Review of Related Literature

Since time immemorial, a physically active and fit way of life has been conceptualized as promoting health and longevity. But not until the nineteenth century the investigators used numerical quantification to show the health habits of physical activity. In their review Paffenberger and Lee (1996) observed the notion that those who choose a physically active way of life, also were likely to be efficient in high quantity living which was best represented by, enjoyment of task undertaken, maintenance of functional capacity, and relief from the symptoms of chronic diseases.

Physical training programmes were shown to improve certain motor performance and cognitive functions observed by Powell (1975).

Despite the evidence of declining function, an increase in activity levels were shown to reverse the effects of (i) inactivity and improved physical condition (Bandenhop et al., 1983); (ii) psychomotor ability (Rikli & Busch, 1986); (iii) cognitive functioning and psychological well-being (Emery and Gatz, 1990); and (iv) haemodynamic and haematological modifications (Attina et al., 1981), in the elderly.

Paffenberger and Lee (1996) had concluded their extensive review that performance of moderate intensity physical activity on a regular basis appeared to be an important ingredient in the recipe for growing older successfully. Men and women who remained active or physically fit during middle or older age tended to live longer than their sedentary counterparts.

The present researcher has collected quite a good number of research papers of leading researchers from various journals and through electronic device. Selected articles for the purpose of review of related literature are presented here parameter-wise.
Physique

The size, shape, and proportions of the human body are not fixed or stable all through the life span of a man. Even during the period of adulthood these changes are common and inevitable. Aging manifests itself by a number of functional and morphological changes of the organism – observed by many researchers. Research of cross-sectional type are scanty in the history of measurement of physique, rather longitudinal studies over a long duration which claim more importance are less in number. A good number of traditional and new methods are there to predict and analyze the body composition and physical dimensions of man.

Height is a basic characteristic known to change with aging. Longitudinal investigation carried by Buchi (1950) revealed that adults who were measured first when aged 47-55 years had during the second measurement nine years later, on an average slightly lower height. Loss of stature within individuals during latter years, was found as an effect that had been attributed to weakening or imbalance of muscle groups, postural changes, osteoporosis, disk deterioration, and spinal deformities such as kyposis and scoliosis described in long back by Totter and Glasser (1951) and latter has been confirmed by many researchers like Rogers (1982), Rossman (1986) etc.

Damon et al. (1972) pointed out the causes of shortness of stature due to compression of the inter-vertebral discs, collapse of the vertebral column. The decrease of stature due to senescence commences around 40 years of age, and accelerates to a loss of as much as 7 cm per decade between 60 to 80 years was revealed by Shephard (1978).

Height of male and female participants of different age groups in World Masters’ Championship in 1975 were compared by Kavanagh and Shephard (1978) and they resolved that standing height was found to reduce with age, due to a combination of secular trend (upto 1 cm/decade) and changes in the configuration of the vertebral column due to kyposis and compression of inter-vertebral discs, most apparent from the sixth decades onwards. Exercise in an adult cannot modify the secular trend, but by strengthening the back muscles
and improving posture, it could conveniently delay the onset of kyposis. It may thus be significant that the master athletes showed a slightly smaller decrease of stature than sedentary individuals from age 35 to 65 years.

*Miall et al. (1967)* studied longitudinally on a large population. They were in opinion that decline of height started earlier in females than males. *Rossman (1986), Herendon (1986), and Davis (1987)* were observed that the rate of decline of height per year was found to less in males than females. The greater rate of decline in females were consistent with the reported higher incidence of osteoporosis and its complications in older women. *Rossman (1986)* also observed that ‘loss of height’ become progressively more severe in the eighth and ninth decades.

In the longitudinal study of a few years back by *Sorkin et al. (1999)* on 2,084 men and women aged 17-94 years over 15 years on men and 9 years on women observed the changes in height of men and women. They concluded that the rate of decrease in height was greater in women than men. For both sexes, height loss began at about 30 years and accelerated with increasing age. Cumulative height loss from age 30-70 years averaged about 3cm for men and 5cm for women, by age 80 years it was found to increase to 7cm for men and 8cm for women.

**Motor Ability**

Francis Galton, who used the term ‘human machine’ for the first time in the history of human performance, was an outstanding pioneer of the nineteenth century, studied on age and strength relation of males and females during 1880s. This was a large step forward because it enabled scholars to separate factors according to the degree to which they were related to age. Sergeant pioneered testing in the area of general motor ability in 1880s for the purpose of assessing athletic ability in men, cited by *Johnson & Nelson (1988)*.

An early study of *Miles (1931)* reported a greater loss of speed of movement in older subjects than their speed of reaction. Formal test of flexibility was appeared in the professional literature in 1941 published by Dr. T. K. Curaton who recommended flexibility as an aspect of physical fitness.
Simonson (1947) found leg strength to decline more rapidly with age than handgrip strength. Chui (1950) conducted a study on the application of weight training for improvement of flexibility. He observed that weight training not only increased flexibility but also strength.

Hodjkins (1962) tried to determine the relationship of reaction time and movement time in females between ages 6 to 84 years to determine the effect of age on reaction time and movement time. He obtained the results that reaction time and movement time are uncorrelated in all age groups, with one exception, that of the group between the ages of 22-37 years. Reaction time improved with age up to age 19, remained constant to age 26, and then decelerated with age. Movement time improved with age up to 15, remained constant to 19, and decelerated thereafter. Shock (1962) studied men and observed that the strength of the dominant hand dropped from 44 kg of pressure at the age 35 yrs to 23 kg at age 90 yrs on grip strength-measuring device. In 1970, deVries investigated the training effects of various duration on men aged 52 to 58 yrs. He observed little improvement in muscle girth and significant improvement in arm strength. From the findings of his study the researcher concluded that the strength improvement was due to greater activation by CNS rather than by any hypertrophic changes in the muscle tissue.

