Hersen, 1998). The short version of the GDS (which has 15 items) was evaluated for validity (De Graen, Heeren, & Gussekloo, 2003) and was shown to detect longitudinal changes in symptoms of depression (Vinkers, Gussekloo, Stek, Westendorp, & Van der Mast, 2004). Also, long detailed interviews and testing batteries are not tolerated well by many older people due to fatigue (Segal et al., 1998). Hence the short version of the GDS was preferred for use in the present study. The GDS-S has been used to assess depression in older people with normal health (T'Sjoen et al., 2005). However one report mentioned that in 'old-old' people (as mentioned in the paper) (i.e, those over the age of 75 years) the GDS-S has a 60 percent sensitivity to detect major depression (as was seen in the present study) in healthy older people (Watson, Lewis, Kistler, Amick, & Boustani, 2004).

With regard to the use of GDS in an Indian population**,** the GDS (short version) as used in the present study, was administered in 1554, mostly illiterate people over the age of 55 years in northern India who were Hindi-speaking (Ganguli et al., 1999). The scale which was developed was called the GDS-H, i.e., geriatric depression scale – Hindi version. The GDS-H had high internal consistency and the factor structure was comparable to that of the original version in English. This Hindi version was considered suitably reliable and valid. In the present study, it was not considered necessary to use the GDS-H, as the group of community dwelling older people who participated in the study were all literate and were able to understand spoken and written English. This was first verified in all subjects before administering the questionnaire, which was possible as the questionnaire was administered on an individual basis.

4.3.3.2 Sleep Rating Questionnaire: Sleep in older persons is characterized by decreased ability to stay asleep, resulting in fragmented sleep and a decrease in daytime alertness (Bliwise, 1992). In the present sleep rating questionnaire there were seven questions, which subjects were asked to answer based on their experience during the week prior to assessment. Asking them to recall their quality and amount of sleep in the week prior to assessment was important, as recall over longer periods is especially likely to be influenced by anamnesis in older persons (Kayed, 1995). The questionnaire consisted of seven questions. The questions were either dichotomous [i.e., two options: yes/no; Questions 5 and 6] or open questions [i.e., Questions 1, 2, 3, 4 and 7].

The questions were:

1. Approximately how long (in minutes) does it take you to fall asleep?
2. How many hours do you sleep each night?
3. How many times (if any) do you wake up during the night?
4. What are the usual reasons for wakening up, if you do so?
5. Do you feel rested in the morning (yes/no)?
6. Do you sleep in the daytime (yes/no)?
7. If your answer to Question 6 was ‘yes’, for how long do your daytime naps last (in minutes)?

Reliability and Validity: The sleep rating questionnaire has been evaluated for its reliability and validity based on standard criteria. Reliability was ascertained based on (i) temporal stability and (ii) internal consistency (Singh, 2002). To assess temporal stability the correlation coefficients were calculated using the data of the ‘no intervention’, Wait-list control group with two correlations being made, viz.: (i) baseline with three months and (ii) baseline with six months. Out of the five variables for which the correlations were made the temporal stability was demonstrated for four. In order to evaluate internal consistency the correlation between two variables, which assessed an equivalent aspect of sleep, was calculated. The two variables were the number of hours slept each night and the feeling of being rested in the morning. The values for the three groups were as follows: Yoga ($r = .643$), Äyurveda ($r = .578$) and Wait-list control ($r = .699$). Validity was inferred based on the content and indirectly based on the test for internal consistency described above.

4.4 DATA EXTRACTION

4.4.1 General Health Measures:

4.4.1.1 Pulmonary Function Tests (PFT): The following values were obtained as a computer printout from the computerized spirometer, i.e., (i) forced vital capacity (FVC), (ii) slow vital capacity (SVC), (iii) maximum voluntary ventilation (MVV), and (iv) expired or minute ventilation (MV).

4.4.1.2 Anthropometric measurements:

4.4.1.2A Body Mass Index (BMI): The Body Mass Index or the Quetelet index was calculated from the equation, BMI = weight in kg/(height in meters) (Altman, Gore, Gardner, & Pocock, 1983).

4.4.1.2B Mid arm circumference: The mid arm circumference was recorded directly in centimeters.

4.4.1.2C The waist-hip ratio was derived from the formula: waist circumference in centimeters/ hip circumference in centimeters.

4.4.1.3 Hand grip strength: Subjects were tested in 6 trials, 3 for each hand alternately with 10 seconds gap between trials. The average of the three values (in Kilograms) for each hand was considered for further analysis.

4.4.2 Neurological Variables

4.4.2.1 Autonomic and respiratory variables:

4.4.2.1A Skin Conductance Level (SCL): The skin conductance level (SCL in micro Siemens) was sampled at 20-second intervals. For each subject, the average of the values obtained during the 5-minute session was used for analysis.

4.4.2.1B Respiratory Rate: The respiratory rate (in breath cycles/ minute) was counted for successive 60 seconds epochs. The readings were averaged for the 5 minute block period.

4.4.2.1C Heart Rate: The heart rate (beats/ minute) was obtained by counting the R waves of the QRS complex in successive epochs of 60 seconds and averaged for the 5 minute block period.

4.4.2.1D Heart Rate Variability (HRV): The HRV power spectrum was obtained using fast Fourier transform analysis (FFT). The power in the HRV series of the following specific bands was studied, viz., the very low frequency component (0.0 - 0.05 Hz), low frequency component (0.05 - 0.15 Hz), and high frequency component (0.15 - 0.50 Hz). The low frequency and high frequency values were expressed as normalized units, which represent the relative of each power component in proportion to the total power minus VLF component [LF norm = LF / (total power-VLF) × 100; HF norm = HF / (total power – VLF) ×100)] (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). The values were obtained directly using the HRV analysis software (Ramakrishnan, Srinivasan, & Fetzer, 1993).

4.4.2.2 Balance, Gait and Mobility

4.4.2.2A The Tinetti gait and balance scale: The items were scored “0”, “1”, “2”. The total for balance and gait was calculated separately. Also, the balance and gait values were added together to obtain the total score. Points were lost to varying degrees for requiring assistance, using an aid (cane, walker, furniture), multiple attempts, staggering, asymmetry, sway, and deviation.

4.4.2.2B The Timed-up-and-go test: The two main aspects, viz. the time taken to get up from the chair, walk and return to the original position and the number of steps taken for the task were used for further analysis.

4.4.2.3 Wechsler memory scale: The components which were tested were: (a) long-term memory (comprising of 5 questions and each correct answer was scored as “1”). (b) orientation (having 5 questions and each correct answer was scored as “1”), (c) mental control [(i) counting digits forward and backwards i.e., 1 to 10 and back to 1, (ii) counting by two (e.g., 2+2=4, 4+2=6, till 20) and alphabets (A to Z). The time taken for completing above mentioned tasks, and the number of errors were noted separately and analyzed. (d) digit span forward and backward (each correct answer scored as 1, the sum of all correct answers for digit span forward and backward were recorded separately), and (e) associate learning (each easy answer was scored as “1” and difficult answer as “2”).

4.4.2.4 Audiometry: The threshold intensities (in dB) were obtained as a computer printout from the computerized audiometer for right and left ears separately after measuring the hearing threshold at the following different frequencies: (i) low frequency (500 Hz and 1.0 KHz) and (ii) high frequency (6.0 KHz, 8.0 KHz and 12 KHz).

4.4.3 Psychological Variables

4.4.3.1 Geriatric Depression Scale: The questionnaire consisted of 15 dichotomous questions [i.e., with two options: Yes/No]. If the answer was 'No' to the questions 1, 5, 7, 11, and 13 and 'yes' to the remaining questions was scored as "1", otherwise scored as 0.

4.4.3.2 Sleep Rating Questionnaire: This questionnaire consisted of seven questions. The questions were either dichotomous [i.e., two options: yes/no; Questions 5 and 6] or open ended questions [i.e., Questions 1, 2, 3, 4 and 7]. The dichotomous questions were scored as follows: if the answer was 'yes' scored as '1' and 'no' scored as '0'. Open ended questions with numerical values as answers (e.g., How many hours do you sleep each night?) were used directly for further analysis.

4.5 DATA ANALYSIS

Data were analyzed using the statistical package (SPSS Version 10.0). The data of baseline, three and six months of all three groups were assessed with tests for normality distribution using both graphical presentations (box plot and histogram) as well as Kolmogorov-Smirnov test. A one way analysis of variance (ANOVA) was used to compare the data of the three groups at baseline.

Repeated measures ANOVA is one in which multiple measurements on the same experimental subjects comprise the replicate data (Kepner & Robinson, 1988). In the present study, the repeated measures ANOVA was used for data analysis since there was a consequential relationship among the within subjects data (Zar, 1999). Hence, the repeated measures ANOVA was used to test for (i) significant differences between the assessments i.e., at baseline, three and six months (this was a Within-Subjects factor; Time) and (ii) differences between the groups (Äyurveda, Yoga and Wait-list control), this was a Between-Subjects factor, and the test for a Time by Group interaction provided a global test for an intervention effect.

The t-test for paired data was used to compare data at three and six months with those at baseline of each group, separately. These parametric tests were used even though the data were found to be not normally distributed as it has been shown that analyses of variance and t-tests are usually robust enough to perform well even if the data deviate somewhat from the requirements of normality and homoscedasticity (Zar, 1999).

The Wilcoxon paired signed ranks test was used as a non-parametric statistical test to compare data at three and six months with those at baseline of each group, separately. When the data were binary (i.e., ‘0’ or ‘1’), another non parametric statistical test i.e., McNemar test was used to compare data at three and six months with those at baseline of each group, separately.

4.6 INTERVENTIONS

4.6.1 Yoga training: Yoga is an ancient Indian science and way of life which brings about relaxation and also induces a balanced mental state (Taimini, 1986). Yoga techniques include physical postures (*āsanās*), voluntarily regulated breathing *(prāṇāyamās*), meditation, and philosophical principles which help to reach a balanced mental state.

The Yoga session was planned to include: physical activity, relaxation, regulated breathing and philosophical aspects of yoga. This was an integrated approach of yoga, derived from principles in ancient yoga texts which emphasize that yoga should promote health at all levels (Gambhirananda, 2002). This combination is believed to promote physical health (physical postures, loosening exercises and relaxation techniques), normal functioning at the subtle energy level (breathing exercises, voluntarily regulated breathing), mental and emotional level (meditation and devotional sessions) and at the intellectual level (lectures on philosophy of Yoga) (Nagendra & Nagarathna, 1985). This is because Yoga practices are meant to act at all levels of functioning to promote an overall wellbeing. Also, the present study evaluated different functions which are modified by the aging process. These range from general health measures to neurological and psychological variables. Hence the diverse Yoga practices were expected to be influencing different aspects of functioning. As the program was an integrated one, the cumulative effects were considered interesting and there was no interest to study the effects of individual practices, separately.

The session was for sixty minutes daily, for six days a week. Subjects practiced breathing exercises (10 min), loosening exercises (*sithilīkaraṇa vyāyāma*, 5 min), physical postures (*āsanās,* 20 min), voluntarily regulated breathing (*praṇāyāma,* 10 min) and yoga-based guided relaxation (15 min), which has been described elsewhere (Vempati & Telles, 2002). There was an additional session in the evening which consisted of devotional songs (*bhajans*, 15 min) and lectures on theory and philosophy of Yoga alternating with 'cyclic meditation'. The last technique is derived from another ancient Indian text (the *mānḍūkyopaniṣad*) and involves alternating cycles of physical postures and supine rest (Telles, Reddy, & Nagendra, 2000).

(**See plate IV** for Yoga practice session at the home for aged. The Yoga module developed for the geriatric population is detailed in **Appendix 10**).

3.6.2 Āyurveda: A closely related ancient Indian discipline, *Āyurveda* (= the` Science of Life', in Sanskrit), provides comprehensive knowledge about diverse aspects of health (Sharma & Dash, 1998). Wide ranges of health measures are covered including massage and herbal preparations. The latter are used for healthy persons (`rejuvenating preparations' or *rasāyanās*) and for therapy. Suṣrutha defines *rasāyana* as a measure, which prolongs life and provides positive health, improves mental faculties and provides resistance and immunity against diseases (Shastry, 1997). Charaka states that the means of obtaining optimum nourishment to the *dhātus* is called *rasāyana* (Sharangadhara, 1985). The present study evaluated the effects of an āyurveda herbal preparation i.e., a 'rejuvenating tonic' (*Rasayana Kalpa* in Sanskrit) on the positive health indicators of persons aged above sixty years.

The method of preparation: 50g of *Emblica officinalis* (fresh fruit), 12.5g of *Sida cordifolia* (coarse powder of the root), 12.5g of *Terminalia arjuna* (fine powder of the dry fruit), were heated with 500ml of water to boiling point and allowed to boil for 15 minutes. The mixture of *Sida cordifolia* and *Terminalia arjuna* was kept aside while the *Emblica officinalis* fruits were removed, mashed, seeded, sieved in a muslin cloth to drain water and then heated with 50g of clarified butter for 5 min. 200g of sugar was added to the mixture of *Sida cordifolia* and *Terminalia arjuna*, mentioned above. This mixture and the *Emblica officinalis* were mixed together. Finally 100g of *Withania Somnifera* (fine powder of the root) and 25g *Piper longum* (fine powder) were added and once the preparation reached room temperature 100g of honey was added. Separate batches of 500g of the preparation were made as and when they were required. (**See plate V**)

10g of this preparation consisted of the following herbs (the Sanskrit names are given in parenthesis): *Withania Somnifera (*ashwagandha roots, 2g), *Emblica officinalis* (amalaki, 1g), *Sida Cordifolia* (bala, 0.25g), *Terminalia Arjuna* (arjuna, 0.25g), *Piper Longum* (pippali, 0.5g). The other contents were: sugar (4g), honey (2g), water and clarified butter (ghee) in the amount required to get the correct semi-solid consistency. The participants were given 10g (1 tablespoon, approximately) twice a day, once in the morning (6 a.m.) and again in the evening (6 p.m.) for 24 weeks. After both doses they were asked to drink 200ml of skimmed milk, as is prescribed in Ayurveda texts (Sharma & Dash, 1998).

The dose (i.e., 10g twice a day) was decided in consultation with experts from a local Ayurveda medical college and from the Ministry of Health and Family Welfare, Government of India. The dose customarily prescribed for people of all ages is 48g per day, though this may be varied based on the health status and 'personality type' (according to Ayurveda) of the individual (Sharangadhara, 1985). The herbal preparation was prepared by an expert in Ayurveda (i.e., a person who had undergone 10 years of pre- and doctoral training in Ayurveda). Regarding the quality control, Ayurveda preparations which are manufactured for sale are required to fulfill norms prescribed by the Drug Licensing Authority, Government of India. In the case of the study preparation (which was made especially for the participants) it was not possible to use the same method of testing. However the Ayurveda expert verified (based on her experience and Ayurveda texts (Hiremath, 2000)) that the constituents were unadulterated and that the method of preparation of the compound was correct. The preparation was given to the participants by a volunteer in the home who had no other part in the trial.

3.6.3 The Wait-list Control group: The Wait-list Control group was not given any intervention but was told that they could receive either Yoga or Ayurveda after the trial. They were asked to continue with the normal routine of the home.

3.6.4 Treatment Fidelity: The treatment fidelity was ensured as follows: To begin with all the participants had agreed to receive whichever treatment was allotted to them, and this was one of the criteria for them to be included in the trial. Apart from this Yoga was practiced in a group. The intervention leader was a trained yoga instructor who had no other part in the trial. The yoga instructor monitored the residents' attendance for the sessions, as well as the correctness of their practice and their involvement in it. The Ayurveda group was given the herbal preparation in another room. Their participation in the program was also monitored and their treatment fidelity was also checked. During the rest of the day there was no chance for participants of one group to practice or receive the program of another group.

Table 4.3: The rationale for using three categories of variables, their usefulness and limitations

Sl. No.	Variable Studied	Rationale	Usefulness	Limitations
1.	General Health Measures			
1.1	**Pulmonary Functions**	Aging is associated with deterioration of pulmonary functions and this a part of the standard test battery	Progress in aging related changes and the efficacy of specific interventions	Subjects need to understand the instructions to perform optimally.
1.2	**Anthropometric Measurements**	Age associated changes in body weight and fat distribution are well documented	The changes associated with fat distribution are associated with specific illnesses	Further objective measurements are required to substantiate these findings
1.3	**Hand Grip Strength**	Muscle strength decreases with age	Muscle endurance of the flexors of the hand can be determined	Subjects need to perform maximally
2.	Neurological Measurements			
2.1	**Autonomic and respiratory variable**	Aging is associated with increased sympathetic activity	Understand Autonomic Nervous System (ANS) functions following an intervention	ANS activity was recorded not Autonomic Function Tests due to the large number of variables and time required
2.2	**Balance, Gait and Mobility**	Falls and decreased mobility are the major contributing factors for morbidity in the elderly	Measures the balance, gait and mobility while performing a required daily function	The tests require the observer to be accurate and attentive

2.3	**Memory**	Memory deficits beyond the age of 60 years is well recognized	The test battery used evaluates long-term memory and orientation, mental control, attention and concentration (digit span forward and backward) and associate learning.	Subjects need to co-operate with the tester
2.4	**Audiometry**	Hearing deficits (high frequency) in the elderly is well documented	Influence of an intervention can be studied	Subjects participation with alertness is mandatory
3.	Psychological Variables			
3.1	**Geriatric Depression Scale – Short version (GDS – S)**	Aging is associated with depression though its not an inevitable consequence	The short version of the GDS has been shown to detect longitudinal changes in symptoms of depression. Also, long detailed interviews and testing batteries are not tolerated well by many older people due to fatigue	The GDS – S is a dichotomous scale which does not allow for in-between responses other than Yes/No.
3.2	**Sleep Rating Questionnaire (SRQ)**	Sleep in older persons is characterized by decreased ability to stay asleep, resulting in fragmented sleep and a decrease in daytime alertness	The Sleep Rating Questionnaire is a brief questionnaire which gives information about all aspects (both quality and quantity) of sleep for the preceding week	SRQ is subjective in nature. Recall over longer periods is especially likely to be influenced by anamnesis in older persons

The results section consists of three main parts, i.e., (I) General Health Measures (II) Neurological Variables and (III) Psychological Variables recorded in two intervention groups (Yoga and Ayurveda) and a Wait-list Control group at baseline and after three and six months.

5.1 GENERAL HEALTH MEASURES:

Recapitulation: The General Health Measures i.e., pulmonary functions and hand grip strength were recorded at baseline and after three and six months, while the anthropometric measurements were made at baseline and after six months, in all three groups (Yoga, Ayurveda and Wait-list Control). The baseline values of all three groups, for all the variables were compared using separate one-way ANOVAs and the results suggested that there were no significant differences at baseline between groups ($p > .05$).

As described under the Methods section (data analysis), separate repeated measures ANOVAs were performed to compare the differences between assessments (baseline, three months and six months or baseline and six months as Within-subjects factor) and the groups (Yoga, Ayurveda and Wait-list Control as Between-subjects factor) and the interaction between the groups and the assessments. Paired t-tests were performed to compare the data of three and six months of all three groups with their respective baseline values.

5.1.1 Pulmonary functions: The pulmonary functions recorded in all three groups at baseline and after three and six months included (a) Forced Vital Capacity (FVC), (b) Slow Vital Capacity (SVC), (c) Maximum Voluntary Ventilation (MVV) and (d) Minute Ventilation (MV).

5.1.1.1 FVC: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between-subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed a significant difference between the groups (F = 5.001, p <.01, Greenhouse-Geisser epsilon = .893), and the interaction between the assessments and groups (F = 4.333, p <.01, Greenhouse-Geisser epsilon = .893) and no significant difference between the assessments (F = .178, p >.05, Greenhouse-Geisser epsilon = .893). The ANOVA results are summarized in Table 5.1.1.1.

The Yoga group showed a significant increase (31.82%) in Forced Vital Capacity (p <.05, paired t-test, baseline versus six months), and the Wait-list Control group showed a significant reduction (35.63%) in the Forced Vital Capacity (p <.05, paired t-test, baseline versus six months). The Ayurveda group showed no significant change (p >.05, paired t-test).

5.1.1.2 SVC: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups - Yoga, Ayurveda and Wait-list Control) showed no significant difference between the assessments (F = 1.186, p >.05, Greenhouse-Geisser epsilon = .962), between the groups (F = .495, p >.05, Greenhouse-Geisser epsilon = .962), and the interaction between the assessments and groups (F = .620, p >.05, Greenhouse-Geisser epsilon = .962). The ANOVA results are summarized in Table 5.1.1.2.

The paired t-test suggested that the comparisons between the values at three and six months with their respective baseline values were not significant for all three groups (p>.05).

Table 5.1.1.1
Pulmonary functions: Forced Vital Capacity
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.787	1.903	0.178	.813
Between-subjects factor (Groups)	2.000	1.487	5.001	**.011**
Interaction (Assessments * Groups)	3.573	0.463	4.333	**.004**
Error (Within-subjects factor)	83.972	0.107		
Error (Between-subjects factor)	47.000	0.297		

*Greenhouse-Geisser epsilon = .893, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.1.1.2
Pulmonary functions: Slow Vital Capacity
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.924	.250	1.186	.309
Between-subjects factor (Groups)	2	.267	.495	.613
Interaction (Assessments * Groups)	3.849	.131	.620	.643
Error (Within-subjects factor)	90.449	.211		
Error (Between-subjects factor)	47	.540		

*Greenhouse-Geisser epsilon = .962, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Fig. 5.1.1.1: Mean ± Standard Deviations of the Forced Vital Capacity (FVC) recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

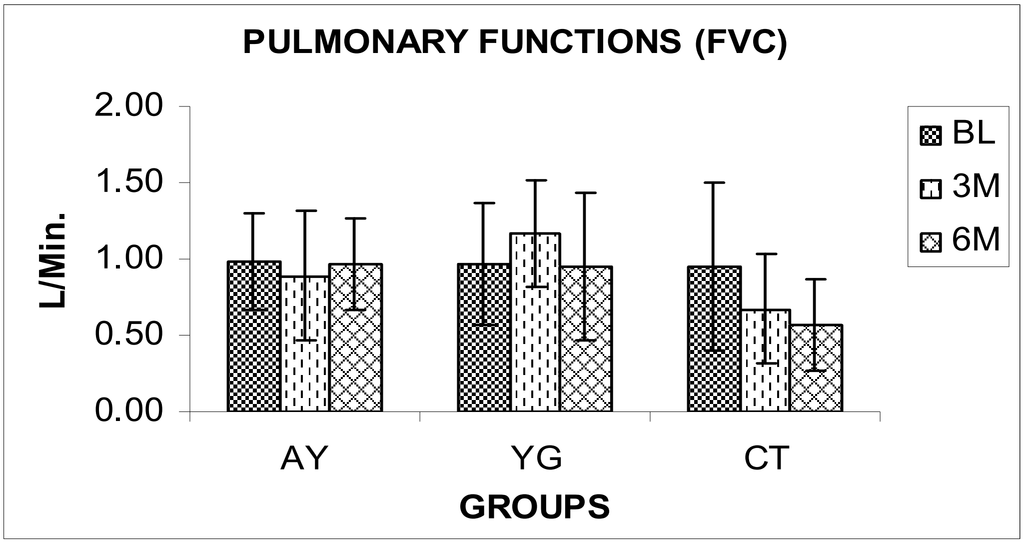
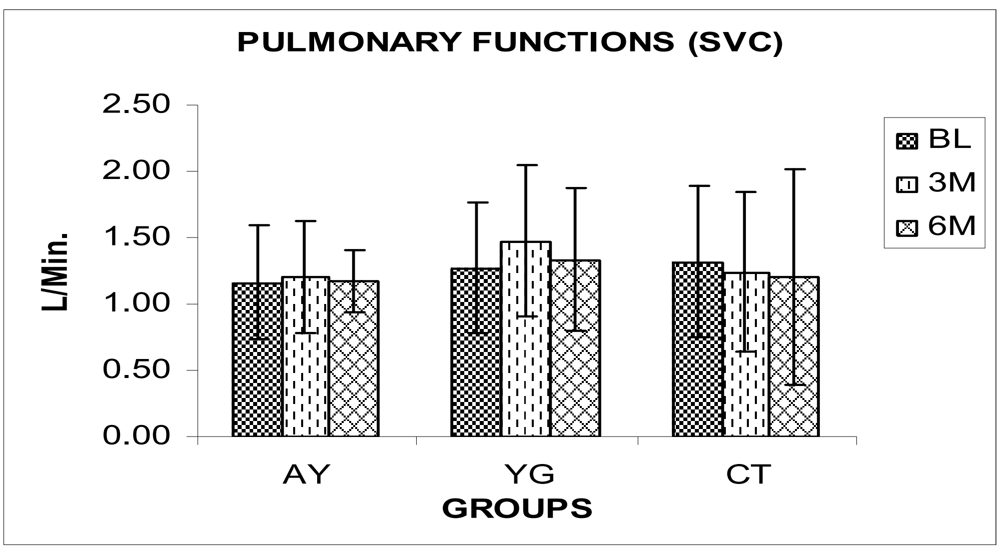


Fig. 5.1.1.2: Mean ± Standard Deviations of the Slow Vital Capacity (SVC) recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.1.1.3 MVV: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between-subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed a significant difference between the assessments (F = 6.018, p <.01, Greenhouse-Geisser epsilon = .945), however, there was no significant difference between the groups (F = .785, p >.05, Greenhouse-Geisser epsilon = .945), and the interaction between the assessments and the groups (F = .908, p >.05, Greenhouse-Geisser epsilon = .945). The ANOVA results are summarized in Table 5.1.1.3.

The Ayurveda group showed a significant increase (22.63%) in Maximum Voluntary Ventilation (p <.05, paired t-test, baseline versus six months), while the Wait-list Control group and the Yoga group showed no significant change (p >.05, paired t-test).

5.1.1.4 MV: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed a significant difference between the assessments (F = 8.040, p <.001, Greenhouse-Geisser epsilon = .973), however, there was no significant difference between the groups (F = .658, p >.05, Greenhouse-Geisser epsilon = .973), and the interaction between the assessments and groups (F = .435, p >.05, Greenhouse-Geisser epsilon = .973). The ANOVA results are summarized in Table 5.1.1.4.

The Yoga group showed a significant increase (51.47%, 34.48% at three and six months respectively) in Minute Ventilation (p <.01, p <.05, paired t-test, baseline versus three and six months respectively). The Ayurveda group also showed a significant increase (39.09%) in Minute Ventilation ($p < .05$, paired t-test, baseline versus three months), while the Wait-list Control group showed no significant change ($p > .05$, paired t-test, baseline versus three and six months).