Chapman et al. (1972) observed the effect of training on joint stiffness and muscular strength of young and older adults. They opined that the cause of age-related decline in strength might be due to alteration of muscle fibre type and motor neuron abnormalities.

Clarke (1975) propounded sit and reach test as objective field test of static flexibility. The sit and reach score provides a simple measure of flexibility in the hip, spine and hamstring muscles and it is the sole test of flexibility adopted in a number of large scale representative population surveys. Buccola and Stone (1975) observed the significant change in flexibility of 60-79 year old men after fourteen weeks of training.
Young and Ismail (1977) observed regular and non-regular adult exercisers (X age = 43.13 yrs.). They found regularly active group increased significantly in physical fitness over the four-year period. Shephard (1978) commented that isometric muscle force is fairly well preserved until about 45 years of age. At age 65, values are 20% smaller in men and 10% in women. He opined that part of this loss may be motivational and loss of lean tissue.

Changes in muscle strength during growth and aging was a matter of sporadic scientific interest since Quetelet's pioneering study in 1836, commented Larsson et al. (1979). In their review they observed that most studies described a decline in isometric strength with age, and the maximum strength could be seen at the age between 25 and 30 years.

Studies of Shepherd (1969) and later Kallman (1990) yielded the result of slow or imperceptible decrease from the twenties to the forties and then accelerated decline in strength. Emes (1979) conducted a regular programme of light exercise on seniors and found noticeable improvement in balance. Sapega et al. (1981) suggested that long duration static stretching carried out with elevated body temperature is optimal for improvement in flexibility.

Fox (1984) opined that motor fitness could effectively be improved by exercise. Shephard (1984) contended that the impairment of flexibility due to the factors like collagen cross linkage, arthritis, and joint ankylosis. Pollock (1974) opined that abdominal muscle endurance and or improvement in flexibility of the lower back and hamstrings can decrease the incidence of low back pain, which often reduce the quality of life.

Piscopo (1985) commented flexibility as the most important element of fitness in older adults, and recognized it as an “indispensable pre-requisite of mobility”. In the cross-sectional study made by Rikli and Busch (1986) on age-matched sedentary & active and young and old women, the researchers found deterioration of motor performance in the variables like balance, flexibility, and grip strength with age. In the same study they found smaller or no significant differences between the older active and young active subjects.

Frontera et al. (1988) found that the muscle strength of older subjects increased after physical training. Shephard et al. (1990) examined the
flexibility on a population of men and women aged 45 to 75 years, with the purpose of identifying common flexibility factors and testing the generality of sit and reach scores relative to age and gender related differences of flexibility at major joints. They observed the sit and reach test was relatively consistent over the eight-month period of observation than goniometric measurements. The researchers concluded that in the elderly as in younger people, no single measurement indicate the loss of flexibility at all joints, however, sit and reach test as the more reliable than other simple measures.

Emery and Margaret (1990) found improvement of flexibility of older females (61 to 86 years) after 12-week exercise training. Both the cross-sectional and longitudinal perspectives were considered by Kallman et al. (1990) to interpret the role of muscle loss in the age related decline of grip strength. The purpose of their extensive study was to determine whether the results of the longitudinal and cross sectional analysis of grip strength agree. They observed the distribution of individual rates of change of grip strength was influenced by decreased muscle mass with age. The cause of age related decline of strength also remains unresolved and it has been attributed to several factors including declining muscle mass (Martin et al., 1985), increasing muscular fibrous tissue (Maclennan et al., 1980), alterations in muscle fibre type and motor neuron abnormalities (Campbell et al., 1973), in older people. The other contributing factors may be chronic diseases, osteoporosis, and osteoarthritis responsible for decreasing physical activity (Shephard, 1984).

Rikli and Edwards (1991) investigated the effects of a three-year exercise program on motor function of women between 57 to 85 years of age. They observed significant improvement in balance and flexibility, and increased grip strength.

Grant et al. (1992) studied the effects of a university fitness programme on health related variables in previously sedentary males (age 21 to 58 years). They suggested that long-duration static stretching carried out with elevated body temperature is optimal for improvement in flexibility. Mondal (1992) observed the influence of chronic exercises for 3 month on strength, speed, endurance, flexibility, balance, and agility of senior citizens participated in his experimental study.
Seilder and Stelmach (1996) reviewed that motor performance often tend to slow and vary with advancement of age. They commented after going through studies of various researchers that elderly supposed to show an increase in movement duration, reduced capacity for decelerating movement, and an inability to calibrate appropriate force levels due to collagen cross-linkage, arthritis, and joint ankylosis.