Table 5.1.1.3

Pulmonary functions: Maximum Voluntary Ventilation

Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.890	303.875	6.018	**.004**
Between subjects factor (Groups)	2.000	329.867	0.785	.462
Interaction (Assessments * Groups)	3.780	45.846	0.908	.459
Error (Within-subjects factor)	88.839	50.491		
Error (Between subjects factor)	47.000	419.965		

*Greenhouse-Geisser epsilon = .945, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.1.1.4

Pulmonary functions: Minute Ventilation

Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.946	99.850	8.040	**.001**
Between subjects factor (Groups)	2.000	24.238	0.658	.523
Interaction (Assessments * Groups)	3.892	5.408	0.435	.778
Error (Within-subjects factor)	91.455	12.419		
Error (Between subjects factor)	47.000	36.831		

*Greenhouse-Geisser epsilon = .973, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.1.1.3: Mean ± Standard Deviations of the Maximum Voluntary Ventilation (MVV) recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

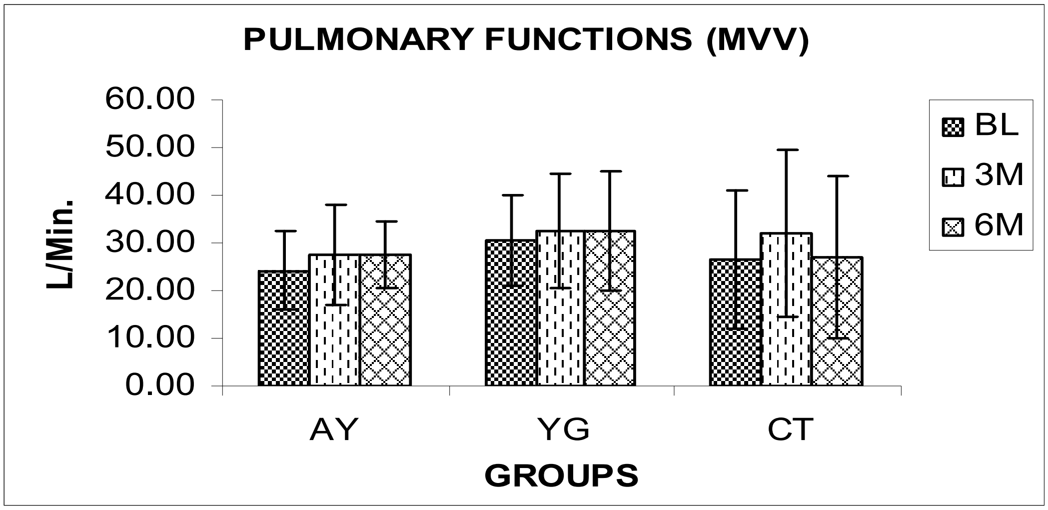
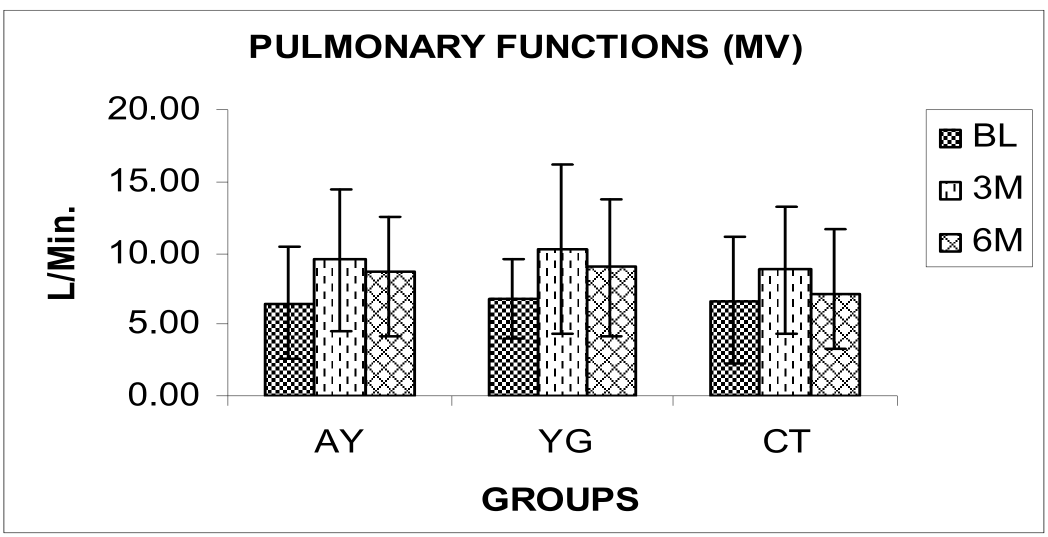


Fig. 5.1.1.4: Mean ± Standard Deviations of the Minute Ventilation (MV) recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



The group mean ± SD for all the variables (i.e., FVC, SVC, MVV and MV) at baseline (n=23, for all three groups) are given in Table 5.1.1.5, at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups respectively) are given in Table 5.1.1.6 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups respectively) are given in Table 5.1.1.7. The summary of changes in pulmonary functions in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.1.1.8. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.1.1.9, Table 5.1.1.10 and Table 5.1.1.11 respectively **(see Appendix 8).**

Table 5.1.1.5: Mean ± Standard Deviations of the pulmonary functions recorded at baseline (BL) for all three groups (Ayurveda, Yoga and Wait-list Control)

VARIABLES	**AYURVEDA**	**YOGA**	**WAIT-LIST CONTROL**
n	23	23	23
FVC (l/min.)	0.98 ± 0.29	0.91 ± 0.39	0.95 ± 0.56
SVC (l/min.)	1.16 ± 0.51	1.27 ± 0.50	1.32 ± 0.56
MVV (l/min.)	24.23 ± 11.47	30.52 ± 11.07	26.33 ± 14.21
MV (l/min.)	6.47 ± 3.33	6.78 ± 2.70	6.64 ± 4.28

p >. 05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list Control groups and comparing Yoga versus Wait-list Control group for all variables

n = number of subjects
FVC = Forced Vital Capacity
SVC = Slow Vital Capacity
MVV = Maximum Voluntary Ventilation
MV = Minute Ventilation
l/min. = Liters per minute

Table 5.1.1.6: Mean ± Standard Deviations of the pulmonary functions recorded at baseline (BL) and after three months (3M) for all three groups (Ayurveda, Yoga and Wait-list Control)

	AYURVEDA		**YOGA**		**WAIT-LIST CONTROL**	
VARIABLES	**BL**	**3M**	**BL**	**3M**	**BL**	**3M**
n	15	15	20	20	20	20
FVC (l/min.)	0.93 ± 0.30	0.89 ± 0.38 - 4.30	0.88 ± 0.39	0.97 ± 0.35 10.23	0.87 ± 0.55	0.67 ± 0.36 -22.99
SVC (l/min.)	1.21 ± 0.42	1.20 ± 0.43 - 0.83	1.27 ± 0.53	1.47 ± 0.54 15.75	1.28 ± 0.57	1.24 ± 0.60 - 3.13
MVV (l/min.)	22.65 ± 7.57	27.52 ± 9.76 21.50	29.75 ± 9.00	32.49 ± 11.30 9.21	25.98 ± 14.53	32.06** ± 17.34 23.40
MV (l/min.)	6.83 ± 3.78	9.5* ± 4.76 39.09	6.78 ± 2.77	10.27** ± 5.65 51.47	6.50 ± 4.44	8.80 ± 4.48 35.38

* *p*<. 05, ** *p*< .01, *** *p*<.001, two tailed, 't' test for paired data comparing the values at three months versus baseline

n = number of subjects
FVC = Forced Vital Capacity
SVC = Slow Vital Capacity
MVV = Maximum Voluntary Ventilation
MV = Minute Ventilation
l/min. = Liters per minute

Table 5.1.1.7: Mean ± Standard Deviations of the pulmonary functions recorded at baseline (BL) and after three months (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA			YOGA			WAIT-LIST CONTROL		
VARIABLES	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
n	12	12	12	18	18	18	20	20	20
FVC (l/min.)	0.93 ± 0.32	0.93 ± 0.42 0.00	0.97 ± 0.30 4.30	0.88 ± 0.40	1.00 ± 0.35 13.64	1.16* ± 0.49 31.82	0.87 ± 0.55	0.67 ± 0.36 -22.99	0.56** 0.30 -35.63
SVC (l/min.)	1.14 0.43	1.30 ± 0.42 14.04	1.17 ± 0.23 2.63	1.22 ± 0.49	1.49 ± 0.57 22.13	1.33 ± 0.54 9.02	1.28 ± 0.57	1.24 ± 0.6 -3.13	1.20 ± 0.81 -6.25
MVV (l/min.)	22.49 ± 8.19	27.72 ± 10.57 23.25	27.58* ± 6.95 22.63	29.18 ± 9.33	32.39 ± 11.86 11.00	32.48 ± 12.6 11.31	25.98 ± 14.53	32.06 ± 17.34 23.40	26.99 ± 16.91 3.89
MV (l/min.)	6.91 ± 3.92	9.39 ± 4.99 35.89	8.75 ± 3.69 26.63	6.70 ± 2.86	10.47 ± 5.92 56.27	9.01* ± 4.79 34.48	6.50 ± 4.44	8.80 ± 4.48 35.38	7.06 ± 4.56 8.62

* $p < .05$, ** $p < .01$, ***$p < .001$, two tailed, t-test for paired data comparing the values at three months versus baseline and six months versus baseline

n = number of subjects
FVC = Forced Vital Capacity
SVC = Slow Vital Capacity
MVV = Maximum Voluntary Ventilation
MV = Minute Ventilation
l/min. = Liters per minute

Table 5.1.1.8: Summary of significant changes in pulmonary functions in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

	AYURVEDA		**YOGA**		**CONTROL**	
Pulmonary functions	**3M**	**6M**	**3M**	**6M**	**3M**	**6M**
FVC (L/Min.)	NSC	NSC	NSC	31.82 %↑ *	NSC	35.63↓ **
SVC (L/Min.)	NSC	NSC	NSC	NSC	NSC	NSC
MVV (L/Min.)	NSC	22.63↑ *	NSC	NSC	23.4 %↑ **	NSC
MV (L/Min.)	39.09↑ *	NSC	51.47 %↑ **	34.48↑ *	NSC	NSC

* p<. 05, ** p< .01, ***p< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

FVC = Forced Vital Capacity

SVC = Slow Vital Capacity

MVV= Maximum Voluntary Ventilation

MV =Minute Ventilation

(L/Min.) = Liters / Minute

NSC =No Significant Change

5.1.2 Anthropometric measurements: The anthropometric measurements recorded in three groups at baseline and after six months included (a) Body Mass Index (BMI), (b) Mid-arm circumference and (c) Waist-Hip ratio.

5.1.2.1 Body Mass Index (BMI): The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed no significant difference between the assessments (F = .681, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = 1.296, p >.05, Greenhouse-Geisser epsilon = 1.000), and the interaction between the assessments and groups (F = 2.794, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.1.2.1.

The comparisons between the values at six months with their respective baseline values for all three groups suggested no significant change (p>.05, paired t-test).

5.1.2.2 Mid-arm circumference: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed no significant difference between the assessments (F = .645, p >.05, Greenhouse-Geisser epsilon = 1.000) between the groups (F = 1.651, p >.05, Greenhouse-Geisser epsilon = 1.000), and the interaction between the assessments and groups (F = 1.293, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.1.2.2.

The Wait-list Control group showed a significant reduction (1.75%) in the Mid-arm circumference (p <.01, paired t-test, comparing the values at six months with the baseline values). The comparisons between the values at six months with their respective baseline values for the Yoga and Ayurveda groups showed no significant change (p >.05, paired t-test).

Table 5.1.2.1
Anthropometric measurements: Body Mass Index
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	0.671	0.681	.413
Between subjects factor (Groups)	2	58.590	1.296	.283
Interaction (Assessments * Groups)	2	2.752	2.794	.071
Error (Within-subjects factor)	47	0.985		
Error (Between subjects factor)	47	45.205		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.1.2.2
Anthropometric measurements: Mid Arm Circumference
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	0.356	0.645	.426
Between subjects factor (Groups)	2	55.202	1.651	.203
Interaction (Assessments * Groups)	2	0.713	1.293	.284
Error (Within-subjects factor)	47	0.552		
Error (Between subjects factor)	47	33.429		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Fig. 5.1.2.1: Mean ± Standard Deviations of the body mass index (BMI) scores recorded at baseline (BL) and after six months (6M) for all three groups for all three groups i.e., Ayurveda (AY), Yoga (YG) and Wait-list Control (CT)

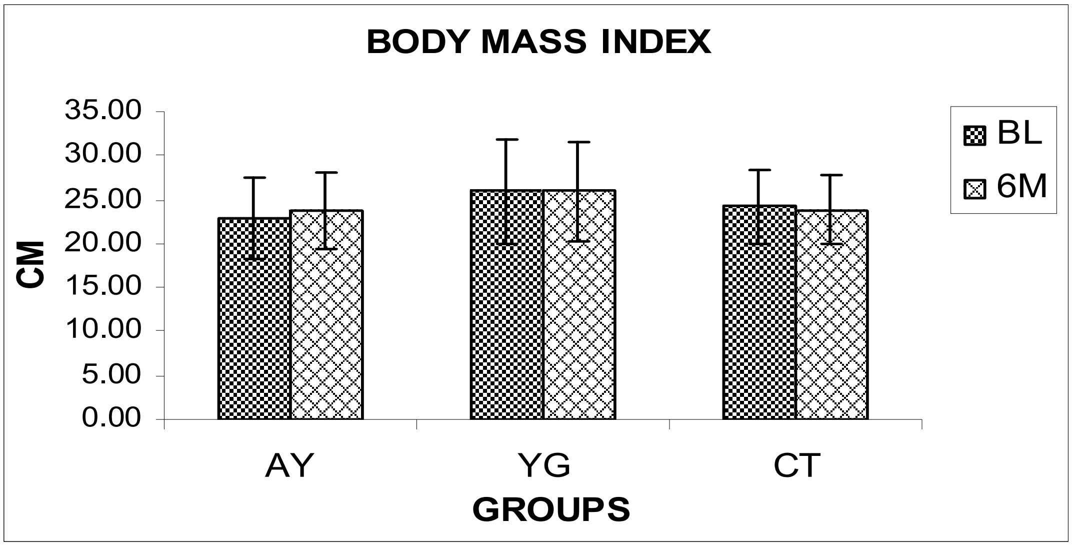
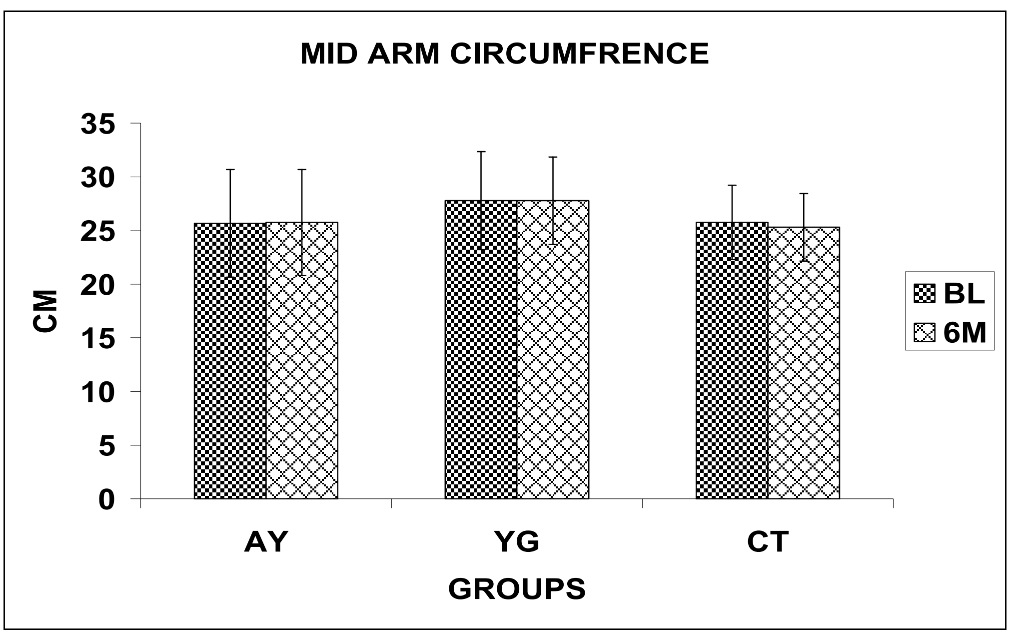


Fig. 5.1.2.2: Mean ± Standard Deviations of mid arm circumference (MAC) scores recorded at baseline (BL) and after six months (6M) for all three groups for all three groups i.e., Ayurveda (AY), Yoga (YG) and Wait-list Control (CT)



5.1.2.3 Waist-Hip ratio: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed a significant difference between the assessments (F = 4.590, p <.05, Greenhouse-Geisser epsilon = 1.000). However there was no significant difference between the groups (F = .583, p >.05, Greenhouse-Geisser epsilon = 1.000), and the interaction between the assessments and groups (F = .785, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.1.2.3

The comparisons between the values at six months with their respective baseline values for all three groups suggested no significant change (p>.05, paired t-test).

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.1.2.4 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.1.2.5. The summary of changes in anthropometric measurements in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months is given in Table 5.1.2.6. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.1.2.7, Table 5.1.2.8 and Table 5.1.2.9, respectively (**see Appendix 8**).

Table 5.1.2.3

Anthropometric measurements: Waist-Hip-Ratio
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	5.086	4.590	**.037**
Between subjects factor (Groups)	2	3.640	0.583	.562
Interaction (Assessments * Groups)	2	8.700	0.785	.462
Error (Within-subjects factor)	47	1.108		
Error (Between subjects factor)	47	6.244		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Fig. 5.1.2.3: Mean ± Standard Deviations of the waist hip ratio (WHR) scores recorded at baseline (BL) and after six months (6M) for all three groups for all three groups i.e., Ayurveda (AY), Yoga (YG) and Wait-list Control (CT)

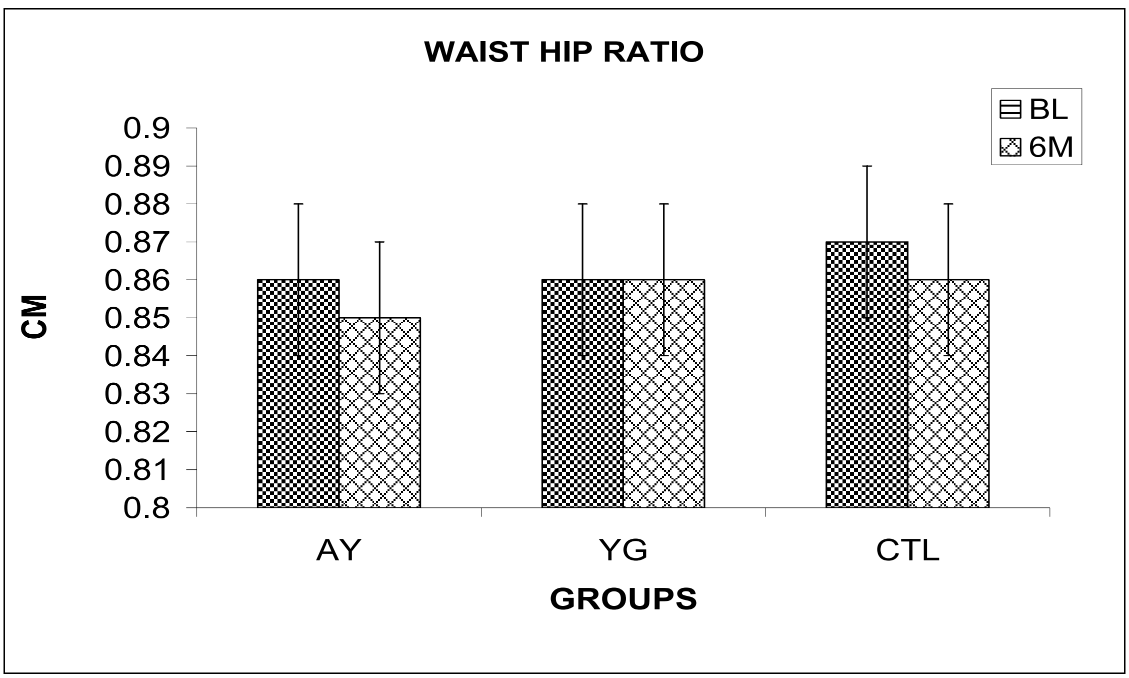


Table 5.1.2.4: Mean ± Standard Deviations of the body mass index (BMI), mid-arm circumference (MAC), waist hip ratio (WHR) scores at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA	YOGA	WAIT-LIST CONTROL
N	23	23	23
BMI (score)	22.87 ± 4.52	25.94 ± 5.85	24.17 ± 4.08
MAC (cm)	26.04 ± 4.35	27.26 ± 4.18	26.17 ± 3.4
WHR (ratio)	0.86 ± 0.01	0.86 ± 0.01	0.87 ± 0.02

p >.05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list Control groups and comparing Yoga versus Wait-list Control group for all variables

Table 5.1.2.5: Mean ± Standard Deviations of the body mass index (BMI), mid-arm circumference (MAC), and waist-hip ratio (WHR) scores at baseline (BL) and after six months (6M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA		**YOGA**		**WAIT-LIST CONTROL**	
VARIABLES	**BL**	**6M**	**BL**	**6M**	**BL**	**6M**
n	12	12	18	18	20	20
BMI (score) % change	22.88 ± 4.52	23.74 ± 4.24 3.76	25.94 ± 5.85	25.91 ± 5.76 -0.12	24.17 ± 4.08	23.84 ± 3.87 -1.37
MAC (cm) % change	25.67 ± 5.02	25.75 ± 4.94 0.31	27.78 ± 4.57	27.78 ± 4.08 0.00	25.75 ± 3.46	25.30** ± 3.13 -1.75
WHR (ratio) % change	0.86 ± 0.02	0.86 ± 0.02 -1.16	0.86 ± 0.02	0.86 ± 0.02 0.00	0.87 ± 0.02	0.86 ± 0.02 -1.15

* *p*<. 05, ** *p*< .01, *** *p* < .001, two tailed, t-test for paired data comparing the values at six months versus baseline and six months versus baseline

Table 5.1.2.6: Summary of significant changes in Anthropometric Measurements in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at three months (3M) and six months (6m) compared to baseline values

	AYURVEDA	**YOGA**	**CONTROL**
Anthropometric measurements	6M	6M	6M
Body Mass Index	NSC	NSC	NSC
Mid arm circumference (cm)	NSC	NSC	1.75↓**
Waist / Hip Ratio	NSC	NSC	NSC

p<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

cm= Centimeter

5.1.3.1 Hand grip strength (left hand): The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups - Yoga, Ayurveda and Wait-list Control) showed a significant difference between the groups (F = 3.995, p <.05, Greenhouse-Geisser epsilon = .742), however, there was no significant difference between the assessments (F = .338, p >.05, Greenhouse-Geisser epsilon = .742), and the interaction between the assessments and groups (F = 2.225, p >.05, Greenhouse-Geisser epsilon = .742). The ANOVA results are summarized in Table 5.1.3.A.

The paired t-test showed that the comparisons between the values at three and six months with their respective baseline values were not significant for all three groups (p>.05).

5.1.3.2 Hand grip strength (right hand): The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups - Yoga, Ayurveda and Wait-list Control) showed a significant difference between the groups (F = 3.495, p <.05, Greenhouse-Geisser epsilon = .886), However, there was no significant difference between the assessments (F = .379, p >.05, Greenhouse-Geisser epsilon = .886), and the interaction between the assessments and groups (F = 1.679, p >.05, Greenhouse-Geisser epsilon = .886). The ANOVA results are summarized in Table 5.1.3.B.

The paired t-test showed no significant changes between the values at three and six months compared with the respective baseline values for all three groups (p>.05).

Table 5.1.3.1
Grip Strength: Left-Hand
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.484	4.737	0.338	.650
Between subjects factor (Groups)	2.000	139.473	3.995	**.025**
Interaction (Assessments * Groups)	2.969	31.201	2.225	.094
Error (Within-subjects factor)	69.769	14.024		
Error (Between subjects factor)	47.000	34.912		

*Greenhouse-Geisser epsilon = .742, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.1.3.2
Grip Strength: Right-Hand
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.772	3.104	0.379	.650
Between subjects factor (Groups)	2.000	139.473	0.995	.250
Interaction (Assessments * Groups)	2.969	31.201	2.225	.094
Error (Within-subjects factor)	69.769	14.024		
Error (Between subjects factor)	47.000	34.912		

*Greenhouse-Geisser epsilon = .886, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.1.3.1: Mean ± Standard Deviations of the hand grip scores recorded at baseline (BL), three months (3M) and after six months (6M) for all three groups i.e., Ayurveda (AY), Yoga (YG) and Wait-list Control (CT)

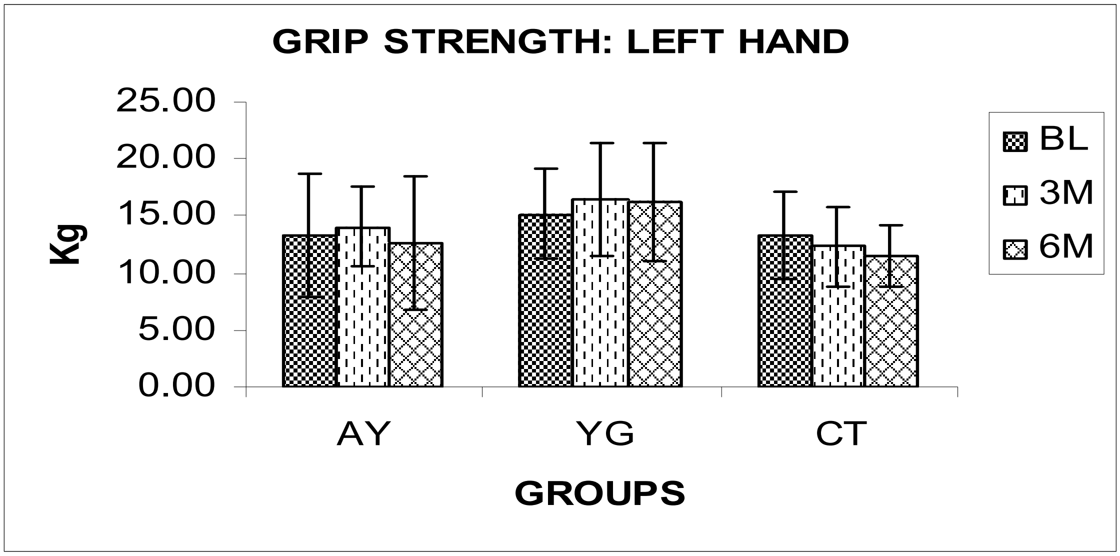
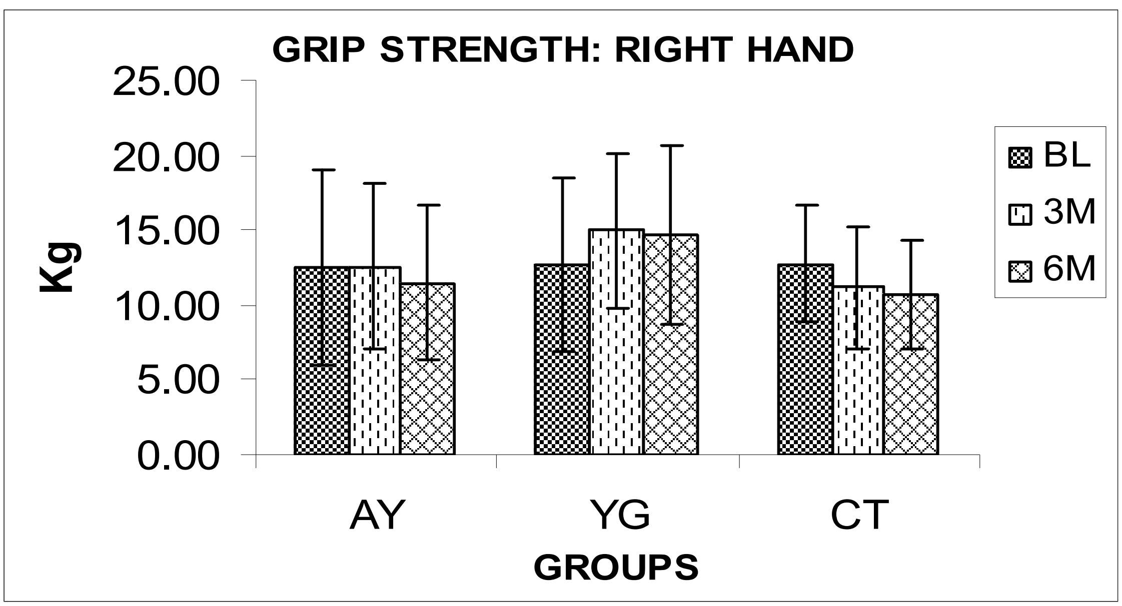


Fig. 5.1.3.2: Mean ± Standard Deviations of the hand grip scores recorded at baseline (BL), three months (3M) and after six months (6M) for all three groups i.e., Ayurveda (AY), Yoga (YG) and Wait-list Control (CT)



The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.1.3.3, at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.1.3.4 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.1.3.5. The summary of changes in hand grip strength in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.1.3.6. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.1.3.7, Table 5.1.3.8 and Table 5.1.3.9 respectively **(see Appendix 8).**

Table 5.1.3.3: Mean ± Standard Deviations of the hand grip strength scores at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list Control)

VARIABLES	AYURVEDA	YOGA	WAIT-LIST CONTROL
n	23	23	23
Right hand (Kg)	13.30 ± 6.04	15.17 ± 5.38	13.28 ± 3.66
Left hand (Kg)	12.48 ± 6.01	12.72 ± 3.55	11.62 ± 3.55

p >.05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list Control groups and comparing Yoga versus Wait-list Control group for all variables

Table 5.1.3.4: Mean ± Standard Deviations of the hand grip strength scores at baseline (BL) and after three months (3M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA		YOGA		WAIT-LIST CONTROL	
VARIABLES	**BL**	**3M**	**BL**	**3M**	**BL**	**3M**
n	15	15	20	20	20	20
Right Hand (Kg) % change	13.17 ± 6.23	12.83 ± 5.31 6.30	14.80 ± 5.65	16.40 ± 4.96 10.81	13.38 ± 3.88	11.47 ± 4.13 -8.07
Left Hand (Kg) % change	11.83 ± 5.88	11.83 ± 4.36 6.26	12.60 ± 3.76	15.00 ± 4.74 19.05	12.55 ± 3.77	10.78 ± 3.41 -11.16

* *p*<. 05, ** *p*< .01, *** *p*<.001, two tailed, t-test for paired data comparing the values at three months versus baseline

Table 5.1.3.5: Mean ± Standard Deviations of the hand grip strength scores recorded from right and left hands at baseline (BL) and after three months (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA			YOGA			WAIT-LIST CONTROL		
VARIABLES	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
n	12	12	12	18	18	18	20	20	20
Right Hand (Kg)	12.08 ± 6.49	13.00 ± 5.46	11.39 ± 5.16	15.25 ± 5.78	16.44 ± 5.17	15.77 ± 5.97	13.38 ± 3.88	12.30 ± 4.13	10.69* ± 3.6
% change		7.62	4.14		7.80	6.56		-8.07	-13.83
Left Hand (Kg)	10.46 ± 5.49	11.13 ± 3.52	10.11 ± 5.88	12.72 ± 3.96	15.03 ± 4.89	13.83 ± 5.23	12.55 ± 3.77	11.15 ± 3.41	10.56 ± 2.74
% change		6.41	9.94		18.16	15.09		-11.16	-14.34

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months versus baseline and six months versus baseline

Table 5.1.3.6: Summary of significant changes in Hand Grip Strength in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

	AYURVEDA		**YOGA**		**CONTROL**	
Hand Grip Strength	3M	6M	3M	6M	3M	6M
Right Hand (Kg)	NSC	NSC	NSC	NSC	NSC	13.8↓*
Left Hand (Kg)	NSC	NSC	NSC	NSC	NSC	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

Kg= Kilogram

5.2. NEUROLOGICAL VARIABLES

Recapitulation: The Neurological variables (Audiometry, Tinetti balance and gait evaluation test, timed-up-and-go test and the heart rate variability) were assessed at baseline and after six months, while the autonomic and respiratory variables and the memory scores were recorded at baseline and after three and six months in all three groups (Yoga, Ayurveda and Wait-list Control). The baseline values of all three groups for all the variables were compared using separate one-way ANOVAs and the results suggested that there were no significant differences at baseline between groups ($p >.05$). As described under the Methods section (data analysis), separate repeated measures ANOVAs were performed to compare the differences between assessments (baseline, three months and six months or baseline and six months as the Within-subjects factor) and the groups (Yoga, Ayurveda and Wait-list Control as the Between subjects factor) and the interaction between the groups and the assessments. The Paired t-tests were performed to compare the data of three and six months of all three groups with their respective baseline values. When the data were dichotomous or scaled (as in the case of Tinetti balance and gait evaluation test), it was ordinal. Hence, a non-parametric statistical test i.e., Wilcoxon paired signed ranks test was used to compare data at six months with those at baseline of each group, separately.

5.2.1 Autonomic and respiratory variables: The autonomic and respiratory variables recorded in all three groups at baseline and after three and six months included (a) galvanic skin conductance, (b) heart rate and (c) Respiratory rate. The heart rate variability was recorded at baseline and after six months.

5.2.1.1 Galvanic skin conductance: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed a significant difference between the assessments (F = 5.589, p <.01, Greenhouse-Geisser epsilon = .976), between the groups (F = 3.860, p <.05, Greenhouse-Geisser epsilon = .976), while the interaction between the assessments and groups was not significant (F = 2.038, p >.05, Greenhouse-Geisser epsilon = .976). The ANOVA results are summarized in Table 5.2.1.1.

Yoga group showed a significant decrease (34.72%) in the Galvanic skin conductance (p <.05, paired t-test, baseline versus six months), while the Wait-list Control group showed a significant increase (41.82%) in the Galvanic skin conductance (p <.05, paired t-test, baseline versus three months). The Ayurveda group showed no change (p >.05, paired t-test).

5.2.1.2 Heart rate: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed no significant difference between the assessments (F = 1.883, p >.05, Greenhouse-Geisser epsilon = .959), between the groups (F = .946, p >.05, Greenhouse-Geisser epsilon = .959) and the interaction between the assessments and groups (F = 2.003, p >.05, Greenhouse-Geisser epsilon = .959). The ANOVA results are summarized in Table 5.2.1.2.

Yoga group showed a significant decrease (8.38%) in the heart rate (p < .01, paired t-test, baseline versus six months), while the Ayurveda and Wait-list Control group showed no change (p >.05, paired t-test).

Table 5.2.1.1
Autonomic variables: Galvanic Skin Conductance
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.951	12.511	5.589	**.005**
Between subjects factor (Groups)	2.000	13.045	3.860	**.028**
Interaction (Assessments * Groups)	3.903	4.562	2.038	.097
Error (Within-subjects factor)	91.710	2.239		
Error (Between subjects factor)	47.000	3.379		

*Greenhouse-Geisser epsilon = .976, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.2.1.2
Autonomic variables: Heart Rate
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.918	96.110	1.883	.158
Between subjects factor (Groups)	2.000	272.921	0.946	.396
Interaction (assessments * subjects)	3.836	102.216	2.003	.104
Error (Within-subjects factor)	90.114	51.027		
Error (Between subjects factor)	47.000	288.493		

*Greenhouse-Geisser epsilon = .959, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.2.1.1: Mean ± Standard Deviations of the galvanic skin conductance at baseline and after three and six months for all three groups (Yoga, Ayurveda and Wait-list control).

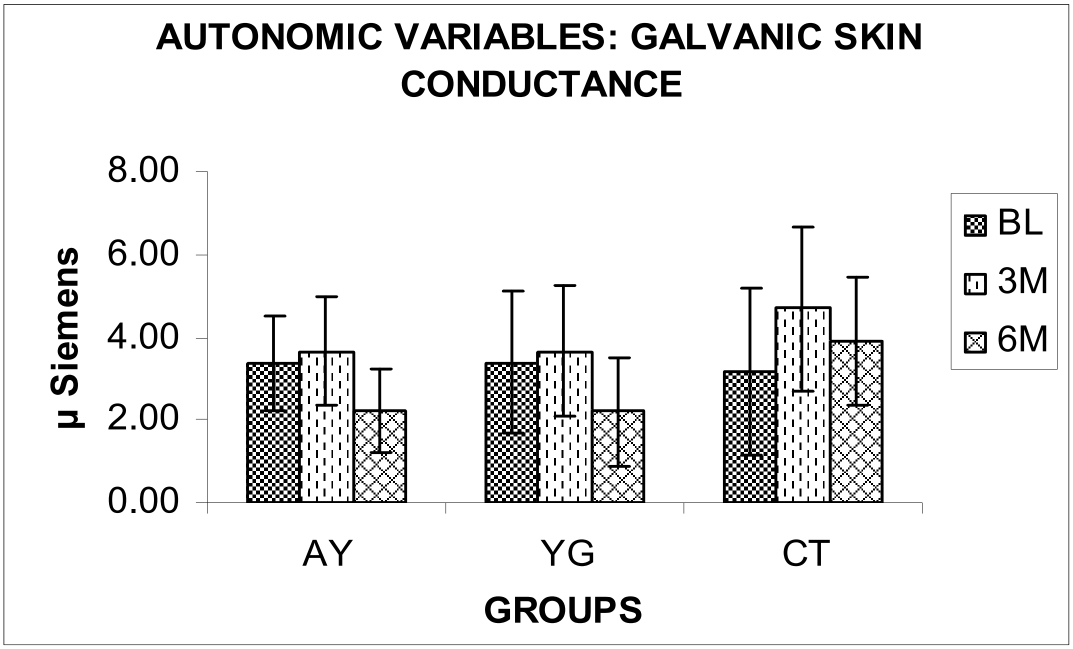
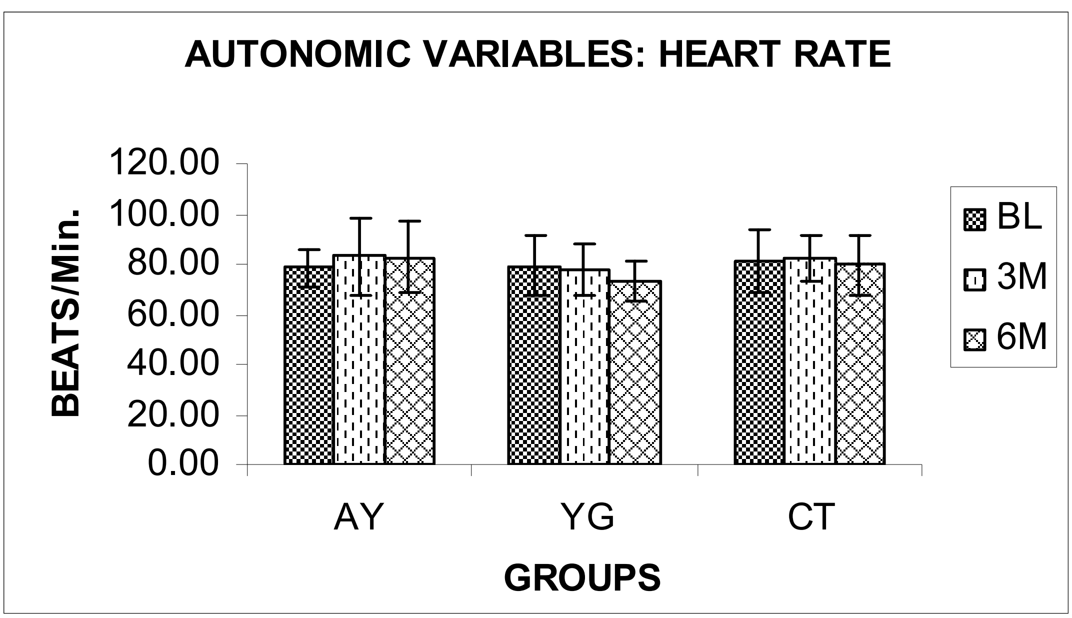


Fig. 5.2.1.2: Mean ± Standard Deviations of the heart rate recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT).



5.2.1.3 Respiratory rate: The repeated measures ANOVA which consisted of one Within-subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list Control) showed significant interaction between the assessments and groups ($F = 3.587$, $p < .05$, Greenhouse-Geisser epsilon = .925). However, there was no significant difference between the assessments ($F = 1.178$, $p > .05$, Greenhouse-Geisser epsilon = .925) and between the groups ($F = .822$, $p > .05$, Greenhouse-Geisser epsilon = .925). The ANOVA results are summarized in Table 5.2.1.3.

Yoga group showed a significant decrease (13.05%) in the respiratory rate ($p < .05$, paired t-test, baseline versus six months), while the Ayurveda and Wait-list Control group showed no change ($p > .05$, paired t-test).

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.1.4, at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.1.5 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.1.6. The summary of changes in autonomic and respiratory variables in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.2.1.7. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.1.8, Table 5.2.1.9 and Table 5.2.1.10 respectively **(see Appendix 8).**

Table 5.2.1.3
Autonomic variables: Respiratory Rate
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within subjects factor (Assessments)	1.849	9.103	1.178	.312
Between subjects factor (Groups)	2.000	21.757	0.822	.446
Interaction (Assessments * Groups)	3.698	27.727	3.587	**.011**
Error (Within subjects factor)	86.907	7.729		
Error (Between subjects factor)	47.000	26.463		

*Greenhouse-Geisser epsilon = .925, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Fig. 5.2.1.3: Mean ± Standard Deviations of the respiratory rate recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT).

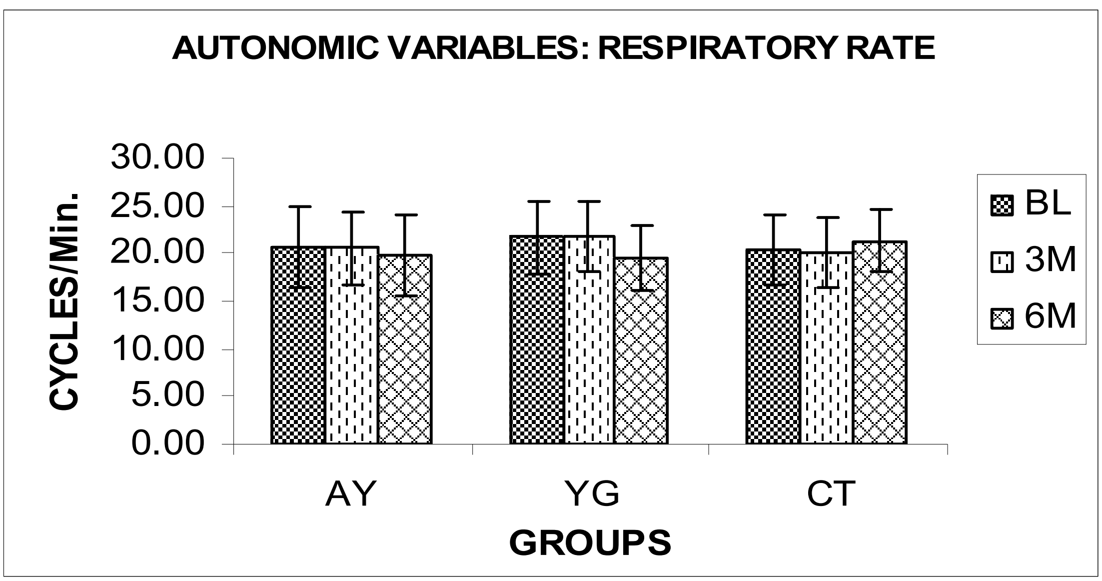


Table 5.2.1.4: Mean ± Standard Deviations of the galvanic skin conductance (GSC), heart rate and respiratory rate at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list control).

VARIABLES	AYURVEDA	YOGA	WAIT-LIST CONTROL
n	23	23	23
G S C (μ Siemens)	2.91 ± 1.68	3.38 ± 1.68	3.16 ± 1.96
Heart Rate (Beats/Min.)	78.57 ± 12.3	79.23 ± 11.87	81.33 ± 11.78
Respiratory Rate (Cycles/Min.)	20.69 ± 3.92	21.74 ± 3.7	20.37 ± 3.65

p >.05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list control group for all variables

Table 5.2.1.5: Mean ± Standard Deviations of the galvanic skin conductance (GSC), heart rate, and respiratory rate at baseline (BL) and after three months (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA		YOGA		WAIT-LIST CONTROL	
VARIABLES	**BL**	**3M**	**BL**	**3M**	**BL**	**3M**
n	15	15	20	20	20	20
G S C (μ Siemens)	3.16 ± 1.18	3.59 ± 1.26 13.61	3.32 ± 1.68	3.66 ± 1.5 10.24	3.30 ± 2.03	4.68* ± 1.99 41.82
Heart Rate (Beats/Min.)	79.60 ± 7.58	82.99 ± 14.1 4.26	78.48 ± 12.22	77.55 ± 10.35 -1.19	80.90 ± 12.31	82.38 ± 9.16 1.83
Respiratory Rate (Cycles/Min.)	20.89 ± 4.02	20.57 ± 4.08 -1.53	22.04 ± 3.87	21.86 ± 3.67 -0.82	20.20 ± 3.55	20.03 ± 3.67 -0.84

* p <.05, ** p <.01, *** p<.001, two tailed, t-test for paired data comparing the values at 3 months versus baseline

Table 5.2.1.6: Mean ± Standard Deviations of the galvanic skin conductance (GSC), heart rate, and respiratory rate recorded at baseline (BL) and after three (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control).

	AYURVEDA			YOGA			CONTROL		
VARIABLES	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
n	12	12	12	18	18	18	20	20	20
G S C (μ Siemens) % change	3.44 ± 1.14	3.57 ± 1.33 3.78	2.69 ± 1.02 -21.80	3.37 ± 1.73	3.58 ± 1.56 6.23	2.2*† ± 1.3 -34.72	3.30 ± 2.03	4.68 ± 1.99 41.82	3.91 ± 1.53 18.48
Heart Rate (Beats/Min.) % change	78.92 ± 7.62	82.32 ± 15.68 4.31	82.50 ± 14.14 4.54	79.63 ± 12.32	78.71 ± 10.09 -1.16	72.96**† ± 8.31 -8.38	80.90 ± 12.31	82.38 ± 9.16 1.83	79.61 ± 11.82 -1.59
Respiratory Rate (Cycles/Min.) % change	20.52 ± 4.17	19.80 ± 3.89 -3.51	19.81 ± 4.16 -3.46	22.46 ± 3.81	22.18 ± 3.72 -1.25	19.53*†† ± 3.28 -13.05	20.20 ± 3.55	20.03 ± 3.67 -0.84	21.32 ± 3.31 5.54

* *p*<. 05, ** *p*< .01, *** *p*< .001, two tailed, t-test for paired data comparing the values at three months versus baseline and six months versus baseline, † *P* < .01, †† *P* <. 001, comparing the values at three months versus six months

Table 5.2.1.7: Summary of significant changes in Autonomic and Respiratory measurements in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

	AYURVEDA		**YOGA**		**CONTROL**	
Autonomic and respiratory	3M	6M	3M	6M	3M	6M
Galvanic Skin Conductance (μ Siemens)	NSC	NSC	NSC	34.72*†	41.82↑*	NSC
Heart rate (Beats/Min.)	NSC	NSC	NSC	8.38**†	NSC	NSC
Respiratory Rate (Cycles/Min.)	NSC	NSC	NSC	13.05*††	NSC	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

5.2.1.11 Heart rate variability spectrum – Low Frequency (LF) power: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the Assessments (F = 4.110, p <.05, Greenhouse-Geisser epsilon = 1.000) and in the interaction between the assessments and groups (F = 3.983, p <.05, Greenhouse-Geisser epsilon = 1.000). However, there was no significant difference between the groups (F = 2.653, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.1.11.

Yoga group showed a significant decrease (22.69%) in the LF power (p < .05, paired t-test, baseline versus six months), while the Ayurveda and Wait-list control group showed no change (p >.05, paired t-test).

5.2.1.12 Heart rate variability spectrum – High Frequency (HF) power: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the Assessments (F = 4.110, p <.05, Greenhouse-Geisser epsilon = 1.000) and in the interaction between the assessments and groups (F = 3.983, p <.05, Greenhouse-Geisser epsilon = 1.000). However, there was no significant difference between the groups (F = 2.653, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.1.12.

Yoga group showed a significant decrease (22.69%) in the LF power (p <.05, paired t-test, baseline versus six months), while the Ayurveda and Wait-list Control groups showed no change (p >.05, paired t-test).

Table 5.2.1.11

Heart rate variability spectrum – Low Frequency power
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	373.48	4.110	**.048**
Between subjects factor (Groups)	2	501.77	2.653	.080
Interaction (Assessments * Groups)	2	361.903	3.983	**.025**
Error **(**Within subjects factor)	52	90.864		
Error (Between subjects factor)	52	189.120		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.1.12

Heart rate variability spectrum – High Frequency power
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	373.481	4.110	**.048**
Between subjects factor (Groups)	2	501.768	2.653	.800
Interaction (Assessments * Groups)	2	361.903	3.983	**.025**
Error (Within subjects factor)	52	90.864		
Error (Between subjects factor)	52	189.120		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Fig. 5.2.1.11: Mean ± Standard Deviations of the HF power of the heart rate variability spectrum at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

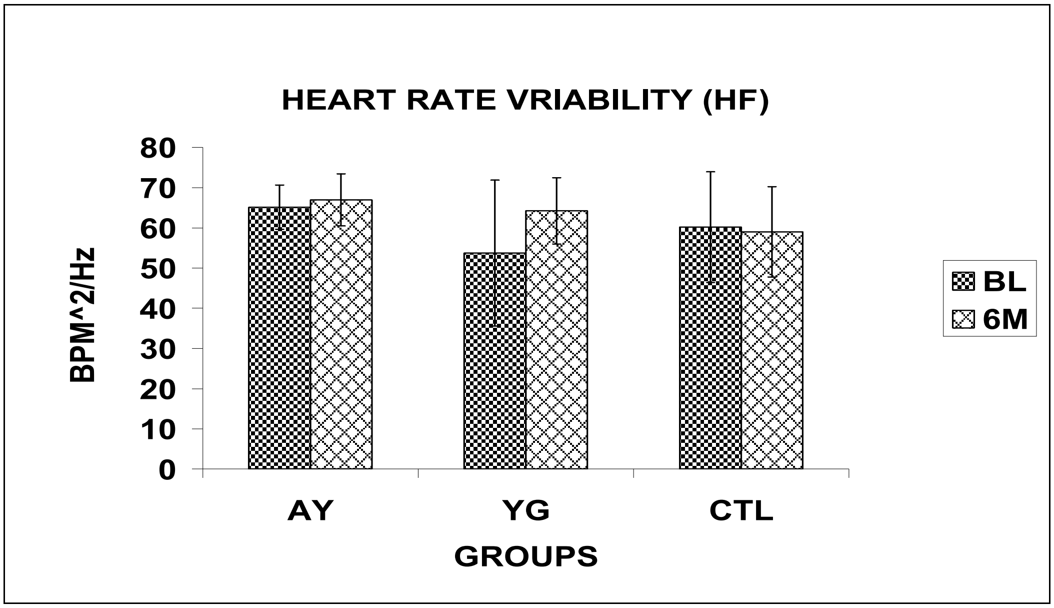
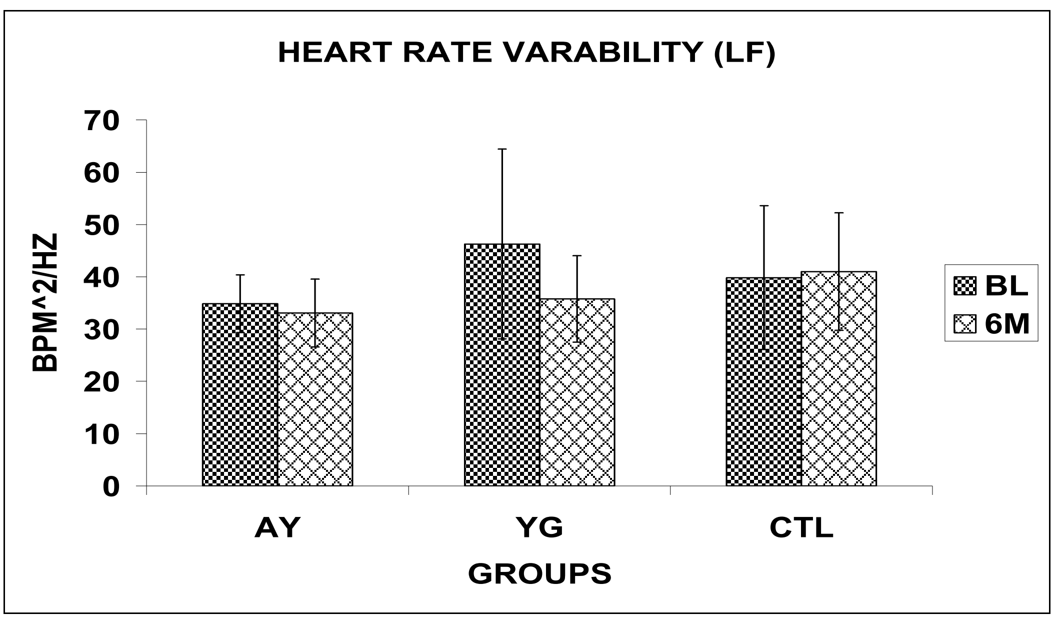


Fig. 5.2.1.12: Mean ± Standard Deviations of the LF power of the heart rate variability spectrum at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.1.13 Heart rate variability spectrum – HF/LF ratio: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the Assessments (F = 3.574, p >.05, Greenhouse-Geisser epsilon = 1.000) and between the groups (F = 2.142, p >.05, Greenhouse-Geisser epsilon = 1.000) and in the interaction between the assessments and groups (F = 2.653, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.1.13.