**Body Composition**

Research to establish indirect methods of determining human body composition had began during 1940s in the laboratory of Bhrnke. Bhrnke (1953) commented that lean body mass do not remain same throughout life, rather it deteriorate with aging. Pett and Ogilvie (1956) demonstrated a decrease of skinfold thickness during advanced age, particularly in men. Lee & Laskar (1958) studied large male samples within the age range of 41-100 years and observed no noteworthy change in skinfold thickness with age. Astrand (1960) measured functional capacity of man by maximal oxygen intake in working condition. His observation was in favour of proportional relationship between lean body mass and $V_{O2\text{max}}$. Parizkova (1963), who contributed a lot in the area of body composition during 1960s & 1970s, experimented on body composition of man with reference to age, diet, and exercise. She found striking positive relationship between lean body composition and physical performance, and intensity of exercise regardless of age in trained than in untrained individuals.

Forbes and Hursh (1963) studied large population of wider age range and observed the decline of L.B.M by 12 kg in 65-70 years age group than the average 25 years aged. In a time course the LBM : Height ratio of an individual, the LBM was found to decline with faster rate than height as concluded by Barter and Forbes (1963).

Parizkova and Eiselt (1966) observed the body composition in old age and the influence of exercise on aged who practiced regularly and intensively for at least 25-30 years. They found a significant difference in absolute amount of LBM between trained and untrained men.
deVries (1970) carried a training programme of 6-week duration on older men (X age = 69.5 years) and observed significant effects of exercise with decrease in body weight and % of body fat at the end. After thorough observation on a number of longitudinal studies related to lean body mass and age, Forbes and Reina (1970) concluded that, an average loss of only 0.29 kg LBM per year for men and 0.12 kg per year for women from age 25 years to 67 years. They were also observed LBM was highest in the third decade of life, thereafter it was found to fall slowly for the next two decades and then more rapidly.

Pollock et al. (1971) experimented on the effects of walking on body composition of sedentary men (X = 48.9 years). Their result was in favour of reduction in body weight and % of body fat.

Parizkova et al. (1971) in their comparative study on body composition on young (X age = 20.7 years) sedentary and both active and sedentary, old men of man age 72.4 years and 73.9 years respectively, noticed significant difference in LBM with reference to age and activity. They made a conclusion that, one of the cause of LBM reduction during aging was due to atrophy of muscular tissue, by decrease in the muscle fibre volume but not by the number of muscle fibres per square millimeter, as it remained same in the young and old.

Buccola and Stone (1975) in their study on 60-69 years old males who underwent 14 weeks exercise programme, observed significant reduction in body weight and 1% of body fat.

Forbs (1976), in a longitudinal study on 20-84 years old male subjects for 14 - year duration, found to decrease LBM by 0.36 kg/year.

Schwartz et al. (1990) observed the changes in fat distributions in normal aging when they examined and compared the fat distribution of very healthy young (18-30 yrs) and older (60-85 yrs) men, and found significantly higher fat deposition on extremities in younger group; conversely significantly higher central and/or intra-abdominal fat in the older group, which considers as an independent predictor of obesity related metabolic abnormalities.
Physiological State

Physiologic and performance measures generally improve rapidly during childhood and reach a maximum between the late teens and 30 years of age (mentioned McArdle, Catch & Catch, 1996). They described as physiological and performance capacities generally decline after about 30 years of age. The rates of decline in the various functions differ and are significantly influenced by many factors including level of physical activity. Regular physical training enables older persons to retain higher levels of functional capacity, especially in cardiovascular function. Regardless of age, regular vigorous physical activity produces measurable physiological improvements. The magnitude of these improvements depends on many factors that include initial fitness status, age, and type and amount of exercise.

In the present study the two mostly used physiological and performance measures i.e. heart rate and blood pressure have been considered to interpret physiological conditions of the subjects.

Heart Rate:

Heart rate response to a standard sub-maximal exercise has long been utilised as a measure of physical fitness. In some tests, heart rate during exercise was employed, but in most cases submaximal recovery heart rate was used. The recovery heart rate of older people was reported to be higher by Simonson (1953) as he observed their fitness was poorer in such tests. However, he pointed out as the higher post exercise heart rates of older subjects could be due to a higher heart rate during exercise, a slower recovery rate after the exercise, or a combination of both.

Montoye et al. (1968) found the relationship between ages and post-exercise heart rate of males and females between 10-69 years of age. He made comparisons between males and females (n = 5448) of different age groups of either sex in exercise heart rate. They observed heart rates were higher before, during, and after exercise in the subjects below 15 years of age than these of above 15 years. Between age 15-50 years in females and 15-60 years in males,
they found little change in exercise heart rate, including terminal exercise heart rate, but the return to post-exercise heart rates were significantly higher in females than in males.

An exercise protocol was prepared by Montoye et al. (1969) to measure submaximal exercise heart rate of males and females of 10-69 years and the same was used in this study for measuring exercise heart rate of 60+ age group. The exercise protocol was a modified Harvard Step Test on 8" bench at the rate of 24 steps (4-counts sequence) per minute for three minutes.

Shephard (1988) mentioned that the resting heart rate of adults depends greatly upon the individual's physical condition. Usually, some loss of condition occurs with aging, and the resting heart rate may increase by a small amount over the adult span.

McArdle et al. (1996) mentioned that no significant change in resting heart rate occurs with aging. However, one well-documented change in cardiovascular function with age is a decline in the maximum exercise heart rate. Regular moderate to vigorous physical activity may produce physiological improvements regardless of age. Of course the magnitude of the changes depends on several factors including initial fitness status, genetics, and the specific types of training.

Blood Pressure:

Rise in blood pressure is common to aging. Well-planned exercise is a good stressor to control one’s blood pressure level as observed by a large number of exercise scientists or researchers.