Yoga group showed a significant increase (19.54%) in the HF/LF ratio (p < .05, paired t-test, baseline versus six months), while the Ayurveda and Wait-list control group showed no change (p >.05, paired t-test).

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.1.14 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.1.15. The summary of changes in autonomic and respiratory variables in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.2.1.16. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.1.17, Table 5.2.1.18 and Table 5.2.1.19 respectively **(see Appendix 8)**.

Table 5.2.1.13

Heart rate variability spectrum – High frequency/ Low frequency ratio
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	1.308	3.574	.064
Between subjects factor (Groups)	2	1.578	2.142	.128
Interaction (assessments * Groups)	2	1.026	2.804	.070
Error (Within subjects factor)	52	.366		
Error (Between subjects factor)	52	.737		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

FIG 5.2.1.13: Mean ± Standard Deviations of LF/HF ratio of the heart rate variability spectrum at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

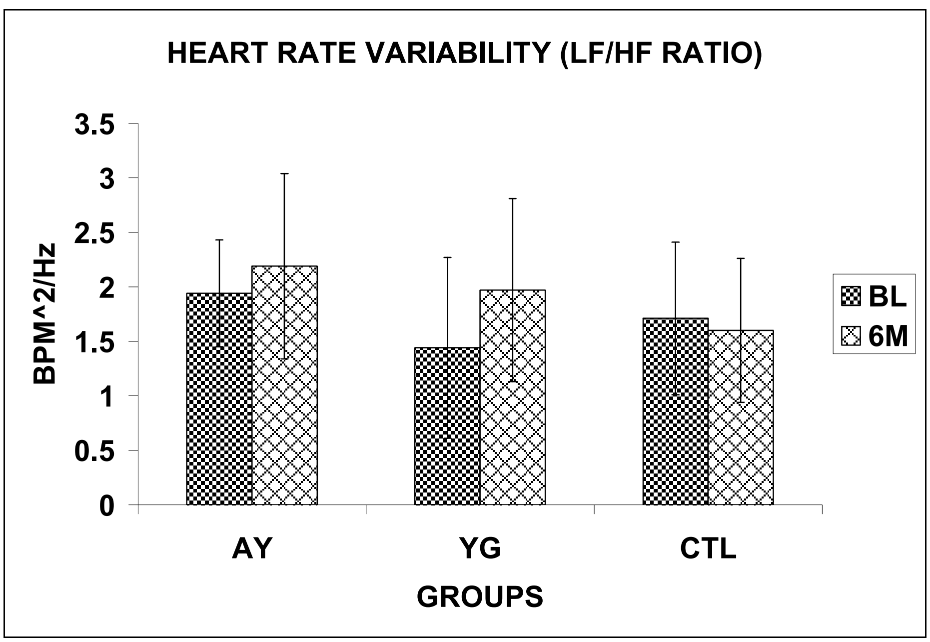


Table 5.2.1.14: Mean ± Standard Deviations of the LF and HF power and LF/HF ratio of the heart rate variability spectrum at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list Control).

	AYURVEDA	**YOGA**	**CONTROL**
n	23	23	23
	38.44	44.23	39.67
LF (nu)	± 9.16	± 17.73	± 13.42
	61.56	55.77	60.33
HF (nu)	± 9.16	± 17.73	± 13.42
	1.73	1.55	1.71
LF/HF Ratio (nu)	± 0.59	± 0.83	± 0.69

p >.05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list Control groups and comparing Yoga versus Wait-list Control group for all variables

Table 5.2.1.15: Mean ± Standard Deviations of the LF, HF power and LF/HF ratio of the heart rate variability spectrum at baseline (BL) and after six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA		**YOGA**		**CONTROL**	
	Baseline	**6 M**	**Baseline**	**6 M**	**Baseline**	**6 M**
n	15	15	20	20	20	20
LF	34.86	33.05	46.27	35.77*	39.84	40.99
(nu)	± 5.52	± 6.48	± 18.15	± 8.26	± 13.75	± 11.23
		-5.19		-22.69		2.89
HF	65.14	66.95	53.74	64.24	60.17	59.01
(nu)	± 5.52	± 6.48	± 18.15	± 8.26	± 13.75	± 11.23
		12.37		36.81		-6.43
LF/HF	1.94	2.19	1.44	1.97*	1.71	1.60
Ratio (nu)	± 0.49	± 0.85	± 0.83	± 0.84	± 0.7	± 0.66
		2.78		19.54		-1.93

* *p* <.05, ** *p* <.01, *** *p* <.001, two tailed, t-test for paired data comparing the values at six months verses baseline

HF = High Frequency, LF = Low Frequency
HF/LF Ratio = High frequency/Low frequency ratio
nu = normalized units

Table 5.1.1.16: Summary of significant changes in Heart Rate Variability in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at six months (6M) compared to baseline values

	AYURVEDA	**YOGA**	**CONTROL**
Heart Rate Variability	6M	6M	6M
LF	NSC	22.69↓*	NSC
HF	NSC	36.81↑*	NSC
HF/LF Ratio	NSC	19.54↑*	NSC

* p<. 05, ** p< .01, ***p< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

LF= Low frequency

HF= High frequency

HF/LF Ratio= High frequency/ Low frequency Ratio

5.2.2 Gait, Balance and Mobility

5.2.2.1 Tinetti balance and gait evaluation: The Tinetti balance and gait evaluation conducted in all three groups at baseline and after three and six months included separate evaluation of (a) balance and (b) gait and (c) the total score of balance & gait.

5.2.2.1A Balance: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments ($F = 5.354$, $p <.05$, Greenhouse-Geisser epsilon = 1.000), and between the groups ($F = 3.682$, $p <.05$, Greenhouse-Geisser epsilon = 1.000). However, the interaction between the assessments and groups was not significantly different ($F = 1.960$, $p >.05$, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.2.1A.

Yoga group showed a significant increase (30.6%) in the balance scores ($p < .001$, Wilcoxon paired signed ranks test, baseline versus six months), while the Ayurveda and Wait-list control groups showed no change ($p >.05$, Wilcoxon paired signed ranks test).

5.2.2.1B Gait: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference in the interaction between the assessments and groups ($F = 3.527$, $p <.05$, Greenhouse-Geisser epsilon = 1.000). However, there was no significant difference either between the assessments ($F = 1.498$, $p >.05$, Greenhouse-Geisser epsilon = 1.000) or between the groups ($F = 2.093$, $p >.05$, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.2.1B.

Yoga group showed a significant increase (26.85%) in the balance scores ($p < .01$, Wilcoxon paired signed ranks test, baseline versus six months), while the Ayurveda and Wait-list control groups showed no change ($p > .05$, Wilcoxon paired signed ranks test).

Table 5.2.2.1A

Gait and Balance evaluation: Measures of balance
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	29.216	5.354	**.025**
Between subjects factor (Groups)	2	56.119	3.682	**.033**
Interaction (Assessments * Groups)	2	10.692	1.960	.152
Error (Within subjects factor)	47	5.457		
Error (Between subjects factor)	47	15.241		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.2.1B

Gait and Balance evaluation: Measures of gait
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	5.188	1.498	.227
Between subjects factor (Groups)	2	25.369	2.093	.135
Interaction (assessments * subjects)	2	12.213	3.527	**.037**
Error (Within subjects factor)	47	3.462		
Error (Between subjects factor)	47	12.120		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

FIG 5.2.2.1A: Mean ± Standard Deviations of the balance scores at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

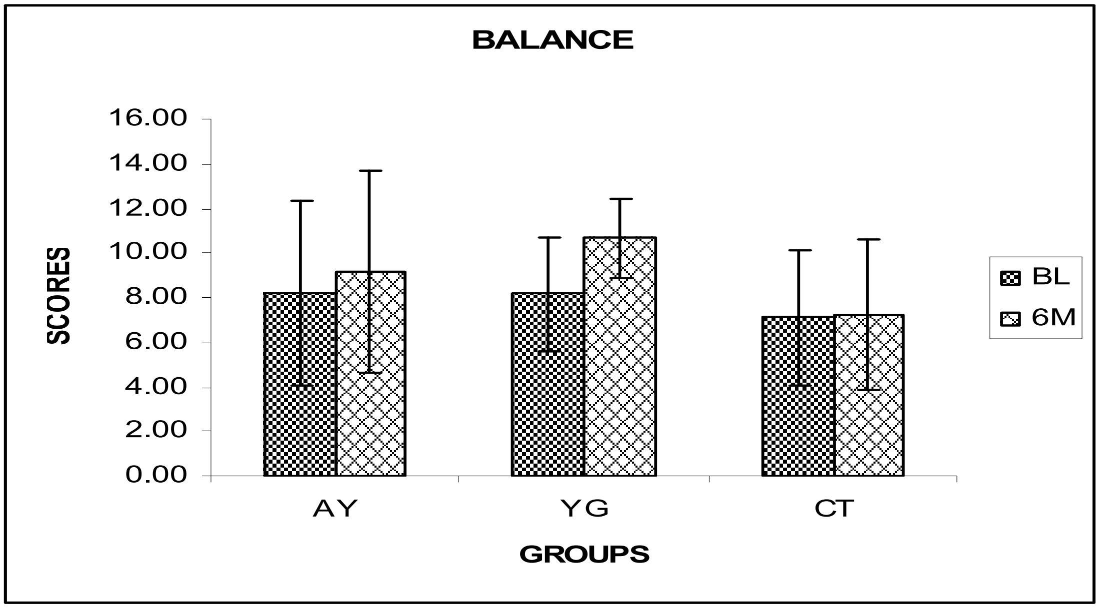
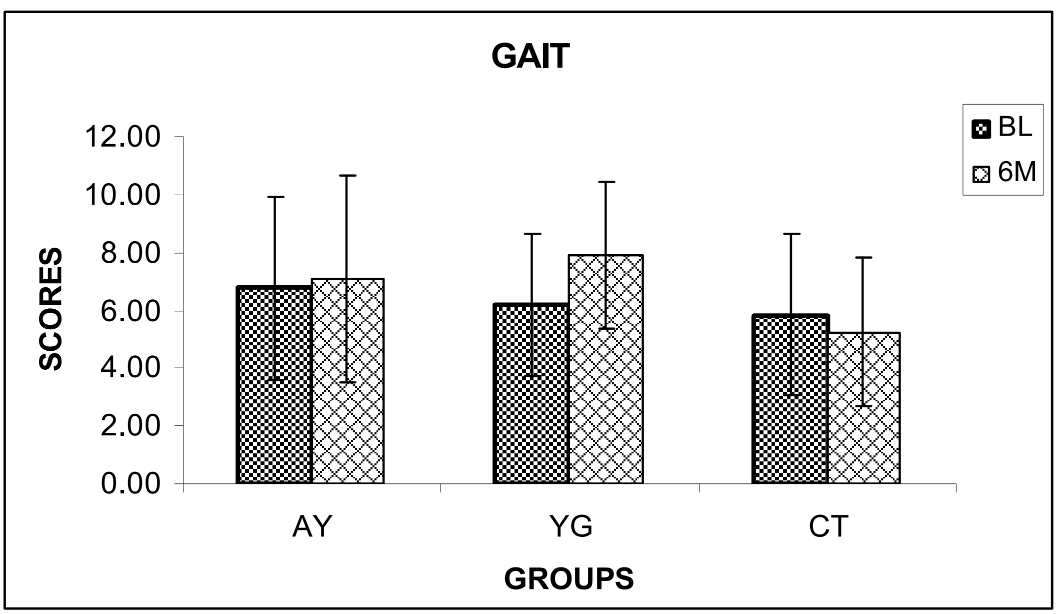


FIG 5.2.2.1B: Mean ± Standard Deviations of the gait scores at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.2.1C Balance and Gait: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments ($F = 5.717$, $p < .01$, Greenhouse-Geisser epsilon = 1.000), and the interaction between the assessments and groups ($F = 4.484$, $p < .05$, Greenhouse-Geisser epsilon = 1.000). However, there was no significant difference between the groups ($F = 2.723$, $p > .05$, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.2.1C.

Yoga group showed a significant increase (28.98%) in the total scores for balance and gait ($p < .001$, Wilcoxon paired signed ranks test, baseline versus six months), while the Ayurveda and Wait-list Control groups showed no change ($p > .05$, Wilcoxon paired signed ranks test).

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.2.1D and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.2.1E. The summary of changes in balance and gait in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months are given in Table 5.2.2.1F. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.2.1G, Table 5.2.2.1H and Table 5.2.2.1I respectively **(see Appendix 8).**

Table 5.2.2.1C

Gait and Balance evaluation: Measures of gait & balance (total score)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within subjects factor (Assessments)	1	66.176	5.717	**.021**
Between subjects factor (Groups)	2	145.772	2.723	.076
Interaction (Assessments * Groups)	2	51.903	4.484	**.017**
Error (Within subjects factor)	47	11.576		
Error (Between subjects factor)	47	53.526		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

FIG 5.2.2.1C: Mean ± Standard Deviations of the gait and scores at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

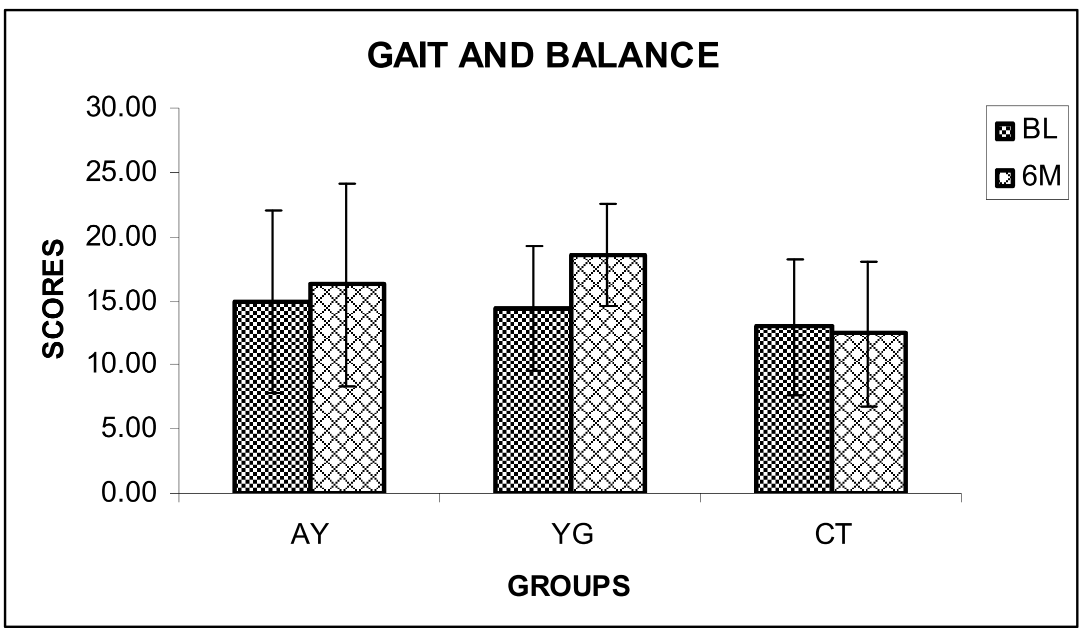


Table 5.2.2.1D: Mean ± Standard Deviations of the balance, gait and total scores at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA	YOGA	CONTROL
	Baseline	**Baseline**	**Baseline**
n	12	18	20
Balance (Score)	8.17 ± 4.13	8.17 ± 2.57	7.10 ± 3.06
Gait (Score)	5.9 ± 3.17	6.5 ± 2.46	5.85 ± 2.76
Total (Score)	12.8 ± 7.15	14.39 ± 4.85	12.95 ± 5.29

p >. 05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list control group for all variables

Table 5.2.2.1E: Mean ± Standard Deviations of the balance, gait and total scores at baseline (BL) and after six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA		YOGA		CONTROL	
	Baseline	**6 M**	**Baseline**	**6 M**	**Baseline**	**6 M**
n	12	12	18	18	20	20
Balance	8.17 ± 4.13	9.17 ± 4.51 12.24	8.17 ± 2.57	10.67*** ± 1.78 30.60	7.10 ± 3.06	7.20 ± 3.38 1.41
Gait	5.9 ± 3.17	7.08 ± 3.55 4.89	6.22 ± 2.46	7.89** ± 2.52 26.85	5.85 ± 2.76	5.25 ± 2.59 -10.26
Total	12.8 ± 7.15	16.25 ± 7.89 8.91	14.39 ± 4.85	18.56*** ± 4.03 28.98	12.95 ± 5.29	12.45 ± 5.64 -3.86

* *p* <.05, ** *p* <.01, *** *p* <.001, two tailed, Wilcoxon paired signed ranks test comparing the values at six months verses baseline.

Table 5.2.2.1F: Summary of significant changes in Balance and Gait measurements in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months (6M) compared to baseline values

	AYURVEDA	**YOGA**	**CONTROL**
Balance and Gait	6M	6M	6M
Balance	NSC	30.60↑***	NSC
Gait	NSC	26.85**	NSC
Total	NSC	28.98↑***	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

5.2.2.2 Timed-up-and-go test: The Timed-up-and-go test conducted in all three groups at baseline and after six months included (a) the time taken to complete the task and (b) number of steps taken to complete the task.

5.2.2.2A Time taken to complete the task: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = 2.721, p >.05, Greenhouse-Geisser epsilon = 1.000), and between the groups (F = .232, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 1.075, p >.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.2.2A.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p>.05).

5.2.2.2B Number of steps taken to complete the task: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 25.114, p <.001, Greenhouse-Geisser epsilon = 1.000), and between the groups (F = 3.865, p <.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 3.645, p <.05, Greenhouse-Geisser epsilon = 1.000). The ANOVA results are summarized in Table 5.2.2.2B.

Both Yoga group and the Ayurveda group showed a significant decrease (31.67%, 19.54%, respectively) in the number of steps taken to complete the task (p < .001, p <.05, respectively, paired t-test, baseline versus six months). The Wait-list control group showed no change (p >.05, paired t-test).

Table 5.2.2.2A
Gait and Balance evaluation: Timed-up-and-go-test, time taken
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	41.185	2.721	.106
Between subjects factor (Groups)	2	5.442	.232	.793
Interaction (Assessments * Groups)	2	16.269	1.075	.350
Error (Within-subjects factor)	47	15.138		
Error (Between subjects factor)	47	23.413		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.2.2B
Gait and Balance evaluation: Timed-up-and-go-test, number of steps
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	376.251	25.114	**.001**
Between subjects factor (Groups)	2	98.876	3.865	**.028**
Interaction (Assessments * Groups)	2	54.602	3.645	**.034**
Error (Within-subjects factor)	47	14.982		
Error (Between subjects factor)	47	25.581		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Fig 5.2.2.2A: Mean ± Standard Deviations of the "timed-up-and-go-test" (time taken to complete the task) at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

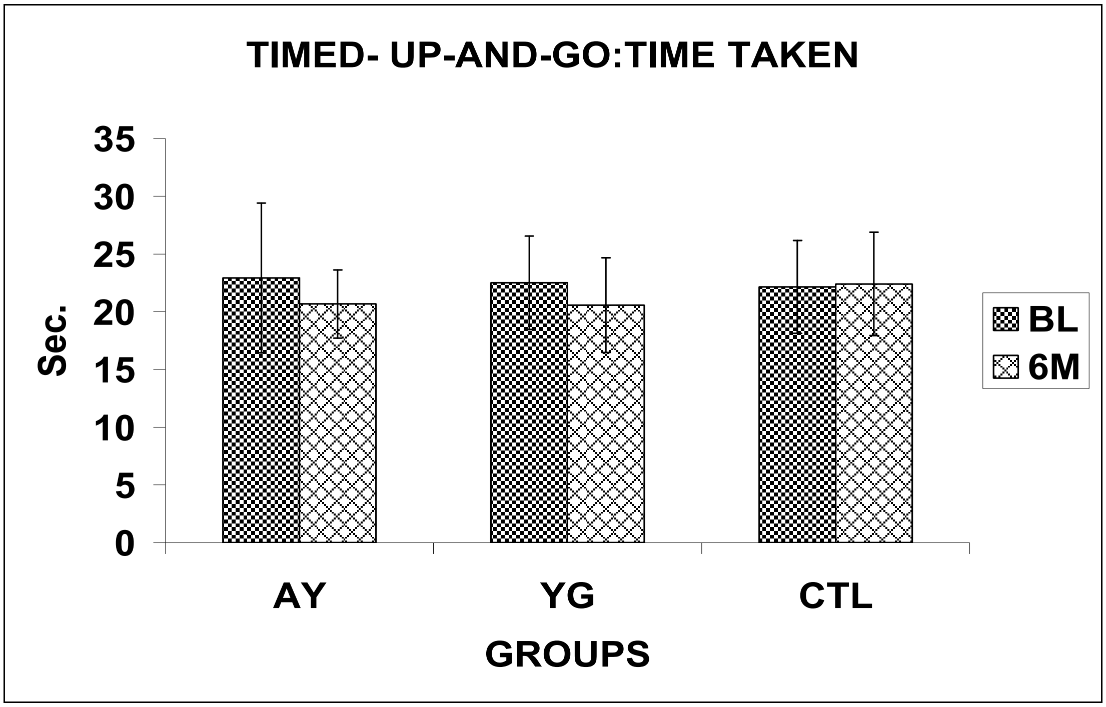
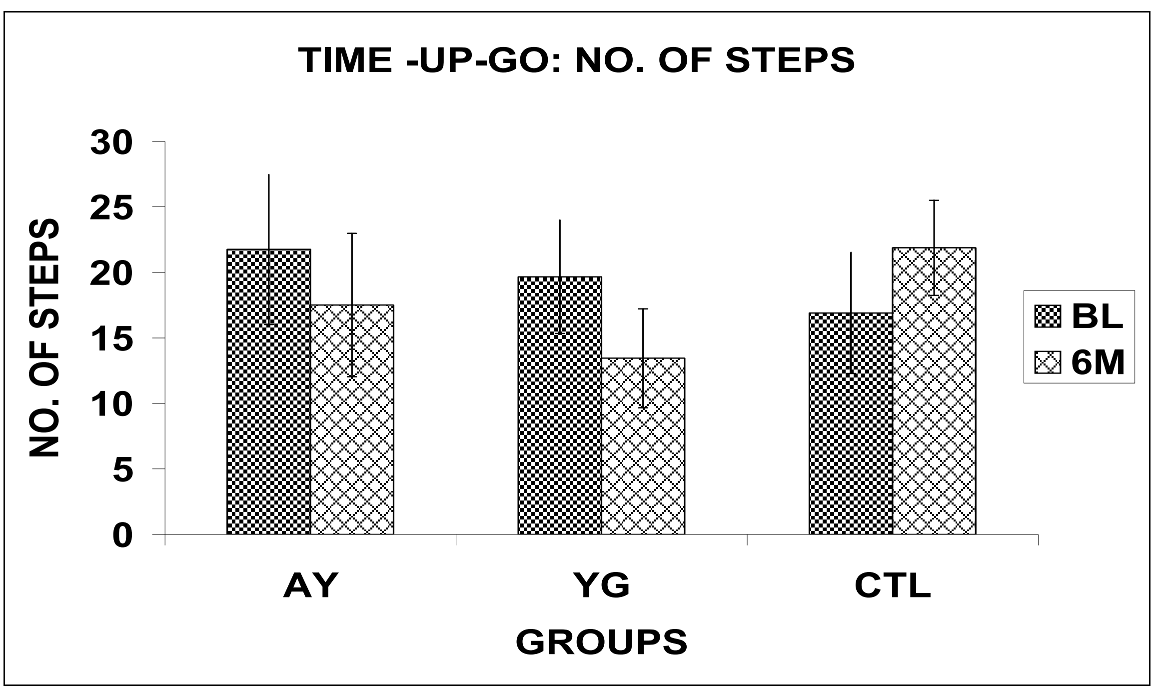


Fig 5.2.2.2B: Mean ± Standard Deviations of the "timed-up-and-go-test" (number of steps used to complete the task) at baseline (BL) and after six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.2.2C and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.2.2D. The summary of changes in the timed-up-and-go test in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months are given in Table 5.2.2.2E. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.2.2F, Table 5.2.2.2G and Table 5.2.2.2H respectively **(see Appendix 8).**

Table 5.2.2.2C: Mean ± Standard Deviations of the "timed-up-and-go-test" (number of steps used to complete the task and the time taken to complete the task) at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list Control)

VARIABLES	AYURVEDA	YOGA	CONTROL
n	23	23	23
STEPS (number)	22.04 ± 8.33	19.70 ± 4.26	17.13 ± 4.98
TIME (Sec.)	24.22 ± 7.07	22.35 ± 4.07	15.45 ± 3.95

p >.05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list control group for all variables

Table 5.2.2.2D: Mean ± Standard Deviations of the "timed-up-and-go-test" (number of steps used to complete the task and the time taken to complete the task) at baseline (BL) and after six months (6M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA		**YOGA**		**CONTROL**	
	Baseline	**6 M**	**Baseline**	**6 M**	**Baseline**	**6 M**
n	12	12	18	18	20	20
STEPS (number) % change	21.75 ± 5.72	17.5* ± 5.47 -19.54	19.67 ± 4.33	13.44*** ± 3.78 -31.67	16.90 ± 4.62	21.87 ± 3.63 -8.58
TIME (Sec.) % change	22.92 ± 6.49	20.67 ± 2.96 -9.82	22.50 ± 4.05	20.56 ± 4.1 -8.62	22.15 ± 4.02	22.40 ± 4.48 1.13

* *p* <.05, ** *p* <.01, *** *p* <.001, two tailed, t-test for paired data comparing the values at six months versus baseline

Table 5.1.1.1E: Summary of significant changes in the Time-up-and-go test in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months (6M) compared to baseline values

	AYURVEDA	**YOGA**	**CONTROL**
Timed-up-and-go	6M	6M	6M
Number of steps	↓19.5%*	↓31.7%****	NSC
Time taken	NSC	NSC	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

5.2.3. Wechsler memory scale: The different aspects of memory recorded using the Wechsler memory scale in all three groups at baseline and after three and six months included (a) Current information, (b) orientation (c) mental control (counting digits by 2, counting alphabets and counting numbers 1 to 10 and back to 1) (d) Digit span (forward and backward) and (e) associate learning (hard and easy).

5.2.3.1 Current information: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 6.442, p <.01, Greenhouse-Geisser epsilon = .913). However there was no significant difference between the groups (F = 1.113, p >.05, Greenhouse-Geisser epsilon = .913) and the interaction between the assessments and groups (F = .520, p >.05, Greenhouse-Geisser epsilon = .913). The ANOVA results are summarized in Table 5.2.3.1.

The Yoga group showed a significant increase (23.91% and 37.24%) in the memory scores recorded at three and six months respectively (p < .01, p <.05, paired t-test, baseline versus three and six months respectively). The Ayurveda and the Wait-list control groups showed no significant change (p >.05, paired t-test).

Table 5.2.3.1

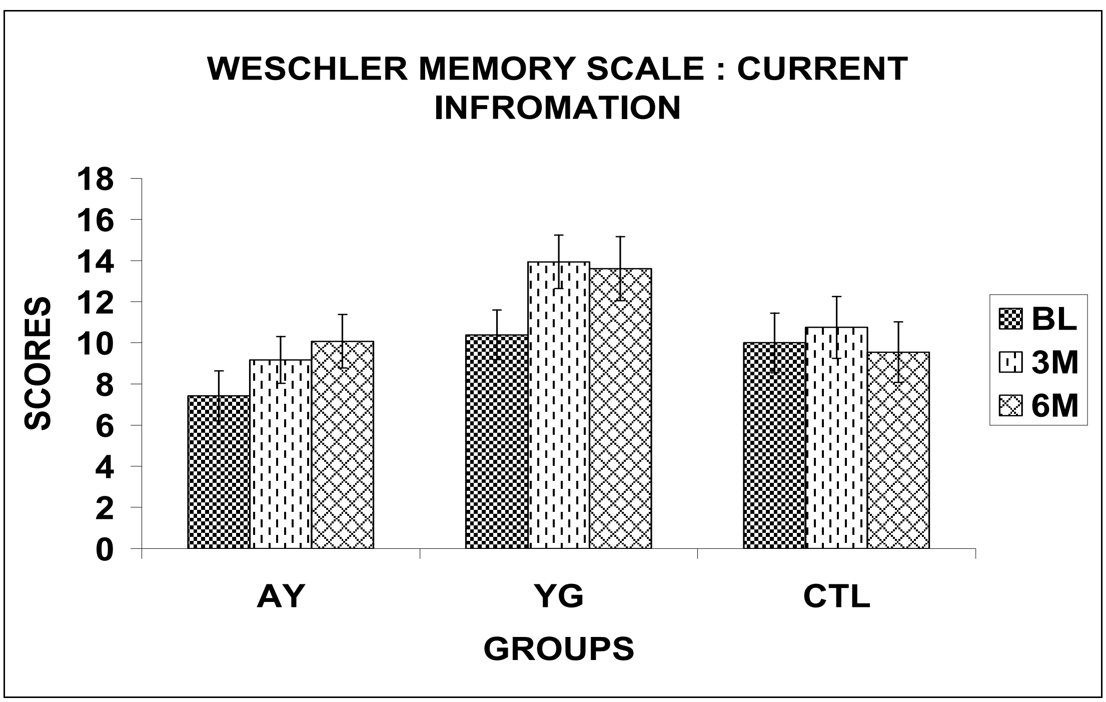
Wechsler memory scale: Current information

Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.827	4.414	6.442	**.002**
Between subjects factor (Groups)	2	4.954	1.113	.337
Interaction (Assessments * Groups)	3.653	.356	.520	.705
Error (Within-subjects factor)	85.847	.685		
Error (Between subjects factor)	47	4.450		

*Greenhouse-Geisser epsilon = .913, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.2.3.1: Mean ± Standard Deviations of the "Wechsler memory scale – current information" at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.3.2 Orientation: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 5.673, p <.01, Greenhouse-Geisser epsilon = .954). However there was no significant difference between the groups (F = 1.823, p >.05, Greenhouse-Geisser epsilon = .954) and the interaction between the assessments and groups (F = 1.464, p >.05, Greenhouse-Geisser epsilon = .954). The ANOVA results are summarized in Table 5.2.3.2.

The paired t-test for the comparisons between the values at three and six months with their respective baseline values showed no significant change for all three groups (p>.05).

5.2.3.3 Mental control: Aspects of memory studied under mental control included (i) counting alphabets, (ii) counting digits by 2 and (iii) counting numbers 1 to 10 and back to 1.

5.2.3.3A Counting alphabets: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 6.807, p <.01, Greenhouse-Geisser epsilon = .837). However there was no significant difference between the groups (F = .944, p >.05, Greenhouse-Geisser epsilon = .837) and the interaction between the assessments and groups (F = 1.930, p >.05, Greenhouse-Geisser epsilon = .837). The ANOVA results are summarized in Table 5.2.3.3A.

The time taken to complete the alphabets has reduced significantly in the Yoga group both at three months (29.51%, $p < .01$, paired t-test) and six months (31.27%, $p < .001$, paired t-test). The Ayurveda and the Wait-list control groups showed no significant change ($p > .05$, paired t-test).

Table 5.2.3.2
Wechsler memory scale: Orientation
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.908	6.112	5.673	**.005**
Between subjects factor (Groups)	2	8.059	1.823	.173
Interaction (Assessments * Groups)	3.816	1.577	1.464	.222
Error (Within-subjects factor)	89.675	1.077		
Error (Between subjects factor)	47	4.421		

*Greenhouse-Geisser epsilon = .954, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Table 5.2.3.3A
Wechsler memory scale: Mental control (alphabets)
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.720	132.204	6.807	**.003**
Between subjects factor (Groups)	2	43.170	.944	.396
Interaction (Assessments * Groups)	3.441	37.488	1.930	.123
Error (Within-subjects factor)	80.856	19.422		
Error (Between subjects factor)	47	45.713		

*Greenhouse-Geisser epsilon = .837, hence df, MS, F and P values are noted taking Greenhouse-Geisser epsilon into account.

Fig. 5.2.3.2: Mean ± Standard Deviations of the scores of Wechsler memory scale – orientation” at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

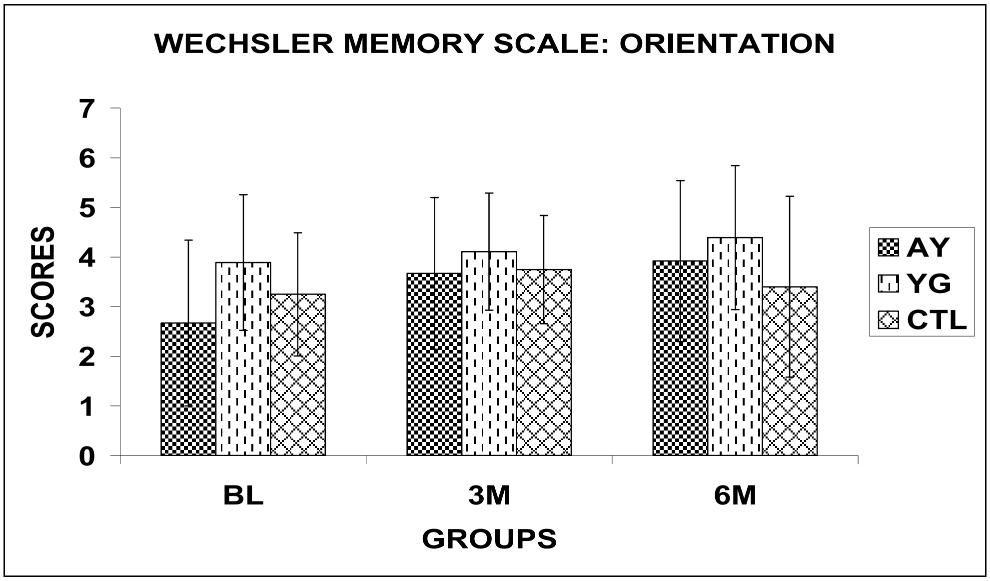
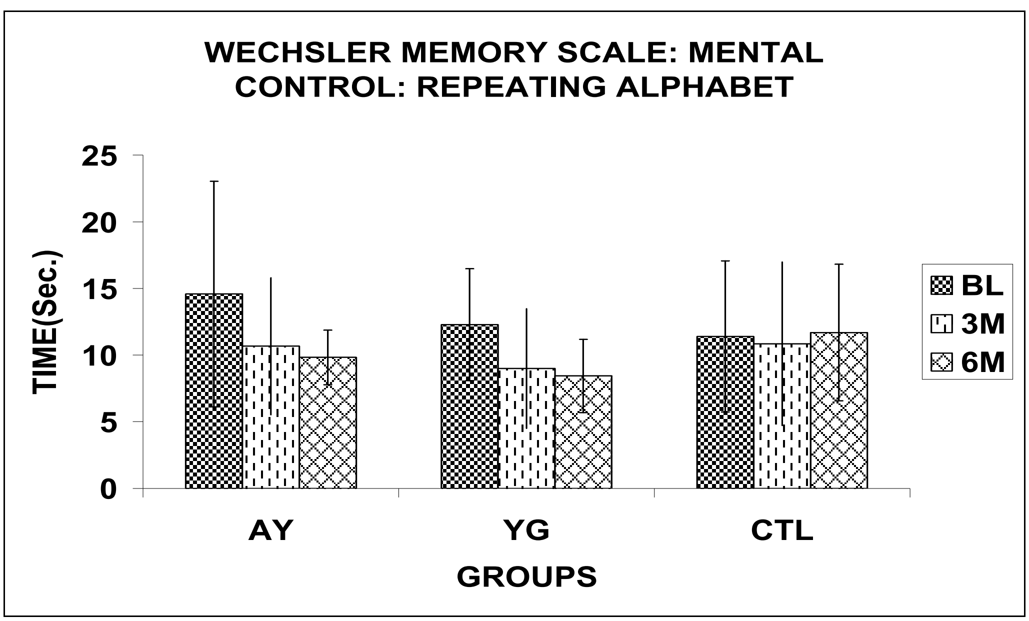


Fig. 5.2.3.3A: Mean ± Standard Deviations of the scores of Wechsler memory scale – mental control (alphabets) at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.3.3B Counting digits by two: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = 1.205, p >.05, Greenhouse-Geisser epsilon = .978), between the groups (F = .736, p >.05, Greenhouse-Geisser epsilon = .978), while there was a significant interaction between the assessments and groups (F = 2.911, p <.05, Greenhouse-Geisser epsilon = .978). The ANOVA results are summarized in Table 5.2.3.3B.

The time taken to count the multiples of two has reduced significantly in the Yoga group (23.07%, p <.05, paired t-test, comparing the values at six month with the baseline values). The Ayurveda and the Wait-list control groups showed no significant change (p >.05, paired t-test).

5.2.3.3C Counting digits 1 to 10 and back to 1: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = 1.697, p >.05, Greenhouse-Geisser epsilon = .812), between the groups (F = .834, p >.05, Greenhouse-Geisser epsilon = .812) and the interaction between the assessments and groups (F = 2.569, p >.05, Greenhouse-Geisser epsilon = .812). The ANOVA results are summarized in Table 5.2.3.3C. The time taken to count 1 to 10 and back to 1 has reduced significantly in the Yoga group (30.58%, p <.001, paired t-test, comparing the values at six months with the baseline values). The Ayurveda and the Wait-list control groups showed no significant change (p >.05, paired t-test).

Table 5.2.3.3B
Wechsler memory scale: Mental control (counting digits by 2)
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.957	21.304	1.205	.304
Between subjects factor (Groups)	2	57.164	.736	.485
Interaction (Assessments * Groups)	3.913	51.139	2.911	**.027**
Error (Within-subjects factor)	91.963	17.672		
Error (Between subjects factor)	47	77.713		

*Greenhouse-Geisser epsilon = .978, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.2.3.3C
Wechsler memory scale: Mental control (counting digits, 1 to 10 and back to 1)
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.623	39.807	1.697	.195
Between subjects factor (Groups)	2	67.753	.834	.441
Interaction (Assessments * Groups)	3.246	60.251	2.569	.056
Error (Within-subjects factor)	76.285	23.454		
Error (Between subjects factor)	47	81.247		

*Greenhouse-Geisser epsilon = .812, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.2.3.3B: Mean ± Standard Deviations of the scores of Wechsler memory scale – mental control (counting digits by 2) at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

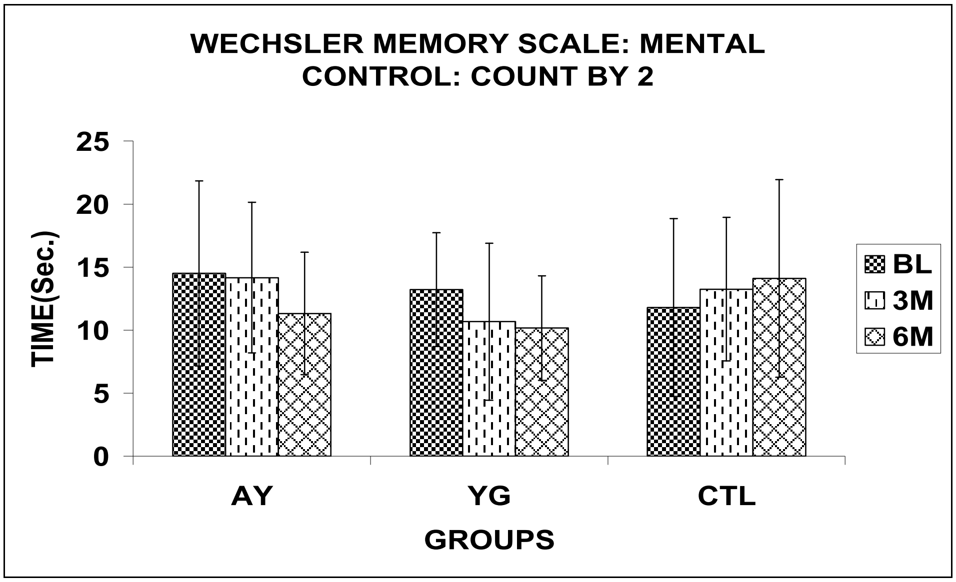
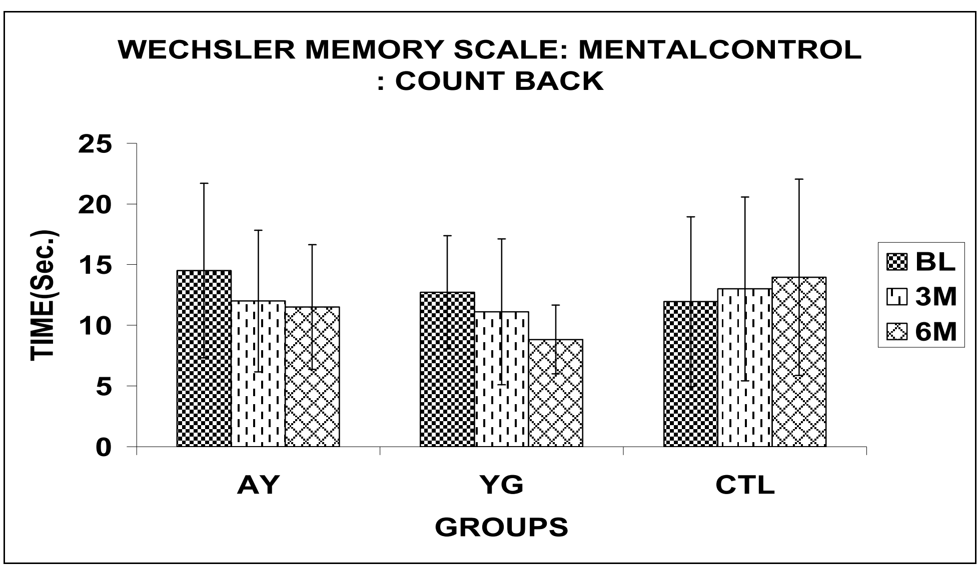


Fig. 5.2.3.3C: Mean ± Standard Deviations of the scores of Wechsler memory scale – mental control (counting digits from 1 to 10 and back to 1) at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.3.4A Digit span forward: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 17.320, p <.001, Greenhouse-Geisser epsilon = .892), between the groups (F = 5.085, p <.05, Greenhouse-Geisser epsilon = .892). However, the interaction between the assessments and groups was not significant (F = 1.335, p >.05, Greenhouse-Geisser epsilon = .892). The ANOVA results are summarized in Table 5.2.3.4A.

The digit span forward scores have increased significantly at three months in all the three groups i.e., Yoga (40.71%, p <.01, paired t-test), Ayurveda (31.12%, p <.05, paired t-test) and Wait-list Control group (42.10%, p <.001, paired t-test). At six months, the scores have significantly increased in the Yoga group (42%, p <.001, paired t-test), while the Ayurveda and Wait-list Control groups showed no change (p >.05, paired t-test).

5.2.3.4B Digit span backward: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 7.408, p <.01, Greenhouse-Geisser epsilon = .931), between the groups (F = 4.815, p <.05, Greenhouse-Geisser epsilon = .931) and the interaction between the assessments and groups (F = 2.780, p <.05, Greenhouse-Geisser epsilon = .931). The ANOVA results are summarized in Table 5.2.3.4B.

The scores of the Yoga group have increased significantly (34.78% and 75.28%, at three and sox months respectively) (p <.05 and p <.01, paired t-test, comparing values at three and six months with the baseline values respectively). The Ayurveda and the Wait-list Control groups showed no change (p >.05, paired t-test).

Table 5.2.3.4A
Wechsler memory scale: Digit span-forward
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.785	519.976	17.320	**.001**
Between subjects factor (Groups)	2	506.824	5.085	**.010**
Interaction (Assessments * Groups)	3.569	40.086	1.335	.266
Error (Within-subjects factor)	83.883	30.021		
Error (Between subjects factor)	47	99.678		

*Greenhouse-Geisser epsilon = .892, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.2.3.4B
Wechsler memory scale: Digit span-backward
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.862	141.023	7.408	**.001**
Between subjects factor (Groups)	2	175.465	4.815	**.013**
Interaction (Assessments * Groups)	3.724	52.923	2.780	**.035**
Error (Within-subjects factor)	87.518	19.038		
Error (Between subjects factor)	47	36.440		

*Greenhouse-Geisser epsilon = .931, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.2.3.4A: Mean ± Standard Deviations of the scores of Wechsler memory scale – digit span forward at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

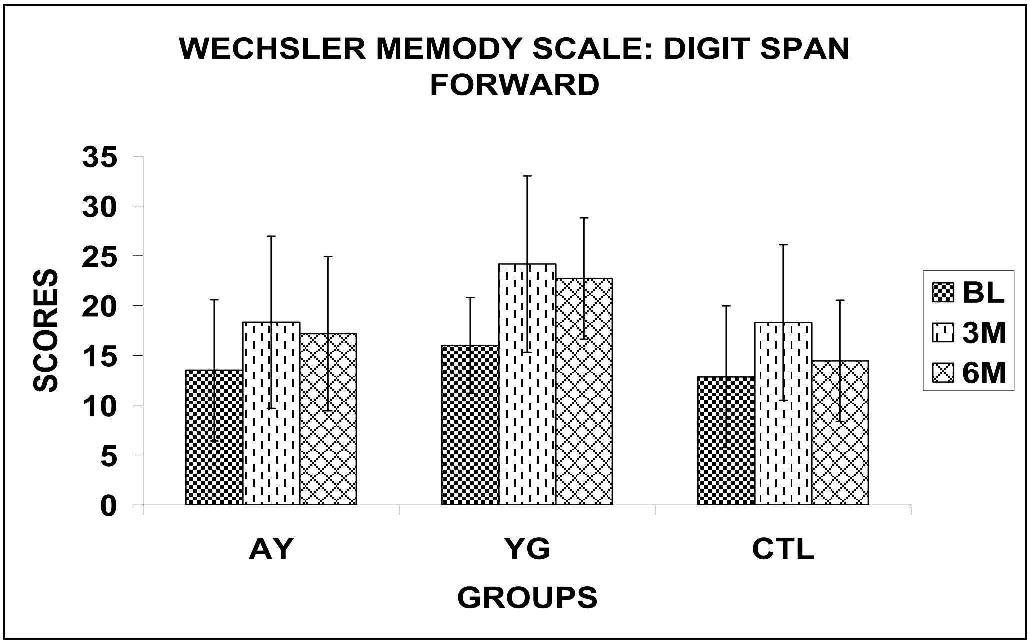
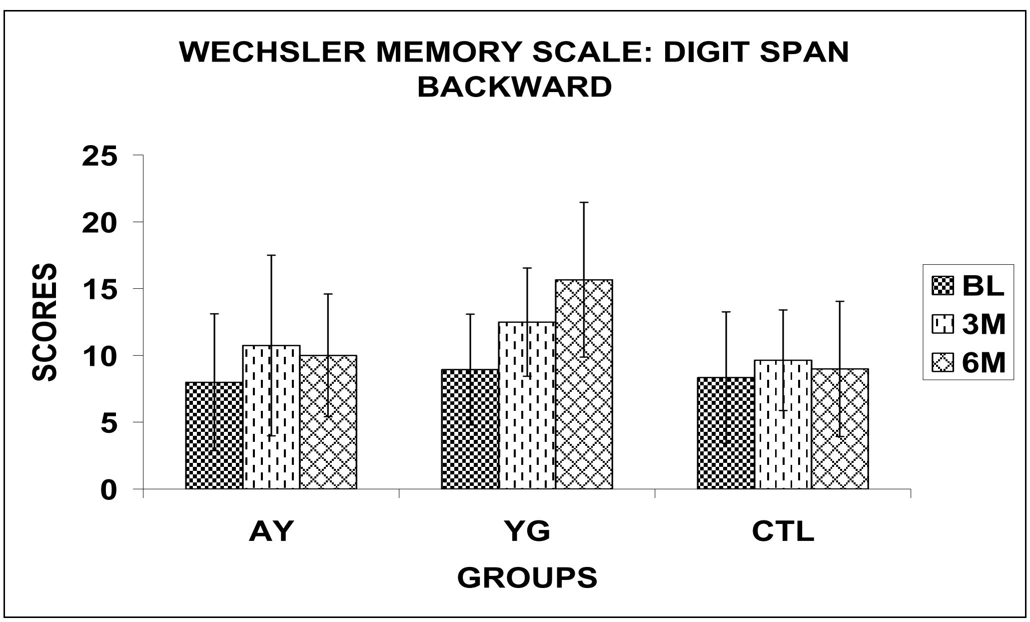


Fig. 5.2.3.4B: Mean ± Standard Deviations of the scores of Wechsler memory scale – digit span backward at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



5.2.3.5A Associate learning - hard: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the groups (F = 3.472, p <.05, Greenhouse-Geisser epsilon = .948), However there was no significant difference between the assessments (F = .454, p >.05, Greenhouse-Geisser epsilon = .948) and the interaction between the assessments and groups (F = 1.361, p >.05, Greenhouse-Geisser epsilon = .948). The ANOVA results are summarized in Table 5.2.3.5A.

The associate learning (hard) scores of the Wait-list control group have decreased (55.77%) significantly (p <.05, paired t-test, comparing values at six months with the baseline values). The Yoga and the Ayurveda groups showed no change (p >.05, paired t-test).

5.2.3.5B Associate learning - easy: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 9.297, p <.001, Greenhouse-Geisser epsilon = .973), between the groups (F = 6.842, p <.01, Greenhouse-Geisser epsilon = .973) and the interaction between the assessments and groups (F = 3.351, p <.05, Greenhouse-Geisser epsilon = .973). The ANOVA results are summarized in Table 5.2.3.5B.

The associate learning (easy) scores of the Yoga group have increased (30.99%) significantly (p <.01, paired t-test, comparing values at six months with the baseline values). The Ayurveda and the Wait-list control groups showed no change (p >.05, paired t-test).