Barry et al. (1966) found a reduction in systolic and diastolic blood pressures by 13.6% and 6.48% respectively after 3 months of rhythmic exercise training on individuals ages 55 to 78 yrs. deVries (1970) experimented the training effect upon men aged 52-88 yrs. After 42-week training both systolic and diastolic blood pressures were reduced significantly.

Pollock et al. (1971) observed significant reduction of diastolic blood pressure on middle-aged men (40-56 yrs) with the consequence of vigorous walking for 20 weeks, 3 days per week. Buccola and Stone (1975) observed the
effects of jogging and cycling programme (14 weeks) on physiological variables of aged men (n = 16, age 60-79 yrs). They found significant decrease in systolic and diastolic blood pressure levels.

Lipsitz (1989) reviewed comprehensively on altered blood pressure homoeostasis with advancing age. The conclusion of his study was a result of physiologic and pathologic changes in blood pressure regulatory mechanisms; there was an intra- and inter-individuals blood pressure variability with advancing age.

The World Health Report (1997) pointed out hypertension as the most common cardiovascular disorder affecting 20% of the adult population.

Human aging is associated with stiffening of the aortic valves, the aorta and more peripheral arteries; thickening of the vascular wall specially in smaller arteries and arterioles, plus widening and elongation of the aorta, which has obvious consequences for the blood pressure commented Svanborg (1996).

Zelasko (2003) described that as life expectancy becomes longer people are susceptible for heart and kidney diseases to develop. The researcher recommended five things to maintain optimum blood pressure level, (a) lose weight (b) adopt the dietary approach to stop hypertension diet (c) reduce sodium intake to no more than 2.4 grams per day or 6 grams of salt (d) increase physical activity, especially aerobic exercise (e) consume alcohol moderately, if at all. Moreover, he commented that, this is not an attempt in favour of medications, rather, it is a promotion for adopting lifestyles that are conducive to healthy blood pressure.

Blood Bio-chemical State

Habitual exercise and/or organized physical fitness programmes have been shown to beneficial for biochemical effects. Haematological modifications induced by physical exercise have been reported by many researchers, common to them are Farinaro et al. (1977); Fox, Naughton and Haskell (1971), who viewed, even if the parameters evaluated were not constant and consistent, agreed on the fact that such modifications occur only when physical exercise is practiced regularly and intensely enough, and that they shortly disappear after discontinuing the activity, observed by Holloszy et al.(1964); Seigal (1970); Joseph and Bena (1977).
Blood Glucose:

Physical inactivity is one of the causes of impaired glucose tolerance with age and the others are poor diet, decreased LBM in which to store carbohydrate, decreased insulin secretion, and insulin resistance. In younger persons, diabetes commonly present with the classical symptoms of poly-urea, poly-dispepsia, weight loss, blurry vision and in the older individuals the initial manifestations may be more subtle and diagnosis delayed, mentioned by Davidson (1979).

Kinney (1982) reported that the fasting plasma glucose concentration did not change with aging or changed only by the insignificant amount of 1 ml/dl per decade.

Reduction in lean body mass occurs with aging. This means that, for a given body weight, the older individuals have more adipose tissue than the young adults. Horwitz (1982) described that adipose tissue uses less amount of glucose than lean body tissue and this could possibly account for some of the decreased glucose tolerance seen in the elderly. The researcher identified the benefits of exercise as it can improve blood sugar control, reduced likelihood hyperglycemia during exercise, enhanced efficiency of fat metabolism, reduced requirement for insulin for type-1 diabetes and reduced amount or elimination of insulin required to control blood sugar in type-II diabetes, and reduced body weight. The researcher enumerated that even prior to the discovery of insulin in 1921, exercise was recommended in the treatment of diabetes. Indeed the 'treatment trial' of diet, insulin, and exercise is a frequent term in protocol for control of hyperglycemia.

Hughes et al. (1993) demonstrated that regularly performed aerobic exercise without weight loss resulted in improved glucose tolerance, rate of insulin stimulated glucose disposal, and increased skeletal muscle GLUT-4 levels in older glucose intolerance subjects. They found no difference between moderate and high intensity exercise (50% Vs 70% max H. R. reserve) on glucose tolerance, insulin sensitivity, or muscle GLUT-4 levels.
Kirwan et al. (1993) found that 9 month endurance training at 80% of the \( \text{max H.R.} \) resulted in reduced glucose stimulated insulin levels.

Hughes et al. (1995) compared the effects of a high carbohydrate (60% CHO and 20% fat) and high fibre (25 gm/100 Kcal) diet with and without 3-month high intensity aerobic exercise (75% \( \text{max H.R.} \)/reserve for 50 min x 4 days/week) in older glucose intolerance men and women. They observed that neither the diet nor the diet plus exercise group improved their glucose tolerance or insulin-stimulated glucose uptake. They concluded with a comment that when combined with exercise, a high carbohydrate diet had a counterregulatory effect.

Serum Cholesterol:

Age related differences in cholesterol levels have been reported by a number of investigators in the middle of the 20th century, and a few of them were McMohan et al. (1951), Keys (1952). Kannel et al. (1961) experimented longitudinally over six years on 5,127 subjects and observed that those with serum cholesterol over 244 gm/100 ml of blood volume have more than three times the incidence of CHD as do those with cholesterol levels less than 210 mg/100 ml.