Table 5.2.3.5A
Wechsler memory scale: Associate learning (hard)
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.895	1.666	.454	.626
Between subjects factor (Groups)	2	31.365	3.472	**.039**
Interaction (Assessments * Groups)	3.791	4.995	1.361	.255
Error (Within-subjects factor)	89.085	3.670		
Error (Between subjects factor)	47	9.034		

*Greenhouse-Geisser epsilon = .948, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.2.3.5B
Wechsler memory scale: Associate learning (easy)
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.947	60.407	9.297	**.000**
Between subjects factor (Groups)	2	172.261	6.842	**.002**
Interaction (Assessments * Groups)	3.893	21.771	3.351	**.014**
Error (Within-subjects factor)	91.488	6.497		
Error (Between subjects factor)	47	25.176		

*Greenhouse-Geisser epsilon = .973, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.2.3.5A: Mean ± Standard Deviations of the scores of Wechsler memory scale – associate learning (hard) at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

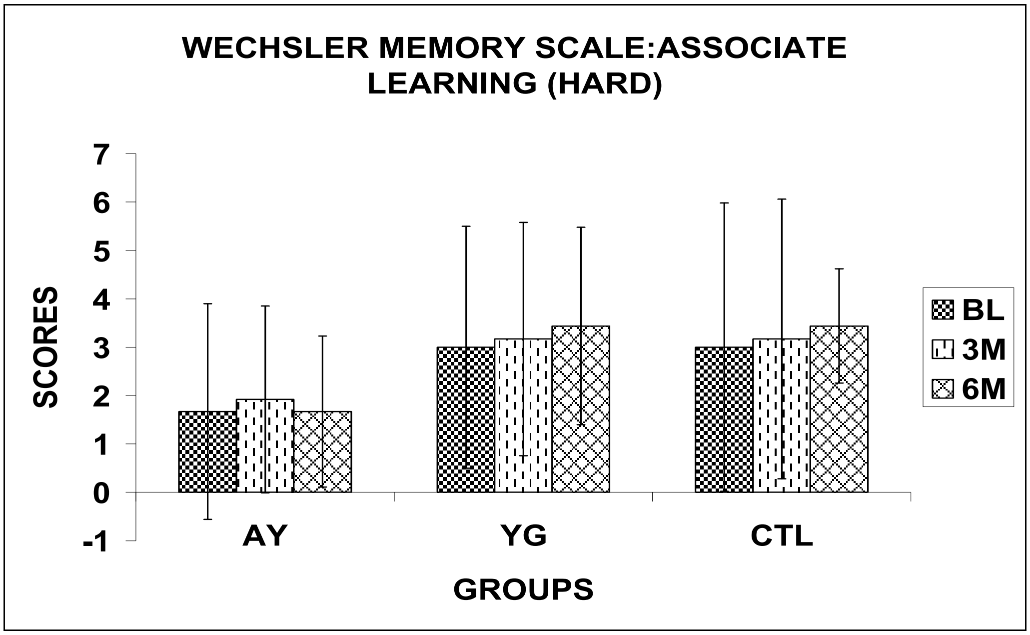
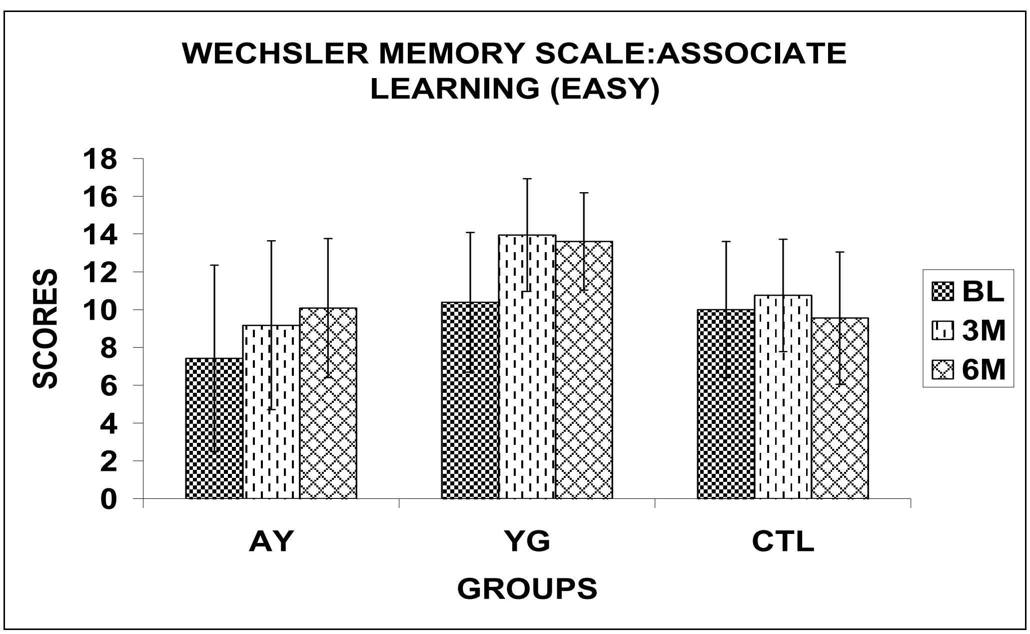


Fig. 5.2.3.5B: Mean ± Standard Deviations of the scores of Wechsler memory scale – associate learning (easy) at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.3.6, at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.3.7 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.3.8. The summary of changes in the components of Wechsler memory scale in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.2.3.9. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.3.10, Table 5.2.3.11 and Table 5.2.3.12, respectively **(see Appendix 8).**

5.2.3.6: Mean ± Standard Deviations of the Memory scores at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA	**YOGA**	**WAIT-LIST CONTROL**
n	n = 23	n = 23	n = 23
Current Information	2.26 ± 1.36	2.48 ± 1.38	2.48 ± 1.5
Orientation	3.35 ± 1.64	4.04 ± 1.43	3.22 ± 1.59
Mental Control Count back	13.35 ± 5.96	12.04 ± 4.5	11.96 ± 6.7
Mental Control Alphabets	11.65 ± 7.61	11.61 ± 4.26	11.48 ± 5.41
Mental Control Count by 2	13.70 ± 6.09	12.13 ± 4.56	12.00 ± 6.97
Digit span Forward	14.74 ± 6.41	17.26 ± 6.11	13.09 ± 6.76
Digit span Backward	8.43 ± 5.34	9.35 ± 4.69	8.74 ± 4.78
Associate learning Easy	8.48 ± 4.45	11.35 ± 4.21	10.43 ± 3.75
Associate learning Hard	1.74 ± 2.03	2.96 ± 2.4	3.22 ± 3.34

$p > .05$, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list control group for all variables

5.2.3.7: Mean ± Standard Deviations of the Memory scores at baseline (BL) and after three months (3M) for all three groups (Yoga, Ayurveda and Wait-list control)

	AYURVEDA		**YOGA**		**WAIT-LIST CONTROL**	
	BL	**3M**	**BL**	**3M**	**BL**	**3M**
n	15	15	20	20	20	20
Current Information	1.87 ± 1.13	2.20 ± 1.01 17.65	2.30 ± 1.17	2.85** ± 1.31 23.91	2.30 ± 1.45	2.60 ± 1.5 13.04
Orientation	3.07 ± 1.71	3.53 ± 1.3 14.98	3.90 ± 1.48	4.10 ± 1.17 5.13	3.25 ± 1.62	3.75 ± 1.45 15.38
Mental Control Count back	14.27 ± 6.76	13.07 ± 5.93 -8.41	12.60 ± 4.57	10.70 ± 5.86 -15.08	11.95 ± 7	13.00 ± 7.56 8.79
Mental Control Alphabets	13.40 ± 8.59	11.20 ± 5.17 -16.42	12.20 ± 4.24	8.6** ± 4.42 -29.51	11.40 ± 5.67	10.85 ± 6.14 -4.82
Mental Control Count by 2	14.53 ± 6.79	14.53 ± 5.57 0.00	12.75 ± 4.53	10.35 ± 6.03 -18.82	11.80 ± 7.06	13.25 ± 5.7 12.29
Digit span Forward	13.27 ± 6.32	17.4** ± 8.18 31.12	16.95 ± 6.39	23.85** ± 8.46 40.71	12.85 ± 7.12	18.3*** ± 7.8 42.10
Digit span Backward	7.93 ± 4.71	10.20 ± 6.34 28.63	9.20 ± 4.51	12.4* ± 3.93 34.78	8.35 ± 4.92	9.65 ± 3.76 15.57
Associate learning Easy	7.53 ± 4.85	8.73 ± 4.28 15.94	10.65 ± 3.65	13.75 ± 3.16 29.11	10.00 ± 3.6	10.75 ± 2.97 7.50
Associate learning Hard	1.47 ± 2.07	1.67 ± 1.84 13.61	2.90 ± 2.47	2.90 ± 2.43 0.00	2.60 ± 2.98	2.05 ± 2.89 -21.15

* *p*<. 05, ** *p*< .01, *** *p*<.001, two tailed, 't' test for paired data comparing the values at 3 months verses baseline

Table 5.2.3.8 Mean ± Standard Deviations of the Memory scores at baseline and after three (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control)

VARIABLES	AYURVEDA			YOGA			WAIT-LIST CONTROL		
	BL	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
n	12	12	12	18	18	18	20	20	20
Current Information	2.00 ± 1.21	2.25 ± 1.14 12.50	2.33 ± 1.3 16.50	2.39 ± 1.2	2.94 ± 1.3 23.01	3.28* ± 1.56 37.24	2.30 ± 1.45	2.60 ± 1.5 13.04	2.80 ± 1.47 21.74
Orientation	2.67 ± 1.67	3.67 ± 1.37 37.45	3.92 ± 1.24 46.82	3.89 ± 1.53	4.11 ± 1.18 5.66	4.39 ± 1.09 12.85	3.25 ± 1.62	3.75 ± 1.45 15.38	3.40 ± 1.82 4.62
Mental Control Count back	14.50 ± 7.19	12.00 ± 5.83 -17.24	11.50 ± 5.13 -20.69	12.72 ± 4.66	11.11 ± 6.01 -12.66	8.83*** ± 2.83 -30.58	11.95 ± 7	13.00 ± 7.56 8.79	13.95 ± 8.08 16.74
Mental Control Alphabets % Change	14.58 ± 8.46	10.67 ± 5.14 -26.82	9.83 ± 2.04 -32.58	12.28 ± 4.2	9.00 ± 4.49 -26.71	8.44*** ± 2.75 -31.27	11.40 ± 5.67	10.85 ± 6.14 -4.82	11.70 ± 5.12 2.63
Mental Control Count by 2	14.50 ± 7.35	14.17 ± 5.98 -2.28	11.33 ± 4.85 -21.86	13.22 ± 4.51	10.67 ± 6.23 -19.29	10.17* ± 4.15 -23.07	11.80 ± 7.06	13.25 ± 5.7 12.29	14.10 ± 7.84 19.49
Digit span Forward	13.50 ± 7.08	18.33 ± 8.64 35.78	17.17 ± 7.73 27.19	16.00 ± 4.8	24.17 ± 8.85 51.06	22.72*** ± 6.08 42.00	12.85 ± 7.12	18.30 ± 7.8 42.41	14.45 ± 6.08 12.45
Digit span Backward	8.00 ± 5.13	10.75 ± 6.76 34.38	10.00 ± 4.59 25.00	8.94 ± 4.14	12.50 ± 4.05 39.82	15.67** ± 5.79 75.28	8.35 ± 4.92	9.65 ± 3.76 15.57	9.00 ± 5.06 7.78
Associate learning Easy	7.42 ± 4.93	9.17 ± 4.47 23.58	10.08 ± 3.68 35.85	10.39 ± 3.7	13.94 ± 2.98 34.17	13.61** ± 2.57 30.99	10.00 ± 3.6	10.75 ± 2.97 7.50	9.55 ± 3.5 -4.50
Associate learning Hard	1.67 ± 2.23	1.92 ± 1.93 14.97	1.67 ± 1.56 0.00	3.00 ± 2.5	3.17 ± 2.41 5.67	3.44 ± 2.04 14.67	2.60 ± 2.98	2.05 ± 2.89 -21.15	1.15* ± 1.18 -55.77

p <.05, ** *p* <.01, ****p* <.001, two tailed, t-test for paired data comparing the values at three months versus baseline and six months versus baseline

TABLE 5.2.3.9 Summary of significant changes in Memory scores in all three groups (i.e., Ayurveda, Yoga and Wait-list control) at three months (3M) and six months (6M) compared to basic values

Wechsler memory	AYURVEDA	YOGA	WAIT-LIST CONTROL
Current Information (Score)	NSC	37.14*	NSC
Orientation (Score)	NSC	NSC	NSC
Mental Control Alphabets (Score)	NSC	-31.27***	NSC
Mental Control count by 2 (Score)	NSC	-23.07*	NSC
Mental Control Count back (Score)	NSC	-30.58***	NSC
Digit Span (Forward) (Score)	NSC	42.00***	NSC
Digit Span (Backward) (Score)	NSC	75.28**	NSC
Associate Learning (Hard) (Score)	NSC	NSC	NSC
Associate Learning (Easy) (Score)	NSC	30.99**	NSC

5.2.4 Audiometry: The audiometric recordings in all three groups at baseline and after six months included measuring the hearing threshold at the following different frequencies: (a) Low frequency (500 Hz and 1.0 KHz) and (b) High frequency (6.0 KHz, 8.0 KHz and 12 KHz).

5.2.4.1A 500Hz (left ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 16.413, p <.001, Greenhouse-Geisser epsilon = 1.000), However, there was no significant difference between the groups (F = 1.908, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 2.287, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.1A.

The Yoga group and the Wait-list Control groups showed a significant reduction (13.02%, 5.67%, respectively) in the threshold intensity recorded at 500 Hz (p <.01, p <.05, respectively, paired t-test, comparing the values at six months with the baseline values), while the Ayurveda group showed no change (p >.05, paired t-test).

5.2.4.1B 500Hz (right ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 9.166, p <.01, Greenhouse-Geisser epsilon = 1.000), However, there was no significant difference between the groups (F = 2.649, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = .755, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.1B.

The paired t-test for the comparisons between the values at six months with their respective baseline values, showed no significant change for all three groups (p>.05).

Table 5.2.4.1A

Audiometry: 500 Hz (Left ear)

Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	227.851	16.430	**.001**
Between subjects factor (Groups)	2	810.500	1.908	.160
Interaction (Assessments * Groups)	2	31.722	2.287	.113
Error (Within-subjects factor)	47	13.868		
Error (Between subjects factor)	47	424.814		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.4.1B

Audiometry: 500 Hz (Right ear)

Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	103.401	9.166	**.004**
Between subjects factor (Groups)	2	2038.771	2.649	.081
Interaction (Assessments * Groups)	2	8.521	0.755	.475
Error (Within-subjects factor)	47	11.281		
Error (Between subjects factor)	47	769.526		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

5.2.4.2A 1KHz (left ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = .380, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = 2.558, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 1.858, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.2A.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p >.05).

5.2.4.2B 1KHz (right ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = 3.962, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = 2.152, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 1.243, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.2B.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p >.05).

Table 5.2.4.2A
Audiometry: 1 KHz (Left ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	6.871	.380	.540
Between subjects factor (Groups)	2	1126.333	2.558	.088
Interaction (Assessments * Groups)	2	33.556	1.858	.167
Error (Within-subjects factor)	47	18.061		
Error (Between subjects factor)	47	440.390		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.4.2B
Audiometry: 1 KHz (Right ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	62.551	3.962	.052
Between subjects factor (Groups)	2	2218.451	2.152	.128
Interaction (Assessments * Groups)	2	19.618	1.243	.298
Error (Within-subjects factor)	47	15.788		
Error (Between subjects factor)	47	1030.858		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

5.2.4.3A 6KHz (left ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = .484, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = 2.064, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = .263, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.3A.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p>.05).

5.2.4.3B 6KHz (right ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant difference between the assessments (F = 8.140, p <.01, Greenhouse-Geisser epsilon = 1.000), and the interaction between the assessments and groups (F = 5.929, p <.01, Greenhouse-Geisser epsilon =1.000). However, there was no significant difference between the groups (F = 2.413, p >.05, Greenhouse-Geisser epsilon = 1.000) The ANOVA results are summarized in Table 5.2.4.3B.

The Ayurveda group showed a significant reduction (8.09%) in the threshold intensity recorded at 6 KHz (p <.05, respectively, paired t-test, comparing the values at six months with the baseline values). The comparisons between the values at six months with their respective baseline values for the Yoga and Wait-list control group showed no change (p >.05, paired t-test).

Table 5.2.4.3A
Audiometry: 6 KHz (Left ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	13.401	.484	.490
Between subjects factor (Groups)	2	1531.910	2.064	.138
Interaction (Assessments * Groups)	2	7.271	.263	.770
Error (Within-subjects factor)	47	27.691		
Error (Between subjects factor)	47	742.259		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.4.3B
Audiometry: 6 KHz (Right ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	155.588	8.140	**.006**
Between subjects factor (Groups)	2	2279.306	2.413	.101
Interaction (Assessments * Groups)	2	113.333	5.929	**.005**
Error (Within-subjects factor)	47	19.113		
Error (Between subjects factor)	47	944.498		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

5.2.4.4A 8KHz (left ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = .272, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = .965, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = .290, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.D1.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p>.05).

5.2.4.4B 8KHz (right ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments (F = .005, p >.05, Greenhouse-Geisser epsilon = 1.000), between the groups (F = 1.260, p >.05, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups (F = 2.089, p >.05, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.4B.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups (p>.05).

Table 5.2.4.4A
Audiometry: 8 KHz (Left ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	9.444	.272	.604
Between subjects factor (Groups)	2	702.833	.965	.388
Interaction (Assessments * Groups)	2	10.056	.290	.750
Error (Within-subjects factor)	47	34.684		
Error (Between subjects factor)	47	728.183		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.4.4B
Audiometry: 8 KHz (Right ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	0.165	0.005	.946
Between subjects factor (Groups)	2	1151.896	1.260	.293
Interaction (Assessments * Groups)	2	73.312	2.089	.135
Error (Within-subjects factor)	47	35.093		
Error (Between subjects factor)	47	914.260		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

5.2.4.5A 12KHz (left ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments ($F = .085$, $p > .05$, Greenhouse-Geisser epsilon = 1.000), between the groups ($F = 1.031$, $p > .05$, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups ($F = .123$, $p > .05$, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.5A.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups ($p > .05$).

5.2.4.5B 12KHz (right ear): The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments ($F = .621$, $p > .05$, Greenhouse-Geisser epsilon = 1.000), between the groups ($F = 2.084$, $p > .05$, Greenhouse-Geisser epsilon = 1.000) and the interaction between the assessments and groups ($F = .617$, $p > .05$, Greenhouse-Geisser epsilon =1.000). The ANOVA results are summarized in Table 5.2.4.5B.

The paired t-test for the comparisons between the values at six months with their respective baseline values showed no significant change for all three groups ($p > .05$).

Table 5.2.4.5A
Audiometry: 12 KHz (Left ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	0.989	0.085	.772
Between subjects factor (Groups)	2	241.722	1.031	.364
Interaction (Assessments * Groups)	2	25.556	2.188	.123
Error (Within-subjects factor)	47	11.678		
Error (Between subjects factor)	47	234.374		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Table 5.2.4.5B
Audiometry: 12 KHz (Right ear)
Analysis of variance

Source	df	MS	F	p value (two tailed)
Within-subjects factor (Assessments)	1	8.897	0.621	.435
Between subjects factor (Groups)	2	445.222	2.084	.136
Interaction (Assessments * Groups)	2	8.833	0.617	.544
Error (Within-subjects factor)	47	14.326		
Error (Between subjects factor)	47	213.629		

Greenhouse-Geisser epsilon = 1.000, hence sphericity assumed

Figure 5.2.4.1 Mean ± Standard Deviations recorded as threshold intensity at baseline (BL) and after six months (6M) for Ayurveda group (Left Ear).

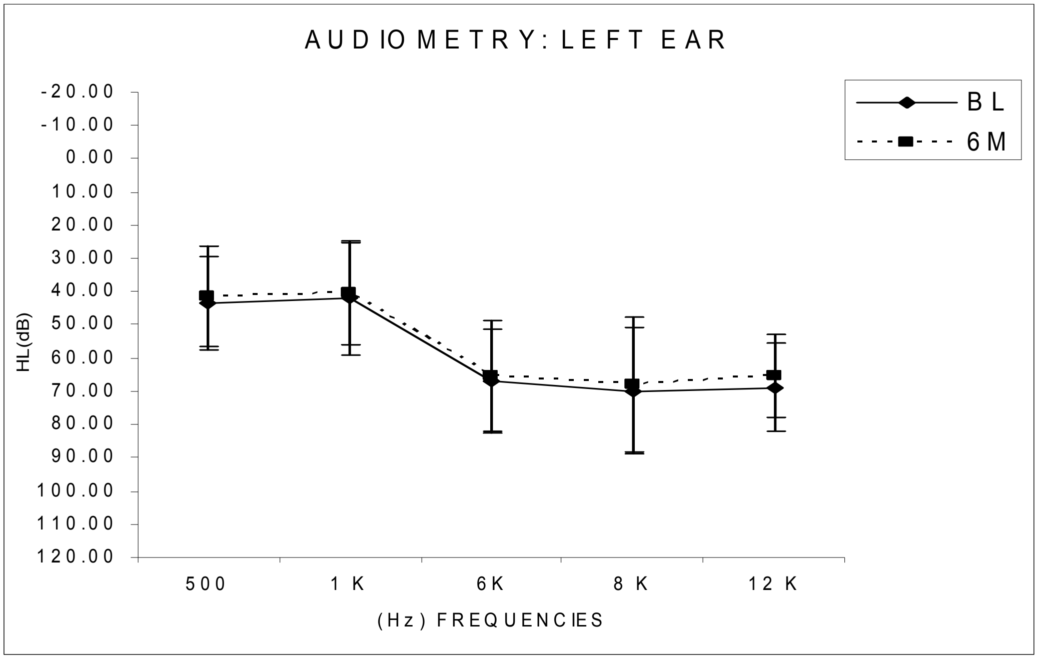


Figure 5.2.4.2 Mean ± Standard Deviations as threshold intensity at baseline (BL) and after six months (6M) for Ayurveda group (Right Ear)

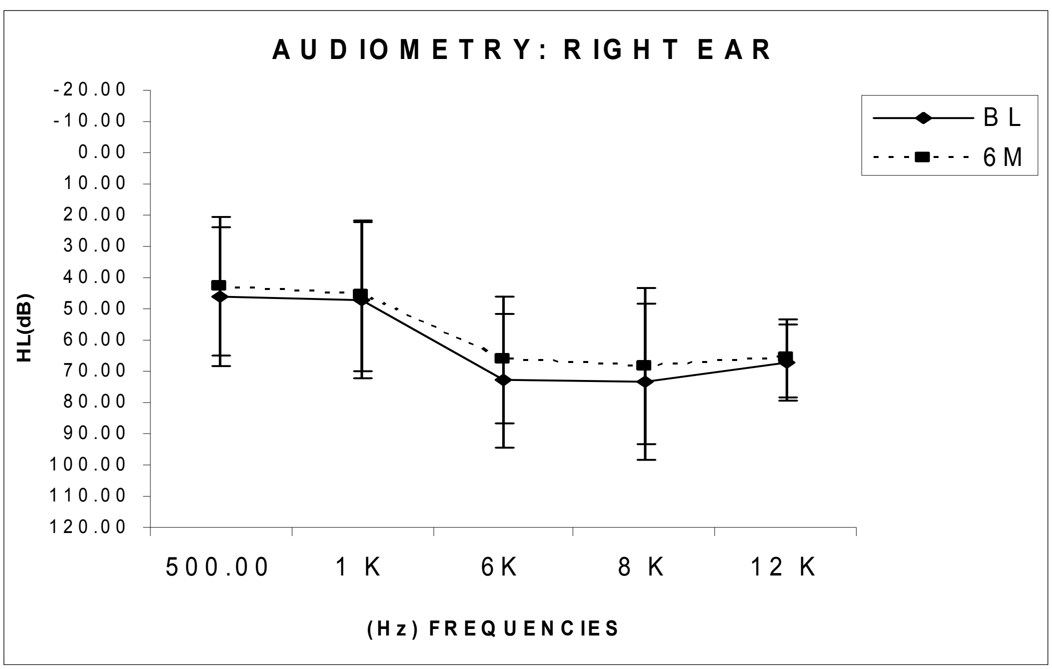


Figure 5.2.4.3 Mean ± Standard Deviations recorded as threshold intensity at baseline (BL) and after six months (6M) for Yoga group (Left Ear)

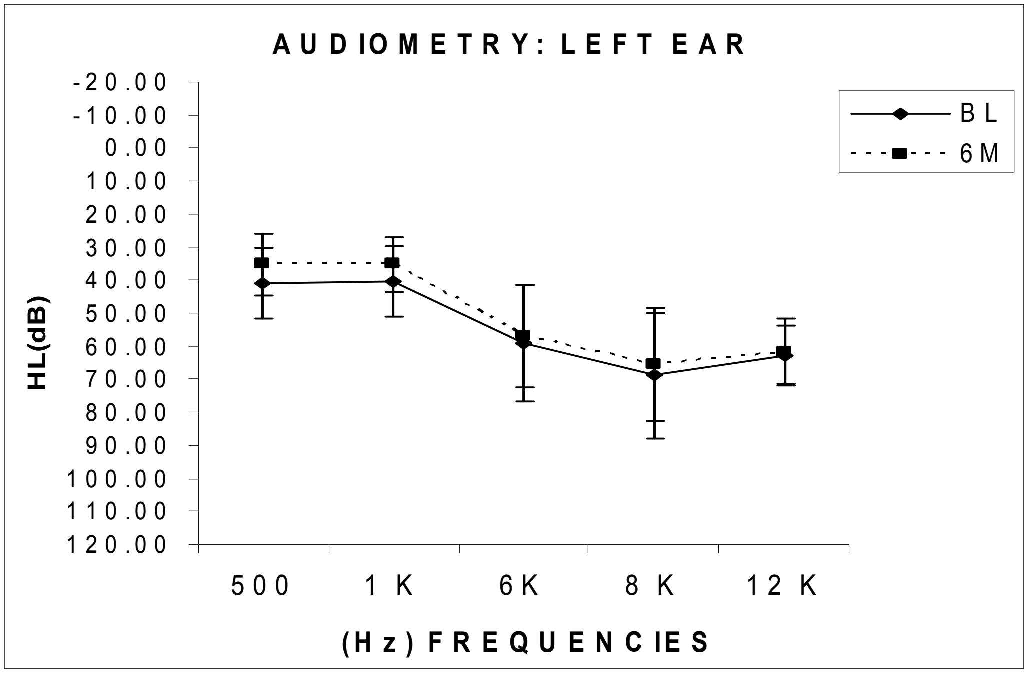


Figure 5.2.4.4 Mean ± Standard Deviations recorded as threshold intensity at baseline (BL) and after six months (6M) for Yoga group (Right Ear)

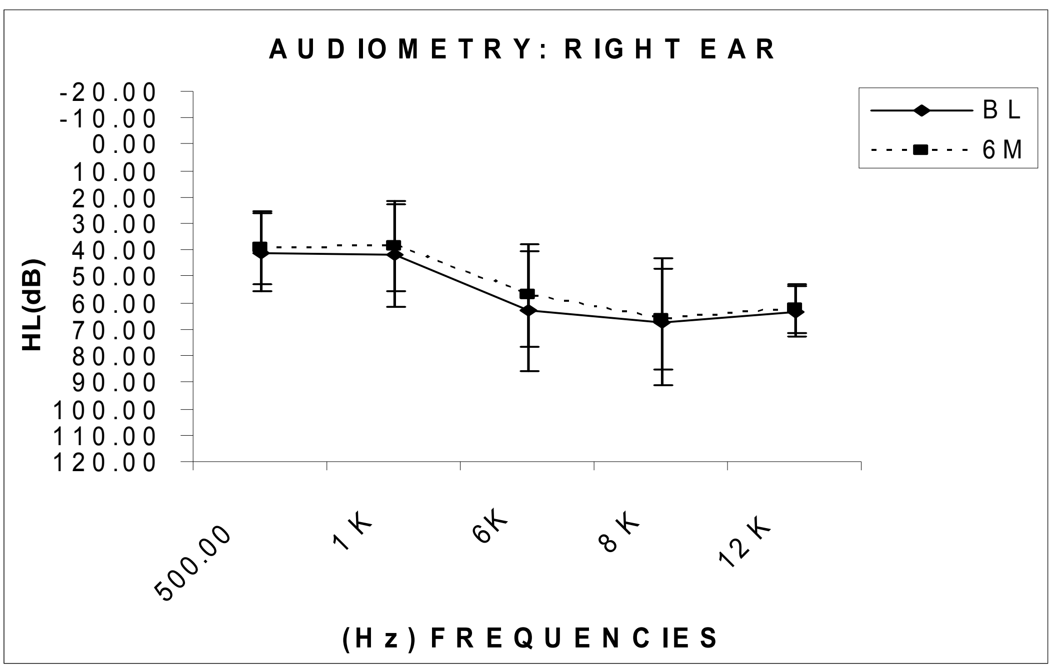


Figure 5.2.4.5 Mean ± Standard Deviations recorded as threshold intensity at baseline (BL) and after six months (6M) for Wait-List Control group (Left Ear)