Thompson et al. (1965) made an investigation concerned with the relationship between serum cholesterol level and sex, age, and racial factors in a group of community volunteers over 60 years of age (60-93 yrs). They also assessed the change within individuals over a three-year period. In their study they observed a consistent curvilinear relationship between age and cholesterol level in clinically healthy people. They concluded that cholesterol levels began to raise gradually after age 18, and peak values were observed in men in the middle fifties and in women as late as sixties.

In the study related to multivariate analysis of the risk of coronary heart disease, Truett, Cornfield, and Kannel (1967) obtained the relationship that obese individuals having with hypercholesterolemia susceptible to increase the risk of CHD. The same relationship was observed by Jenkins et al. (1969). High blood cholesterol level was well recognized as one of the principal risk
factors associated with the development of ischemic heart disease and other manifestations of atherosclerosis, commented Stalmer et al. (1972).

Miles (1974) introduced an exercise programme on men (n = 22, age 28-54 years). The programme was metered physical training of 11 weeks duration for four days per week. After completion of the programme, average serum cholesterol level was decreased by 32.2 mg/100 ml.

In an interesting study, Thompson et al. (1980) experimented with the acute effect of prolonged exercise on serum lipids of twelve men, aged 24-50 yrs, who participated in a 42 km foot race. Significant reductions of 6% to 10% were found at 4-66 hours, however, total cholesterol did not change immediately after prolonged exercise.

Another interesting study conducted by Weltmen et al. (1980) observed that a combination of calorie restriction and metered exercise for 10-week duration, resulted in a significant decrease (> 16 mg/100 ml) in total cholesterol. Furthermore, the entire decrease in serum cholesterol level was due to decrease in LDL and VLDL cholesterol. HDL cholesterol was not altered with their treatment. In the same study they obtained the result that caloric restriction resulted in total cholesterol reduction due to reduced HDL cholesterol and VLDL and LDL cholesterol levels were not changed with caloric restriction.

Straugenberg (1981) investigated a total of 149 men (mean age 56 years) who underwent a training programme of four weeks duration, with two daily sessions, lasting 30-45 min, five times a week. Post-test serum cholesterol level was significantly decreased (from 265.23 mg/100 ml to 227.83 mg/100 ml for whole group and in the persons (n = 45) having hypercholesterolemia the serum cholesterol level also significantly decreased (from 327.62 mg/100 ml to 270.00 mg/100 ml).

Repeated acute, prolonged exercise considerably lower total cholesterol level but increase the HDL cholesterol level and these changes occur despite increased food intake, concluded Writh et al. (1983).

Metivier and Gauthier (1988) observed the effects of acute physical exercise (60 min duration) on blood serum cholesterol levels of men with
mean age of 53.9 years. They observed increased (223.2 mg/100 ml) level following the work bout to fall to near original values (207.2 mg/100 ml) one hour later. Blumenthal et al. (1989) found decreased cholesterol levels of men and women (n = 33, age 60-83 yrs) after 16 weeks aerobic exercise training (3 days/week).

Kobayashi et al. (2005) conducted a study to determine the effects of marathon run on serum lipid of fifteen males (X age 43.5 yrs). They observed:

(i) LDL-cholesterol levels were not affected significantly by the race, but transiently reduced significantly below baseline for 3 days, returning to baseline after about 1 week.

(ii) HDL-cholesterol elevated 14% in the first day after the race and remained significantly elevated for 3 days but then turned toward baseline.

(iii) Total cholesterol levels were slightly increased by the race and then reduced significantly below baseline after 2 days before returning to baseline by 1 week.

(iv) The total-cholesterol/HDL ratio (lower values considered beneficial) was reduced 9% immediately after the race, and the ratio subsequently declined to 16% below baseline for 3 days reaching the baseline level after 2 weeks.

Cognitive Ability

Birren et al. (1980) mentioned that reaction time, especially CRT, is considered to be a primary indicator of overall cerebral functioning.

Ponds et al. (2000) made a comment on the basis of previous related works that subjective health and emotional state are both related to subjective decline of cognitive functioning. They pointed out age-related decline in subjective cognitive functioning started at the age of 50 years and steadily increased afterward. This decline they found not restricted to memory, but also involved changes in attention, mental speed, planning, and decision-making.
Reaction Time:

More than a century past, Rutherford (1894) observed that RT to light could be improved with practice regardless of age. The data from Galton’s Anthropometric Laboratory, as analyzed by Koga and Morant (1923), were among the earliest studies demonstrating slower simple reaction times to auditory and visual stimuli by older subjects. Subsequently, the studies of Bellis (1933), Birren and Botwinick (1955), Ferris et al. (1976) have confirmed this finding from simple auditory and visual reaction times.

Throughout the developmental stage up to about 25 years of age in an individual, reaction time decreases at first rapidly and then more slowly following the same type of growth function. Luria (1932) was of the opinion that the young child might be expected to show a very short reaction time. On complex reaction time tasks involving more than one stimulus or response, Goldfrab (1941) observed that older adults are slower than younger adults.

Reaction time may differ from individual to individual and also in the same individual vary from day to day and even from event to event commented by Hull (1942). He further opined as, this behavioural oscillation is an overall characteristic of the organism, not to be explained by any single factor.

Pierson and Montoye (1958) studied 400 male subjects and concluded that RT is significantly related to chronological age. Grew (1959) paid attention to observe on the possible relationship between age and complexity of response, and time of initiating the response in reaction time. He concluded that the increase latency of response prevalent in elderly subjects than younger ones which may cause by breakdown of manipulative part to response.