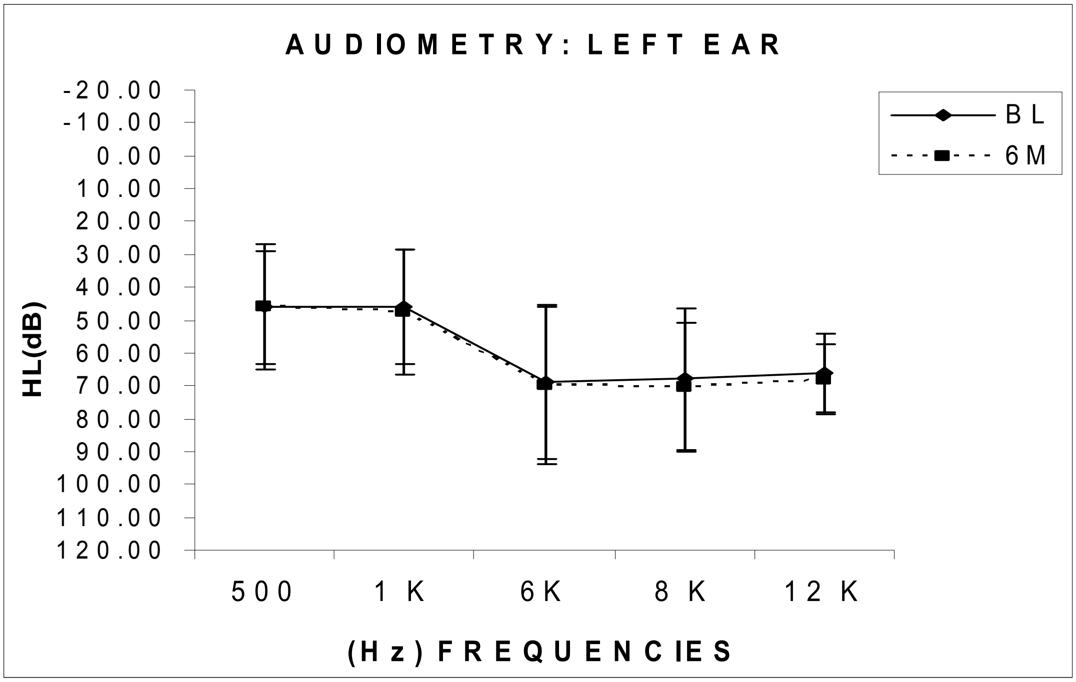
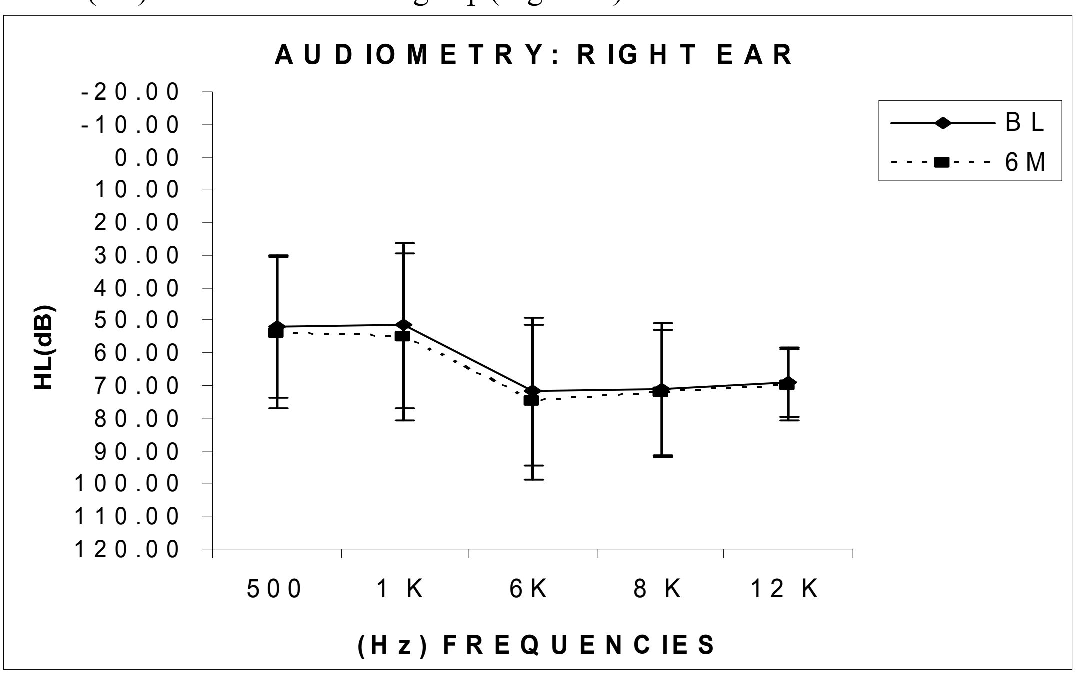


Figure 5.2.4.6 Mean ± SD recorded as threshold intensity at baseline (BL) and after six months (6M) for Wait-List Control group (Right Ear)



The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.2.4.6, and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.2.4.7. The summary of changes in the threshold intensities recorded in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at six months is given in Table 5.2.4.8. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.2.4.9, Table 5.2.4.10 and Table 5.2.4.11, respectively (see Appendix 9).

Table 5.2.4.6: Mean ± Standard Deviations of the threshold intensities for the low and high frequencies recorded from both right and left ears at baseline (BL) for all three groups (Yoga, Ayurveda and Wait-list control).

VARIABLES	AYURVEDA	YOGA	WAIT-LIST CONTROL
n	23	23	23
500 Hz (L)	43.48 ± 12.38	40.87 ± 10.94	46.09 ± 17.32
500 Hz (R)	46.09 ± 17.19	40.87 ± 14.97	51.96 ± 22.09
1 KHz (L)	42.17 ± 13.64	40.22 ± 12.2	46 ± 16.88
1 KHz (R)	47.17 ± 20.16	41.96 ± 19.17	51.52 ± 25.38
6 KHz (L)	66.96 ± 16.01	59.13 ± 17.1	68.91 ± 23.64
6 KHz (R)	73.04 ± 19.47	63.04 ± 20.77	71.74 ± 22.74
8 KHz (L)	70.00 ± 16.38	64.57 ± 11.28	67.83 ± 21.58
8 KHz (R)	73.48 ± 21.45	63.48 ± 11.26	71.09 ± 19.77
12 KHz (L)	68.91 ± 11.28	62.61 ± 8.9	65.87 ± 11.84
12 KHz (R)	67.17 ± 11.26	63.26 ± 9.96	68.91 ± 10

$p > .05$, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list Control group for all variables

Table 5.2.4.7: Mean ± Standard Deviations of the threshold intensities for the low and high frequencies recorded from both right and left ears at baseline (BL) and after six months (6M) for all three groups (Yoga, Ayurveda and Wait-list control).

VARIABLES	AYURVEDA		YOGA		WAIT-LIST CONTROL	
	Baseline	6 M	Baseline	6 M	Baseline	6 M
n	12	12	18	18	20	20
500 Hz (L)	42.50 ± 13.9	41.25 ± 15.09 -2.94	40.56 ± 10.69	35.28** ± 9.47 -13.02	48.50 ± 17.25	45.75* ± 19.01 -5.67
500 Hz (R)	46.25 ± 22.07	42.92 ± 22.1 -7.20	40.83 ± 14.68	39.17 ± 13.96 -4.07	55.00 ± 21.76	53.75 ± 22.93 -2.27
1 KHz (L)	40.00 ± 16.92	40.42 ± 15.44 1.05	38.06 ± 10.73	35.28 ± 8.13 -7.30	47.00 ± 17.43	47.75 ± 19.09 1.60
1 KHz (R)	47.92 ± 25.09	45.83 ± 23.92 -4.36	41.11 ± 19.37	38.33 ± 17.24 -6.76	55.00 ± 25.18	55.00 ± 25.65 0.00
6 KHz (L)	67.08 ± 15.73	65.42 ± 16.71 -2.47	57.78 ± 17.51	56.94 ± 15.26 -1.45	69.75 ± 23.37	70.00 ± 23.9 0.36
6 KHz (R)	72.08 ± 21.16	66.25* ± 20.35 -8.09	60.56 ± 22.87	57.22 ± 19.34 -5.52	73.50 ± 22.77	75.00 ± 23.73 2.04
8 KHz (L)	67.50 ± 19.01	67.92 ± 20.39 0.62	61.39 ± 18.85	61.11 ± 17.03 -0.46	68.75 ± 21.64	70.50 ± 19.8 2.55
8 KHz (R)	72.08 ± 24.91	68.33 ± 24.98 -5.20	60.00 ± 23.89	62.50 ± 19.04 4.17	71.25 ± 20.25	72.25 ± 19.57 1.40
12 KHz (L)	66.67 ± 13.2	65.42 ± 12.33 -1.87	62.78 ± 8.78	61.67 ± 10 -1.77	66.25 ± 12.02	68.00 ± 10.81 2.64
12 KHz (R)	66.25 ± 12.08	65.83 ± 12.58 -0.63	63.61 ± 9.52	61.94 ± 9.26 -2.63	69.50 ± 10.5	69.75 ± 10.94 0.36

* p <.05, ** p <.01, *** p <.001, two tailed, t-test for paired data comparing the values at six months verses baseline L = Left Ear, R = Right ear

Table5.2.4.8: Summary of significant changes in threshold intensities recorded from both right and left ears in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

Variable	**AYURVEDA**	**YOGA**	**WAIT-LIST CONTROL**
	6M	6M	6M
500 Hz (L)	NSC	13.02↓**	5.67↓*
500 Hz (R)	NSC	NSC	NSC
1 KHz (L)	NSC	NSC	NSC
1 KHz (R)	NSC	NSC	NSC
6 KHz (L)	NSC	NSC	NSC
6 KHz (R)	8.09↓*	NSC	NSC
8 KHz (L)	NSC	NSC	NSC
8 KHz (R)	NSC	NSC	NSC
12 KHz (L)	NSC	NSC	NSC
12 KHz (R)	NSC	NSC	NSC

p<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

5.3 PSYCHOLOGICAL VARIABLES

Recapitulation: The Psychological variables (geriatric depression scale and the sleep rating questionnaire) were recorded at baseline and after three and six months in all three groups (Yoga, Ayurveda and Wait-list control). The baseline values of all three groups for all the variables were compared using separate one-way ANOVAs and the results suggested that there were no significant differences (p >.05). As described under the Methods section (data analysis), separate repeated measures ANOVAs were performed to compare the differences between assessments (baseline, three months and six months) and the groups (Yoga, Ayurveda and Wait-list control) and the interaction between the groups and the assessments. The paired t-tests were performed to compare the data of three and six months of all three groups with their respective baseline values. When the data were dichotomous or scaled, it was ordinal. Hence, a non-parametric statistical test i.e., Kruskal-Wallis test was used, where the Test Variable List consisted of the three groups (Äyurveda, Yoga and Wait-list control) and the Grouping Variable was assessments (i.e., Baseline, Three and Six months). The Wilcoxon paired signed ranks test was used to compare data at three and six months with those at baseline of each group, separately. When the data were binary (i.e., '0' or '1'), a non parametric statistical test i.e., McNemar test was used to compare data at three and six months with those at baseline of each group, separately.

5.3.1 Geriatric depression scale: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a statistically significant Time by Group interaction (F = 8.625, p <.001), indicating that the pattern of change in assessments over time differed among the groups. Degrees of freedom were adjusted using the Greenhouse-Geisser epsilon ($\acute{\varepsilon}$ =.981) due to violation of the sphericity assumption. The ANOVA results are summarized in Table 5.3.1.

The Yoga group showed a significant decrease in the geriatric depression scores at three months (p <.001, paired t-test), as well as at six months (p <.001, paired t-test). The Ayurveda group and the Wait-list Control group showed no significant change (p >.05).

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.3.1.1, and at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.3.1.2 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.3.1.3. The summary of changes in the geriatric depression scores recorded in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.3.1.4. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.3.1.5, Table 5.3.1.6 and Table 5.3.1.7, respectively **(see Appendix 8)**.

Table 5.3.1 .1

Geriatric depression scale
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.962	35.192	13.134	**.001**
Between subjects factor (Groups)	2	65.490	4.201	**.021**
Interaction (Assessments * Groups)	3.925	23.111	8.625	**.001**
Error (Within-subjects factor)	92.245	2.679		
Error (Between subjects factor)	47	15.591		

*Greenhouse-Geisser epsilon = .981, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Fig. 5.3.1.1: Mean ± Standard Deviations of the Geriatric depression scores at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT).

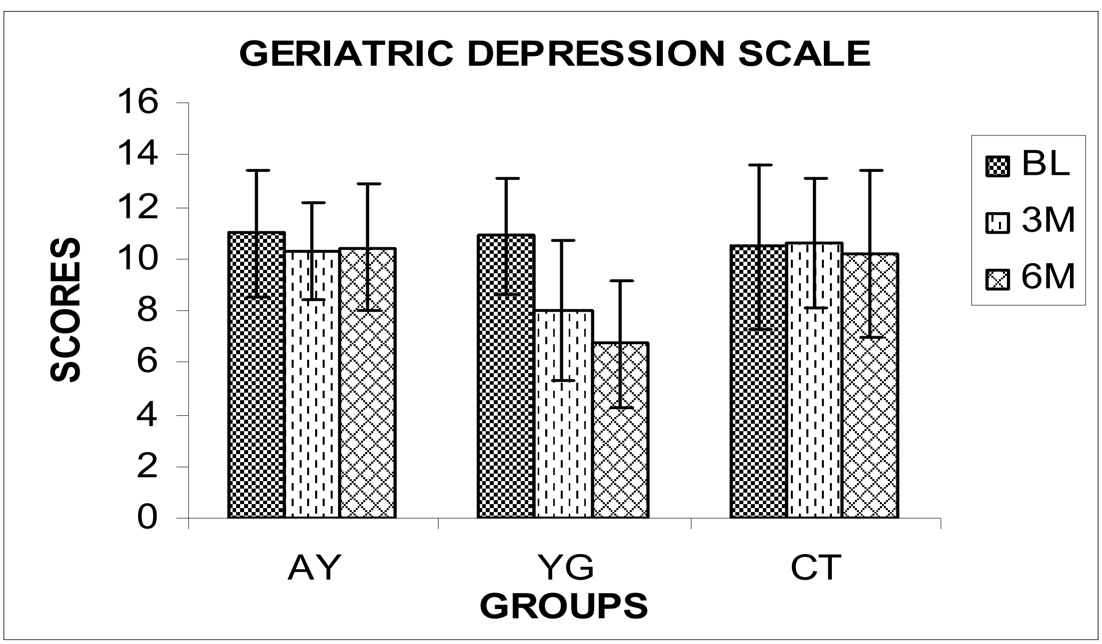


Table 5.3.1.2: Mean ± Standard Deviations of the geriatric depression scores at baseline for all three groups (Yoga, Ayurveda and Wait-list control)

VARIABLE	AYURVEDA	YOGA	CONTROL
n	23	23	23
Geriatric Depression Scores	10.65 ± 2.44	10.65 ± 2.17	9.91 ± 3.46

p >. 05, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list Control group for all variables

Table 5.3.1.3: Mean ± Standard Deviations of the geriatric depression scores at baseline (BL) and after three months (3M) for all three groups (Yoga, Ayurveda and Wait-list Control)

VARIABLE	AYURVEDA		YOGA		CONTROL	
	BL	**3M**	**BL**	**3M**	**BL**	**3M**
n	15	15	20	20	20	20
Geriatric Depression Scores	10.40 ± 2.59	9.80 ± 2.31	10.85 ± 2.25	8.10*** ± 2.69	10.45 ± 3.14	10.60 ± 2.46
% change		-5.77		-25.35		1.44

* *p* <.05, ** *p* <.01, *** *p* <.001, two tailed, paired t-test, comparing the values at three months versus baseline

5.3.1.4: Mean ± Standard Deviations of the geriatric depression scores at baseline and after three and six months for all three groups (Yoga, Ayurveda and Wait-list control)

VARIABLE	**AYURVEDA**			**YOGA**			**CONTROL**		
	BL	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
n	12	12	12	18	18	18	20	20	20
Geriatric Depression Scores	11.00 ± 2.45	10.33 ± 1.87	10.42 ± 2.47	10.89 ± 2.22	8.00 ± 2.74	6.72*** ± 2.44	10.45 ± 3.14	10.60 ± 2.46	10.20 ± 3.19
% change		-6.09	-5.27		-26.54	-38.29		1.44	-2.39

* $p<.05$, ** $p<.01$, *** $p<.001$, two tailed, paired t-test, comparing the values at three months versus baseline and six months versus baseline

Table 5.1.1.5: Summary of significant changes in Geriatric Depression Scale in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

	AYURVEDA		**YOGA**		**CONTROL**	
	3M	6M	3M	6M	3M	6M
Geriatric Depression Scale (Score)	NSC	NSC	25.35↓***	38.29↓***	NSC	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

5.3.2 Sleep rating questionnaire: The different aspects of sleep assessed using the Sleep rating questionnaire in all three groups at baseline and after three and six months included (a) time taken to fall asleep, (b) number of hours slept each night (c) Feeling of being rested in the morning (d) afternoon sleep and (e) number of awakenings each night.

5.3.2.1 Time taken to fall asleep: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed a significant interaction between the assessments and groups ($F = 2.694$, $p < .05$, Greenhouse-Geisser epsilon = .892). However there was no significant difference between the assessments ($F = 3.020$, $p > .05$, Greenhouse-Geisser epsilon = .892), and between the groups ($F = 1.324$, $p > .05$, Greenhouse-Geisser epsilon = .892). The ANOVA results are summarized in Table 5.3.2.1.

The paired t-test showed that there was a significant reduction in the time taken to fall asleep in the Yoga group ($p < .05$, comparing values at three months and six months with the baseline values, separately). The Ayurveda and the Wait-list control groups showed no change ($p > .05$, paired t-test).

5.3.2.2 Hours of sleep each night: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments ($F = 2.547$, $p > .05$, Greenhouse-Geisser epsilon = .899), between the groups ($F = .066$, $p > .05$, Greenhouse-Geisser epsilon = .899), and the interaction between the assessments and groups (F = 1.804, p >.05, Greenhouse-Geisser epsilon = .899). The ANOVA results are summarized in Table 5.3.2.2.

Table 5.3.2.1
Sleep rating questionnaire: Time taken to fall asleep
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.785	510.706	3.020	.060
Between subjects factor (Groups)	2	1060.958	1.324	.276
Interaction (Assessments * Groups)	3.569	455.502	2.694	**.042**
Error (Within-subjects factor)	83.876	169.085		
Error (Between subjects factor)	47	795.576		

*Greenhouse-Geisser epsilon = .892, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account

Table 5.3.2.2
Sleep rating questionnaire: Hours of sleep each night
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.797	1.963	2.547	.090
Between subjects factor (Groups)	2	.094	.066	.936
Interaction (Assessments * Groups)	3.594	1.391	1.804	.142
Error (Within-subjects factor)	84.466	.771		
Error (Between subjects factor)	47	1.438		

*Greenhouse-Geisser epsilon = .899, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Fig. 5.3.2.1: Mean ± Standard Deviations of the time taken to fall asleep at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT).

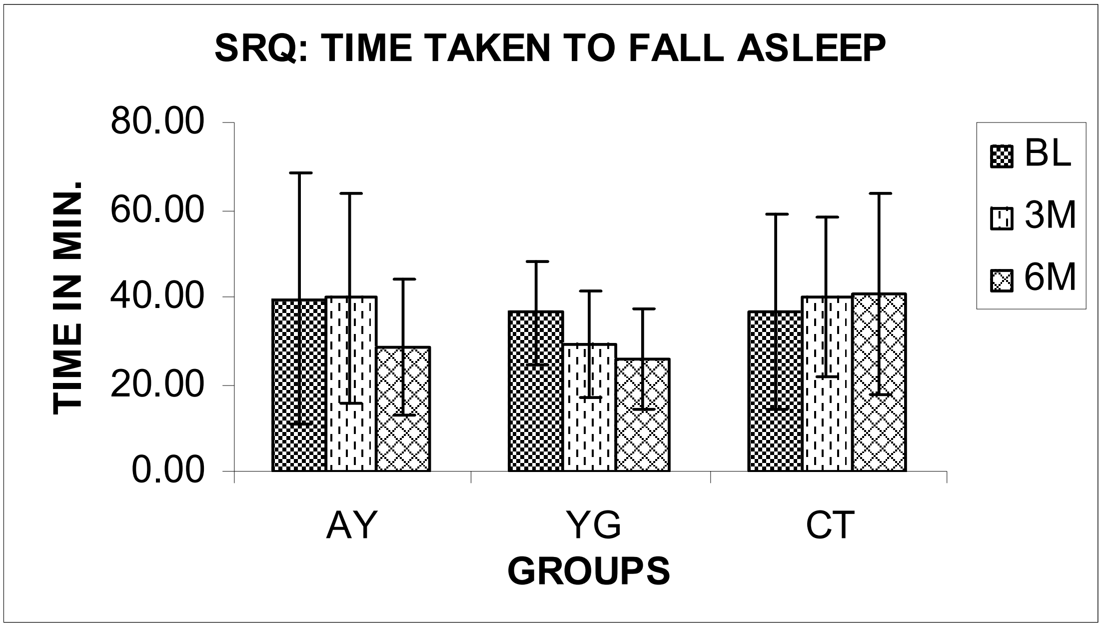
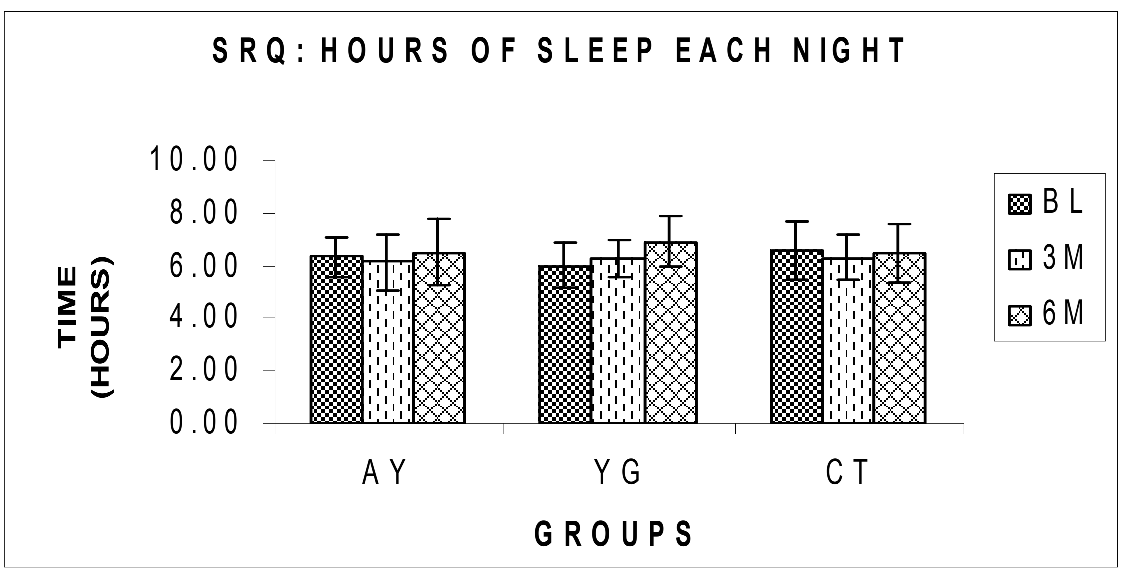


Fig. 5.3.2.2: Mean ± Standard Deviations of the hours of sleep each night at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



SRQ = Sleep Rating Questionnaire

The paired t-test showed that there was a significant increase in the number of hours slept each night in the Yoga group ($p <.05$, comparing values at three months and six months with the baseline values, separately). The Ayurveda and the Wait-list control groups showed no change ($p >.05$, paired t-test).

5.2.3.3 Number of awakenings each night: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments ($F = 2.066$, $p >.05$, Greenhouse-Geisser epsilon = .968), between the groups ($F = .066$, $p >.05$, Greenhouse-Geisser epsilon = .968), and the interaction between the assessments and groups ($F = .484$, $p >.05$, Greenhouse-Geisser epsilon = .968). The ANOVA results are summarized in Table 5.3.2.3.

The paired t-test showed that there was a significant decrease in the number of awakenings each night in the Yoga group ($p <.05$, comparing values at three months and six months with the baseline values, separately). The Ayurveda and the Wait-list control groups showed no change ($p >.05$, paired t-test).

5.3.2.4 Afternoon sleep: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments ($F = .976$, $p >.05$, Greenhouse-Geisser epsilon = .910), between the groups ($F = 1.324$, $p >.05$, Greenhouse-Geisser epsilon = .910), and the interaction between the assessments and groups ($F = 1.048$, $p >.05$, Greenhouse-Geisser epsilon = .910). The ANOVA results are summarized in Table 5.3.2.4.

Table 5.3.2.3
Sleep rating questionnaire: Number of awakenings each night
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.650	.852	2.066	.134
Between subjects factor (Groups)	2	1.126	.066	.936
Interaction (Assessments * Groups)	3.594	1.391	.484	.619
Error (Within-subjects factor)	91.009	.412		
Error (Between subjects factor)	47	2.324		

*Greenhouse-Geisser epsilon = .968, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Table 5.3.2.4
Sleep rating questionnaire: Afternoon sleep
Analysis of variance

Source	df*	MS*	F*	p value* (two tailed)
Within-subjects factor (Assessments)	1.819	81.893	.976	.374
Between subjects factor (Groups)	2	1456.333	1.324	.276
Interaction (Assessments * Groups)	3.639	87.896	1.048	.387
Error (Within-subjects factor)	85.511	83.898		
Error (Between subjects factor)	47	1099.858		

*Greenhouse-Geisser epsilon = .910, hence df, MS, F and p values are noted taking Greenhouse-Geisser epsilon into account.

Fig. 5.3.2.3: Mean ± Standard Deviations of the awakenings each night at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)

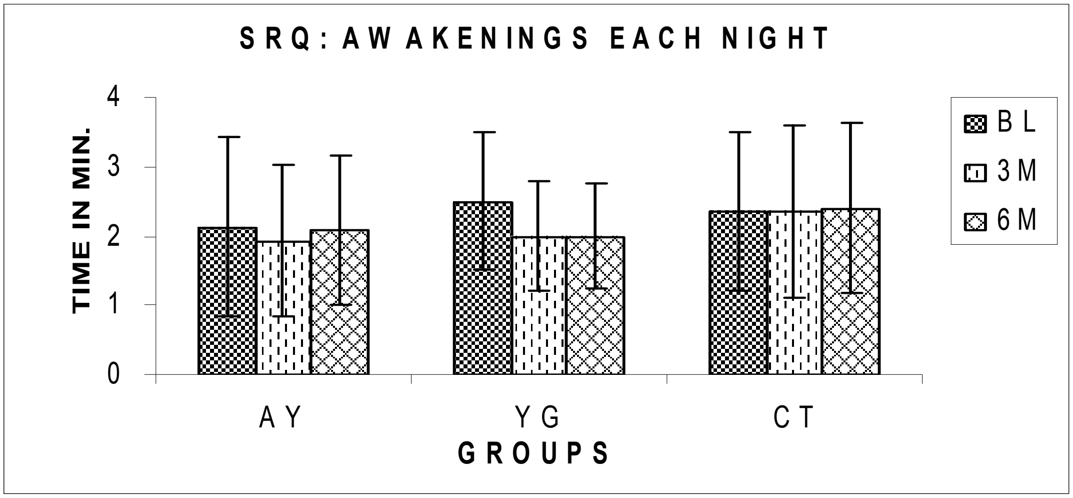
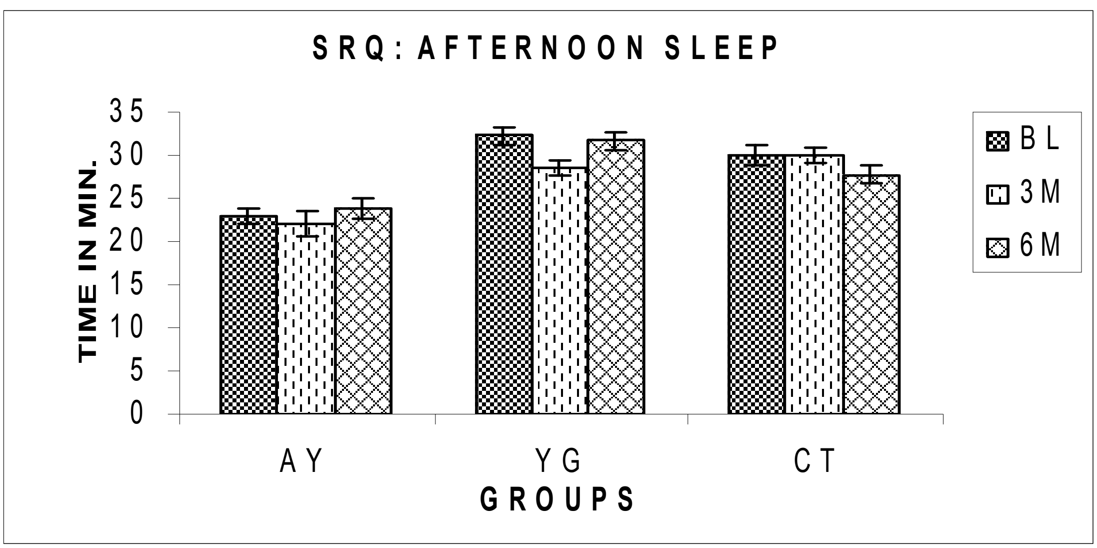


Fig. 5.3.2.4: Mean ± Standard Deviations of the afternoon sleep at baseline (BL) and after three (3M) and six months (6M) for all three groups i.e., Yoga (YG), Ayurveda (AY) and Wait-list Control (CT)



SRQ = Sleep Rating Questionnaire

The paired t-test suggested that the comparisons between the values at three and six months with their respective baseline values were not significant for all three groups ($p>.05$).

5.3.2.5 Feeling of being rested in the morning: The repeated measures ANOVA which consisted of one Within subjects factor (Assessments - baseline, three months and six months) and one Between subjects factor (Groups – Yoga, Ayurveda and Wait-list control) showed no significant difference between the assessments, between the groups and the interaction between the assessments and groups ($p >.05$, Greenhouse-Geisser epsilon = .910). The ANOVA results are summarized in Table 5.3.2.5.

The McNemar test for the "feeling of being rested in the morning" showed that there was a significant increase in the 'feeling of being rested in the morning' in the yoga group at six months ($N = 18$, $P< .05$) compared with the baseline values, while other groups showed no significant change.

The group mean ± SD at baseline (n=23, for all three groups) are given in Table 5.3.2.6, and at three months (n=15, 20 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.3.2.7 and at six months (n=12, 18 and 20, for Ayurveda, Yoga and Wait-list Control groups, respectively) are given in Table 5.3.2.8. The summary of changes in self rated quality of sleep recorded in all three groups (i.e., Ayurveda, Yoga and Wait-list Control) at three months and six months are given in Table 5.3.2.9. The actual data of individual subjects in Ayurveda, Yoga, and Wait-list Control groups are presented with group mean ± SD in Table 5.3.2.10, Table 5.3.2.11 and Table 5.3.2.12, respectively **(see Appendix 8).**

Table 5.3.2.6: Mean ± Standard Deviations of the components of the sleep rating questionnaire scores at baseline for all three groups (Yoga, Ayurveda and Wait-list control)

VARIABLE	AYURVEDA	YOGA	CONTROL
n	23	23	23
Afternoon sleep (min.)	22.17 ± 18.02	35.87 ± 27.78	31.30 ± 20.68
No of awakening in each nigh (number)	2.26 ± 1.21	2.48 ± 0.94	2.30 ± 1.22
Time Taken to fall asleep (min.)	39 ± 21.75	36.30 ± 10.99	36.74 ± 22.08
Feeling Being Rested (score)	0.48 ± 0.51	0.26 ± 0.45	0.61 ± 0.5
Hours of Sleep (hours)	6.13 ± 1.06	5.78 ± 1.0	6.43 ± 1.16

$p >. 05$, two tailed, one-way ANOVA, comparing the baseline values of Ayurveda versus Yoga and Wait-list control groups and comparing Yoga versus Wait-list control group for all variables

Table 5.3.2.7: Mean ± Standard Deviations of the components of the sleep rating questionnaire scores at baseline and after three months for all three groups(Yoga, Ayurveda and Wait-list control)

	AYURVEDA		**YOGA**		**CONTROL**	
	Baseline	**3M**	**Baseline**	**3M**	**Baseline**	**3M**
N	15	15	20	20	20	20
Afternoon Sleep (min.) % change	23.00 ± 18.69	22.00 ± 20.34 -4.35	32.25 ± 22.45	28.50 ± 21.71 -11.63	30.00 ± 21.21	30.00 ± 19.47 0.00
No of awakening in each night (number) % change	2.13 ± 1.3	1.93 ± 1.1 -9.39	2.50 ± 1	2.00* ± 0.79 -20.00	2.35 ± 1.14	2.35 ± 1.23 0.00
Time Taken to fall asleep (min.) % change	39.33 ± 25.83	39.67 ± 25.53 0.86	36.50 ± 11.48	29.00* ± 12.31 -20.55	36.25 ± 22.53	39.75 ± 18.39 9.66
Feeling Being Rested (score) % change	0.53 ± 0.52	0.53 ± 0.52 0.00	0.25 ± 0.44	0.45 ± 0.51 80.00	0.60 ± 0.5	0.50 ± 0.51 -16.67
Number of hours slept each night (hours) % change	6.33 ± 0.9	6.13 ± 1.55 -3.16	5.80 ± 1.01	6.25* ± 0.79 7.76	6.55 ± 1.1	6.30 ± 0.86 -3.82

* *p* <.05, ** *p* <.01, *** *p* <.001, two tailed, t-test for paired data comparing the values at six months verses baseline comparing the values at six months versus baseline.

Table 5.3.2.8: Mean ± Standard Deviations of the components of the sleep rating questionnaire at baseline (BL) and after three (3M) and six months (6M) for all three groups (Yoga, Ayurveda and Wait-list Control)

	AYURVEDA			YOGA			CONTROL		
	BL	**3M**	**6M**	**BL**	**3M**	**6M**	**BL**	**3M**	**6M**
N	12	12	12	18	18	18	20	20	20
Afternoon Sleep (min.) % change	21.25 ± 20.68	18.75 ± 17.07 -11.76	23.75 ± 16.25 11.76	35.83 ± 20.67	30.83 ± 21.51 -13.95	31.67 ± 22.36 -11.61	30.00 ± 21.21	30.00 ± 19.47 0.00	27.75 ± 21.37 -7.50
No of awakening in each night (number) % change	2.17 ± 1.19	1.92 ± 0.9 -11.52	2.08 ± 1.08 -4.15	2.56 ± 0.78	2.06 ± 0.64 -19.53	2.00* ± 0.77 -21.88	2.35 ± 1.14	2.35 ± 1.23 0.00	2.40 ± 1.23 2.13
Time Taken to fall asleep (min.) % change	40.83 ± 28.83	35.83 ± 23.92 -12.25	28.33 ± 15.57 -30.61	36.39 ± 11.86	28.61 ± 12.22 -21.38	25.83* ± 11.66 -29.02	36.25 ± 22.53	39.75 ± 18.39 9.66	40.75 ± 23.13 12.41
Feeling Being Rested (score) % change	0.50 ± 0.52	0.50 ± 0.52 0.00	0.50 ± 0.52 0.00	0.28 ± 0.46	0.39 ± 0.5 39.29	0.67† ± 0.49 139.29	0.60 ± 0.5	0.50 ± 0.51 -16.67	0.60 ± 0.5 0.00
Number of hours slept each night (hours) % change	6.33 ± 0.78	6.33 ± 1.07 0.00	6.50 ± 1.24 2.69	6.00 ± 0.84	6.17 ± 0.71 2.83	6.89* ± 0.96 14.83	6.55 ± 1.1	6.30 ± 0.86 -3.82	6.45 ± 1.1 -1.53

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data, † p< .05, McNemar test comparing the values at three months versus baseline and six months versus baseline

Table 5.3.2.9: Summary of significant changes in Sleep Rating Questionnaire in all three groups (i.e., Ayurveda,Yoga and Wait-list Control) at three months (3M) and six months (6M) compared to baseline values

	AYURVEDA		**YOGA**		**CONTROL**	
Sleep Rating Questionnaire	3M	6M	3M	6M	3M	6M
After Noon Sleep (min.)	NSC	NSC	NSC	11.61↓	NSC	NSC
Number of awakenings each night (number)	NSC	NSC	20.00↓*	21.88↓*	NSC	NSC
Time taken to fall asleep (min.)	NSC	NSC	20.55↓*	29.02↓*	NSC	NSC
Feeling of being rested in the morning (score)	NSC	NSC	NSC	139.29↑†	NSC	NSC

* *p*<. 05, ** *p*< .01, ****p*< .001, two tailed, t-test for paired data comparing the values at three months (3M) versus baseline and six months versus baseline

The present study evaluated the effects of two interventions (viz., Yoga and Ayurveda) compared to a Wait-list Control group in institutionalized older persons. Assessments were made at baseline and after three and six months of the interventions. The assessments were of three main categories: (i) general health measures, (ii) neurological assessments, and (iii) psychological assessments. All changes referred to in this section were those which were statistically significant, detailed under the Results section.

Among the general health measures, there were changes in the pulmonary functions and the hand grip strength at three months. In the Ayurveda group, there was an increase in the minute ventilation by 39.1 percent. In the Yoga group there was an increase in the minute ventilation by 51.5 percent. The increase in minute ventilation in the Ayurveda and Yoga groups at three months would be more likely due to an increase in the tidal volume rather than an increase in the breath rate. This may be speculated as the polygraph recording of the respiratory rate showed no change in either group.

At six months, the pulmonary functions showed changes and also there were changes in anthropometric measurements. Unlike at three months, at six months the Ayurveda group did not show changes in minute ventilation, but showed an increase in maximum voluntary ventilation by 22.6 percent. This possibly showed greater voluntary effort in this group at the six monthly assessments. The Yoga group showed an increase in forced vital capacity by 31.8 percent and continued to show an increase in minute ventilation (34.8 percent). This suggested that lung volumes and capacities improved in the Yoga group after six months. The Wait-list control group showed a decrease in the forced vital capacity by 35.6 percent which may suggest that in the absence of interventions, respiratory function deteriorated though the magnitude of change needs to be understood. Also, while the hand grip strength did not change at six months, the mid-arm circumference which is taken to be an indicator of muscle mass, decreased by 1.8 percent at the end of six months.

With respect to changes in the Yoga group, there was an increase in FVC and minute ventilation. In an earlier study, an increase in the lung capacity following Yoga practice was attributed to an increased development of respiratory musculature (Bhole, 1967). The group who received the Ayurveda intervention showed an increase in minute ventilation and Maximum Voluntary Ventilation at the end of six months. The underlying mechanisms cannot be speculated upon as the physiological effects of the individual components as well as of the combination used in the Ayurveda preparation have not been studied. In contrast to the Yoga and Ayurveda groups, the Wait-list control group showed a decrease in mid-arm circumference which indicates muscle mass and hand grip strength which indicated muscle endurance. Also, there was a reduction in the vital capacity. These findings suggest that in the absence of an intervention, the Wait-list Control group actually showed deterioration in functioning.

In summary, the two interventions i.e., Yoga and Ayurveda showed a positive impact on the general health measures (pulmonary functions) while the no intervention control group showed deterioration in functioning.

With respect to the neurological assessments, at three months there were no changes in autonomic and respiratory variables in the two intervention groups, while in contrast, the Wait-list Control group showed an increase in galvanic skin conductance by 41.8 percent, suggesting an increase in sympathetic sudomotor activity. This is important as it is already known that in the aged, there is a shift in the sympatho-parasympathetic balance towards sympathetic dominance (Mathias, 2003).

The Wechsler memory scale was used to assess different aspects of memory. As described in the introduction, memory may be categorized based on the "systems" and on the "process". The results will be discussed considering both views. At three months, the Yoga group showed an improvement in scores for current information suggesting improvement in semantic memory. There was also an increase in the short term primary memory based on the digit span forward test (a 40.7 percent increase). The short term working memory also appeared to have improved, based on an increase in the digit span backward score. The Ayurveda and Wait-list Control group both showed an increase in the digit span forward score, which suggested an improvement in short term primary memory. Since the magnitude of change in this measurement was similar for all three groups, the improvement in short term primary memory may be merely due to a re-test effect.

At six months, there were significant changes in the autonomic and respiratory variables. These changes were suggestive of reduced sympathetic activity based on a decrease in galvanic skin conductance, in heart rate, in the low frequency component of the heart rate variability spectrum and an increase in the high frequency/low frequency ratio suggesting a shift in the sympatho-vagal balance towards vagal dominance. The decrease in the respiratory rate in the Yoga group suggested that psychophysiological arousal was also lower. These findings are especially important as older persons have been described to have a higher sympathetic tone (Mathias, 2003).

Other important indicators of neurological functions which were studied were the gait and balance. Both of them improved significantly after six months of Yoga. The gait was also assessed in a test called "timed-up-and-go test". Since short steps are indicative of a poor gait (Rubenstein & Trueblood, 2004), the number of steps taken to cover a fixed distance were noted at the beginning and end of six months. Following six months of both Yoga and Ayurveda, there was a decrease in the number of steps, though the magnitude of change was more after Yoga than after Ayurveda (an average of 6.23 steps reduction versus an average of 4.25 steps reduction respectively).

With respect to the scores in the Wechsler memory scale, the Yoga group performed better at six months in the test for current information (indicative of semantic memory), digit span forward (indicative of short term primary memory), digit span backward (indicative of short term working memory), and paired associate learning for pairs which are easy to associate (indicative of episodic memory). In contrast, in the Wait-list Control group there was a decrease in the scores for paired associate learning of pairs which were difficult to associate. This may suggest a deterioration of episodic memory in the Wait-list Control group, especially when it was difficult to establish associations between pairs.

Following Yoga there was a decrease in heart rate, respiratory rate, galvanic skin conductance and in the power of the Low Frequency band of the Heart Rate Variability (HRV) spectrum while the High Frequency band of HRV increased. These changes suggested an increase in cardiac vagal and decrease in cardiac sympathetic discharge (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). The gait, ability to balance and mobility all improved following Yoga. While the exact basis is not known the improvement may be related to factors such as better visuo-motor co-ordination (Malathi & Parulkar, 1989), postural re-adjustment (Dhume & Dhume, 1991) and improved proprioception (Naveen, & Telles, 2003). The semantic memory, primary and working short-term memory and episodic memory have improved since reduced anxiety facilitates remembering (Ax, 1953). It is possible that the anxiety reducing effect of Yoga practice was the basis of these changes. Also, the practice of Yoga has already been shown to induce "a state of alertful rest" and reduced distractibility (Wallace, Benson, & Wilson, 1971).

The absence of change in the Ayurveda group may be related to the fact that the number of participants at six months was reduced to twelve, versus eighteen in the yoga group and twenty in the control group. Hence the present study shows that compliance with taking an herbal preparation has specific difficulties.

The Wait-list Control group showed an increase in skin conductance suggestive of increased sudomotor sympathetic activity and possibly of physiological activation. Finally this group showed a decrease in the scores of episodic memory.

These findings once again suggest that in the absence of an intervention, the Wait-list Control group actually showed deterioration in functioning.

In summary, Yoga practice has brought about changes suggestive of reduced physiological activation and improved gait, balance and mobility and different components of memory. The Ayurveda group showed no significant changes with respect to the neurological variables except mobility while the Wait-list Control group showed signs of physiological activation, reduced memory scores and hand grip strength (suggestive of reduced muscular endurance).

The psychological assessments were two: depression scores and the self rated quality of sleep. At three months, the Yoga group showed a decrease in the geriatric depression scores. There was also a decrease in the time taken to fall asleep (by an average of 7.5 minutes) and in the number of awakenings each night. In contrast, in the Yoga group there was an increase in the number of hours slept each night (0.45 hours).

At six months also, the Yoga group showed a decrease in depression scores, time taken to fall asleep (10.56 minutes), and number of awakenings each night. The Yoga group showed an increase in number of hours slept each night (1.29 hours), and in the subjective feeling of being rested in the morning. These results suggest that Yoga practice improves subjective feelings of psychological wellbeing both at three and at six months. Neither of the other two groups showed a change in the two variables indicative of psychological status.

The changes in mood with a decrease in scores indicating depression following Yoga may be related to multiple factors. For example, physical activity is known to increase endorphin secretion (Hall & Brody, 1999**),** while guided relaxation was shown to reduce the secretion of hormones related to stress. Since Yoga incorporates both physical activity and relaxation, these factors may have contributed to the positive affect following Yoga. The Yoga group showed improvements in several aspects of their self rated quality of sleep such as a decrease in time taken to fall asleep, an increase in the number of hours slept each night, an increase in the feeling of being rested in the morning. Once again these benefits may be attributed to increase in physical activity and relaxation associated with Yoga.

The changes in general health measures viz., lung functions and grip strength and anthropometric measurements which occurred in the present older population were seen previously in volunteers of an younger age group following Yoga training. For example, sports teachers (group average age 34.7 ± 5.9 years) who had already been involved in various physical activities for approximately nine years, showed an improvement in vital capacity after three months of Yoga training (Telles, Nagarathna, Nagendra, & Desiraju, 1993). Apart from this, the beneficial effects of Yoga practice in improving lung functions have been shown in army personnel (Ray, Sinha, Tomer, Pathak, Dasgupta, & Selvamurthy, 2001) and in bronchial asthma patients (Goyeche, Abo, & Ikemi, 1982; Nagarathna & Nagendra, 1985). The hand grip strength was shown to be significantly higher in children after ten days of Yoga training and in adults after a one month Yoga training program (Dash & Telles, 2001). Yoga practice was also shown to improve the hand grip strength in sports teachers (Telles, Nagarathna, Nagendra, & Desiraju, 1993) and patients with rheumatoid arthritis (Haslock, Monro, Nagarathna, Nagendra, & Raghuram, 1994;

Dash & Telles, 2001). Changes in lung functions following Ayurveda *per se* have not been documented. Ayurvedic preparations typically consist of a combination of substances (Sharma & Dash, 1998). However, they have been a number of reports on the pulmonary benefits of specific herbal substances such as *Tulsi* (*Ocimum Sanctum*) (Prakash & Gupta, 2005). These references are large in number and have not been cited here as this report examined the effects of a preparation which consisted of a number of traditionally described substances, not of any one, alone. .

With respect to the neurological measures, studies on the effects of Yoga practice on autonomic and respiratory variables have been well documented. An early study described the psychophysiological effects of transcendental meditation (TM) as producing a wakeful hypometobolic state, characterized by an increase in heart rate and skin resistance, and in EEG alpha and decreased breath rate and oxygen consumption (Wallace, 1970; Wallace, Benson, & Wilson, 1971). More recently, a combination of Yoga practices have been showed to have comparable effects in sports teachers (Telles, Nagarathna, Nagendra, & Desiraju, 1993), community home girls (Telles, Narendran, Raghuraj, Nagarathna, & Nagendra, 1997), children with impaired vision (Telles & Srinivas, 1999). In all these cases there were signs of reduced sympathetic activity in different subdivisions (e.g., sudomotor sympathetic, vasomotor sympathetic and cardiac sympathetic).

Balance is an important variable and is disturbed in various conditions apart from aging. For example, certain cases of mental retardation are associated with poor balance. Experienced meditators when assessed on a balance board showed better performance compared to a group who received dextroamphetamine (Dhume &

Dhume, 1991). The memory scores of university students were found to improve following the practice of TM (Kember, 1985). A single study reported the effects of four Yoga breathing practices on verbal and spatial memory task scores (Naveen, Nagarathna, Nagendra, & Telles, 1997). The results suggested that yoga breathing through a particular nostril increases spatial task scores rather than verbal scores, and no lateralized effect was seen.

The decrease in depression scores following yoga of the present study is in line with previous reports of an improved sense of wellbeing following yoga shown by Ray and colleagues (2001), as well as another report in which a specific Yoga practice called Sudarshan Kriya Yoga (SKY) which includes high frequency breathing was given to persons with diagnosed depression and the effects were compared with those of a conventional anti-depressant (i.e., imipramine) and with electroconvulsive therapy (Janakiramaiah, Gangadhar, Naga Venkatesha Murthy, Harish, Subbukrishna, & Vedamurthachar, 2000). It was found that SKY produced lesser benefits than electroconvulsive therapy but could be considered as a potential alternative to drugs in melancholia, as a first line of treatment.

In a study on exercise-effects, since Yoga practice has several aspects, namely physical activity, relaxation, awareness of breathing and detached observation, a 10-week exercise program was more effective than health education talks in reducing depression in older adults with depressive disorder (Mather et al., 2002). These results suggested the importance of older adults with depressive disorder, taking part in group exercise activities.

With regard to the effects of Yoga on sleep, the improvement in sleep following yoga seen here is in line with earlier reports that yoga is one among other complementary therapies, which are useful in the management of insomnia (Lang, Huntley, & Ernst, 2001). The practice of yoga has been shown to reduce signs of physiological arousal in normal volunteers based on measurements of autonomic and respiratory variables and oxygen consumption (Telles, Reddy, & Nagendra, 2000; Vempati & Telles, 2002), as well as a decrease in plasma catecholamine levels (Udupa, Singh, & Yadav, 1973). A similar benefit of reduced physiological arousal following yoga was also seen in persons with higher than usual arousal to begin with, related to their social circumstances (Telles, Narendran, Raghuraj, Nagarathna, & Nagendra, 1997) or to physical impediments (Telles & Srinivas, 1999).

In summary Yoga training has brought about a state of positive affect and improved the quality and quantity of sleep (self rated). The Ayurveda and Wait-list Control groups showed no influence on the psychological variables.

In conclusion this is the first trial in which Yoga and Ayurveda have been evaluated as separate interventions for older persons. There have been significant benefits following the introduction of Yoga as a part of routine of these older persons. The improvements were in diverse areas such as pulmonary functions, autonomic status, gait and balance, different aspects of memory, the affect or mental state and quality of sleep.

However, it is essential to keep in mind that the study was conducted on older persons who were institutionalized and who had no adequate income. This would make the present group different from older people in their own houses and who have control over their finances. This also suggests areas for future research mentioned under the next section (i.e., an appraisal of the thesis)

OVERVIEW

A critical review of the work done has been made with an objective of understanding the limitations of the study as well as to get insights into ideas for future research.

LIMITATIONS OF THE STUDY

(i) The study was conducted on older persons who were residing in an old age home. This population was preferred for two main reasons: (i) their living conditions were uniform, and (ii) since they were residing in the home, it could be expected that there would be a lower rate of dropouts. However, the fact that the study was conducted on institutionalized older persons who also had inadequate finances, raises a question about whether the findings would be applicable to older persons in general. For example, 'older persons in general' could include older persons living in a family or a community setting and older persons living in an institution but with adequate financial resources.

(ii) While the first point was a limitation of the study, the second point describes the weakness of the study. This weakness was that there was a high number of dropouts in the Ayurveda group which was believed to be due to the subjects erroneous concept of undesirable effects of the preparation as well as individual factors. However, it is necessary to emphasize that every attempt was made to convince the volunteers that the preparation had none of the adverse effects which were reported, but in spite of it dropouts did occur. This serves to highlight possible difficulties in administering a herbal preparation, especially to older persons who may have their own concepts and fears related to the intake of any medicine or remedy.

STRENGTHS

This study is the first randomized control trial which has evaluated both Yoga and Ayurveda compared with a Wait-list Control group in older persons taking into account a wide range of variables such as (i) measures for general health, (ii) neurological status and (iii) psychological functioning. Also, the assessments were made after three and six months of the respective interventions, allowing for a longitudinal follow-up and evaluation of progression in any changes seen. The other strength of the study is that participation of the subjects in the interventions was closely supervised.

POSSIBLE AREAS OF FUTURE RESEARCH

As mentioned above, the present randomized control trial evaluated Yoga and Ayurveda for the promotion of positive health in older persons, who were (i) living in an old age home and (ii) had inadequate financial resources. Hence, while the trial did demonstrate several benefits with Yoga practices and some benefits with the Ayurveda preparation, it would be desirable to evaluate these interventions in older persons in different settings, e.g., living at home or as part of a community or without inadequate finances. It may also be interesting to understand the mechanisms involved in the improvements in some of the measures studied, e.g., a whole night polysomnography study would give essential further information, substantiating the improvement in self-rated quality of sleep in the aged population studied here.

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