Simple reaction time is somewhat diminished with aging commented by Weiss (1965). However, Gottsdanker (1982) concluded that, movement response required in extremely simple re-action takes longer time in the elderly than the younger ones.
Murrell (1970) experimented on the effects of extensive practice on age differences in reaction time. He concluded that the age difference was marked when the number of choices i.e. complexity of the response increased.

Spirduso (1975) compared physically active elderly subjects to age matched sedentary subjects and to younger subjects and concluded that the data of psychomotor speed in seniors were almost equal to younger subjects.

Buccola and Stone (1975) observed a minor change after a jogging and cycling program of 14-week on aged (60-79 yrs.). Decrements in reaction time as a component of cognitive functioning were evidenced by Horn and Donaldson (1976) and Botwinick and Thompson (1978).

Clarkson and Kroll (1978) and Spirduso (1988) observed the proportionately greater effect of exercise on CRT than on SRT and they were in opinion that the impact of exercise was more in CNS than peripheral part of the mechanism. Spirduso (1980) observed that, laboratory induced supplemental oxygen resulted to improve reaction time performance.

The researchers like Baylor & Spirduso (1988), Rikli and Bouch (1986), Sherwood and Selder (1979) agreed that choice reaction time has proportionately larger percentage of pre-motor area that is central part of the nervous system, is largely influenced by physical activity level than mere SRT.

Spirduso et al. (1988) experimented on aged motor function with reference to time. They observed 8-11% better time in younger age group (20-29 years) than elderly group (50-59 yrs). These differences were consistent with Dutsmann et al. (1984) who also found an 8-11% difference between physically active and sedentary groups of men and women.

Emery and Margaret (1990) included reaction time as a cognitive function unlike many of their predecessors like Botwinick & Thompson (1978); Horn and Donaldson (1976), and successors like Rikli and Edwards (1991), examined the effect of physical exercise programs on older adults’ cognitive function, and found improvement after the exercise programme.

Light and Spirduso (1990) examined the effects of age and movement complexity on response latencies. The result of their study indicated that age as a variable contributed more to the identification of movement complexity factors in motor control than complexity of the task.
Rikli and Edwards (1991) in a longitudinal study on older women (n = 31, age 57-85 yrs) observed that CRT was more influenced by increased activity level than was SRT. The increase rates were 4% and 9.67% in SRT and CRT respectively.

Salthouse (1996) described that between age 20 to 90 years the simple and choice reaction time increase about 0.5 ms per year and for choice reaction time it is 1.7 ms per year. He opined that reaction time is an important topic on aging mainly for three reasons (i) the speed with which a simple response can be produced is a very elementary behavioural measure and may function as a relatively direct indicator of an individual’s neurological status (ii) studies of RT have revealed moderately large age relations and these relations are among the most consistent and robust in all of the behavioural sciences and (iii) RT measures have been found to be related to measures of higher cognitive functioning.

Visual Perception:

Relationship between physical activity and CFF has drawn attention to the researchers since long back; for example, Simonson and Benton (1943) found decreased CFF score after running activity.

Extensive studies have been conducted by a number of researchers correlating age and CFF, and impact of exercise on CFF. A definite decrease of CFF with increasing age was reported by Brozek and Keys (1945). While Misiac (1947) found this declination from twenty years.

Mallick and Chattopadhyay (1983) reported a higher score in the age group of 13-15 years than 19-20 yrs. They described that the cause of decrease of CFF with the age may be either due to peripheral factors (retinal) or due to central factors (sub-cortical or cortical) or both.

Anxiety is found to close relationship with CFF score. Low anxiety group had been shown with higher CFF score by a large number of researchers and common to them are Simonson and Brozck (1952), Goldstone (1955), Chatterjee (1980).
Bartley (1959) reported that strenuous aerobic work decrease the CFF level. On the other hand, Volle et al. (1978) reported that mild exercise increased CFF score.

Powell (1982) explored the possibility of using peripheral CFF technology as a basis for inferring differences between right and left cortical hemispheric activity following exercise. A significant decrease was found in CFF score between right and left peripheral field after exhaustive exercise. Mondal and Banerjee (1991) confirmed this observation in a similar type of study. Powell (1983) opined that CFF score might be utilised as a typological index of nervous system reactivity.

Powell (1988) indicated that high-intensity aerobic training program significantly reduce CFF score which was seen to reflect in turn a reduction in central sympathetic response. Mondal and Banerjee (1992) had shown significantly lower CFF score in trained athletes than that of non-athletes. Mondal (1992) observed in his experimental study that the significant reduction of CFF in senior citizens.

Tassi et al. (2000) examined diurnal-pattern of visual discrimination threshold in adults. They found no statistically significant differences for the differential threshold, however, the threshold level was low in the morning.

Psychological State

Singer (1992) made an extensive review and concluded it with following potential psychological benefits of vigorous physical activity:

(a) Exercise can help reduce state anxiety.
(b) Exercise can help decrease the level of mild to moderate depression.
(c) Long-term exercise can help reduce neuroticism and anxiety.
(d) Exercise may be an adjunct to the professional treatment of severe depression.
(e) Exercise can help reduce various kinds of stress.
(f) Exercise can have beneficial emotional effects across all ages for both sexes.
It is estimated that as many as 25% of the population suffers from mild to moderate depression, anxiety, or the other emotional disorders. Some could cope with these disorders individually without professional assistance. Physical activity can be a promising aid for such people, commented Brown (1988).

Martens (1972) defined state anxiety as consciously perceived feelings of apprehension and tension, accompanied by arousal of the autonomic nervous system and trait anxiety as 'an acquired behavioural disposition that predisposes an individual to perceive a wide range of objectively non-dangerous circumstances, as threatening, and to respond with state anxiety reactions disproportionate in intensity to the magnitude of the objective danger'.

Depression is one of the most common and treatable psychiatric illness in late life. It is also a major cause for cognitive impairment, anxiety, and psychotic symptoms among the elderly. Koen & Blazer (1996) described depression- a disorder of mood that involves symptoms of sadness, discouragement, and feelings of hopelessness, as well as loss of appetite, difficulty sleeping and loss of energy. Although depression can be a transient state for some, for others it may last many months, and sometimes, many years.

Anxiety:

Levitt (1980) commented that State-Trait-Anxiety Inventory (STAI) is perhaps the most extensively used and highly regarded instrument for the assessment of State-Trait-Anxiety in any area of psychological investigation.

Morgan et al. (1980) used exercise as a relaxation technique to reduce anxiety. They found State-Anxiety increased in a fairly linear fashion throughout the first half of both run and walk, than reached a plateau and remained stable for second half of the exercise.

Himmelfrab and Murrell (1983) conducted a study on elderly subjects (n = 279) of age between 54 to 100 years and obtained the mean trait anxiety score as much as 36.43. Studies of Dishman (1985 & 1986), Morgan and Goldston (1987) have shown that both of short and long form exercise brings about psychological enhancement and mental well-being.
Schwab et al. (1985) observed that exercise helped to reduce anxiety levels among special groups of older adults, including patients with dementia. de Coverly Veale (1987) pointed out that improvement in psychological well-being following exercise may result from enhanced feelings of mastery or from elevation in plasma opioid levels.

Shephard et al. (1987) introduced an exercise programme on elderly (45-75 years). The results of the study revealed that both the forms of state and trait anxiety were less on experimental subjects than controls after 20 weeks of experimental period. Stepto & Bolton (1988) observed the positive effect of aerobic exercise on mood state and decreased anxiety level in normal subjects. Stephens (1988) observed a positive relationship between level of physical activity and mental health.

Blumenthal et al. (1989) studied aged men and women (60-83 years). They introduced an aerobic exercise programme (3 days/week for 16 weeks) for experimental groups. In the same study there were two another groups, one of the groups practiced yoga for same duration and another group was sedentary. The anxiety level was measured by STAI of Spielberger et. al. (1970) and the average scores of the three groups altogether was 31.3 of the beginning of the study. They found significant decrease in trait anxiety in men and state anxiety in women who underwent into the exercise programme and the control men subjects increased the anxiety level significantly.

Mossess et al. (1989) randomly assigned 95 subjects of either a high intensity (70-75% max heart rate value), a moderate intensity (60% of maximal heart rate) aerobic training regimen, and strengthening and stretching regime, which served as an attention placebo control. All three regimens were equated in frequency (three supervised and three unsupervised sessions per week) and duration of 10 weeks. Reduction in anxiety as a psychological benefit was evident in moderate aerobic exercise group. But not for the other two training regimens, however, greatest improvement in the fitness measures was observed in high intensity group.
Emery and Gatz (1990) considered anxiety as the measure of well-being of an individual. In their experimental study for 12-week exercise training on older women (61-86 yrs.) they observed decreased anxiety level in experimental group and the control group remained same.

After an extensive review on the impact of various physical activities Singer (1992) made a conclusion that exercise can help reduce state anxiety and long-term exercise can help reduce trait anxiety. Ekkekakis et al. (1999) measured state anxiety in the context of acute exercise. They found that after an aerobic exercise session state anxiety level of young subjects was changed.

Depression:

Geriatric depression has a wide range of genetic, psychosocial, and acquired biological determination. These are specially common among older adults. Late life can be a time of loss and disturbing change in health, activity level, social roles, friendship and family networks, and financial circumstances. Impaired cerebral function due to vascular disease in age associated degenerative diseases increase depression among elderly (Koening & Blazer, 1996). Older persons with major depression and physical illness experience increased mortality when compared to non-depressed persons.

Matt and Dean (1993) studied depression of elderly persons from social support aspect and found enhanced depression in old age influenced largely by loss of social support because of death of spouse, friends, and disengagement in social life.

Emery and Gatz (1990) mentioned depression as a measure of psychological well-being of an individual. They took a venture to observe the effects of exercise training programme on psychological well-being of community residing older adult (n = 48, age 61 to 68 years). The training programme of the study was for 12-week duration, composed of stretching, aerobic exercises, Strengthening and cool down type of exercise for one hour session, likewise twice sessions per week. After completion of the programme significant decrease in depression levels were observed in experimental subjects.
Symptoms of depression were found to peak in late teens, and dropped off with age until the 60s and increased again with old age, remarked Mirowsky and Ross (1992). Hooyman and Kiyak (1996) pointed out that economic stress has an impact on depression with aging. They opined that reduced and fixed income with aging couldn’t satisfy the demands of livelihood and increased medical expenses, which are common in old age.

Koening and Blazer (1996) defined depression as "a disorder of mood that involves symptoms of sadness, discouragement, and feelings of hopelessness, as well as loss of appetite, difficulty sleeping, and loss of energy". Besides impairing quality of life and producing severe emotional pain, depression also impacts adversely on other health outcomes and on use of health services. Older persons with major depression and physical illness experience increased mortality when compared to non-depressed persons.

Harba et al. (1997) pointed out three sources of stress account for increase in depression with aging. Those three sources are poor health, economic stress, and less social support. However, Mirowsky and Ross (1989) argued that sense of control (mastery) is the most important psychological resource with which to cope with stress when feeling in control of their lives. They mentioned that depression symptoms are present in about 15% of older adults and common symptoms are reduced energy and concentration, sleep problems, decreased appetite, weight loss, and somatic complaints in the elderly. The symptoms may be different in older depressed patients from those seen in younger adults because of an increased emphasis on somatic complaints in older people.

Reich (1999) after examining the relationship between depression level and personality disorder commented that depression is highly related to personality of an individual.

Suzane et al. (2000) tried to find out longitudinal relationships between depressive symptoms and health in normal older and middle-aged adults. After a thorough study on a large sample of 1,479 individuals, their findings were (i) different durations of depressive symptoms had different relationship to health, (ii) health had an impact on short-term increase in depressive
symptoms had a weaker impact on health (iii) long term depressive symptoms had a clear impact on health. They concluded that physical illness can affect depressive states and traits, but not states can affect illness.

**Gait Pattern**

Research on human movement studies momentum during nineteenth century mainly due to development of new technology. Radiography and cinematography have opened the field of time-motion study in to new horizon.

The first experiment in gait biomechanics was completed more than 160 years ago by Weber and Weber (1836). Spielberg (1940) reported that one of the earliest symptoms of old age in walking was a manner of making initial floor-contact with the foot in a relatively horizontal position rather than heel-toe sequence.

The most obvious characteristic of the gait of older subjects was the shorter stride lengths and broader area of support observed by Drillis (1961). Dean (1965) noticed that people choose step lengths that were proportional to step frequencies.

Murry et al. (1966) observed the ratio of 0.69 between step length and step frequency when they compared free and fast walking patterns of normal men.

Murry, Kory and Clarkson (1969) studied thoroughly on walking patterns of men between ages 20 to 87 years. Marked differences were noticed for the men above age 65 years. The older men walked at a slower cadence for both free and fast speed walking. Their data revealed that the mean stride length of the subjects younger than 65 years averaged 89% of their height where as the mean stride lengths of the men older than 65 years averaged 79% of their height.

Hoshikawa et al. (1971) found in their study that at the same walking speed, trained athletes took longer steps than non-trained individuals, however, both the groups were matched in height and leg length. During walking three requirements must have to meet by the CNS claimed
Grillner (1975). That requirements are – (a) production of a basic locomotion pattern necessary to propel the body in the intended direction (b) balance control and (c) adapting the basic gait pattern to environmental demands.

Zarrugh et al. (1974) observed that on an average the ratio of step length and step frequency was 0.70 for men and 0.60 for women did not change in treadmill walking with different speed.

Nilsson et al. (1985) studied changes in leg movements and muscle activity with speed locomotion and mode of progression in humans. They noticed that both step length and step frequency were changed when walking velocity changed.

The transition from walking to running was found to occur at an average velocity of 1.92 m/s and the reverse change from running to walking occurred at 1.85 m/s, propounded by Thorsterson and Robertson (1987). Nilsson and Thorstersson (1987) advocated that if people allowed to walk freely, choose a certain velocity and walking pattern (step length and step frequency) at any given speed from very low to maximally high, people vary their walking patterns.

Himan et al. (1988) studied a large population (age 19-102 years), and observed a curvilinear decline in walking speed and step length with age. They also observed, age was not a significant factor before age 62 and concluded that the decrease of normal gait speed is 0.11% per year for men and the decline is 1.62% per year beyond the age of 62 years.

The linear relationship between stride length and cadence confirmed by Elble et al. (1991) which was observed earlier by Dean (1965), Zarrugh & Radeliffe (1978). Elble et al. (1991) pointed out that changes in walking pattern in older people due to both aging and disease. Age-related neurological decline, fear of falling due to poor orientation, reduced cardiopulmonary function, joint disease, reduced muscular strength and increased joint rigidity are the causes of change in walking pattern.

Dobbs et al. (1992) commented that free walking speed correlated with balance and the greater the forward backward sway in an upright posture, the
slower the speed. Zatsiorky, Werner, and Kaimin (1994) reviewed comprehensively on basic kinematics of walking to analyze basic factors and theories dealing with two basic kinematics variables of human gait, i.e. step length and step frequency. They resolved that (a) there are four possible determinants of step length, i.e., push-off action of the stance leg, pull-off action at the hip during swing phase, pelvic rotation, and braking action at the knee during the later swing phase (b) the relationship between step length and step frequency is approximately linear over a broad range of walking speed; (c) regardless of the experimental paradigm employed, when step frequency increases (from 40 to 200 steps/min), velocity of progression increases, and vice-versa.

Woollacott (1996) described after investigation on age-related changes in gait pattern: (a) slower walking velocity (b) smaller displacement amplitudes of the joints, and (c) shorter stride length in the elderly between 60-72 years of age.

Williams et al. (2000) in very recent past introduced a training programme of 8 weeks duration on older women (age - 73-92 years) and observed the postwalking speed and step length were significantly improved through training.

Reviewing the research work of leading researchers, it is evidenced that there are dearth of literature on Indian context. Therefore, the planning of the present research is made accordingly and included a wide range of parameters.