CHAPTER II
REVIEW OF RELATED LITERATURE

The review of literature is instrumental in the selection of the topic, formation of hypothesis and deductive reasoning leading to the research problem. It helps to get a clear idea and supports the findings with regard to the problem under study (Thirumalaisamy, 1995).

Study of related literature implies locating, reading and evaluating reports of research as well as reports of casual observation and opinion that are related to the individual’s planned research reports.

2.1. STUDIES ON YOGA

Hafner-Holter, et.al. (2009) conducted a study on Effects of fitness training and yoga on well-being, social competence and body image. It describes and compares influences from a physical activity program and a yoga program on well-being, mood, stress coping, body-image and social competence in healthy people. Eighteen persons attending a gym and 21 taking part in a yoga program answered following questionnaires before entering the program and after taking part for 20 units: Body-Image-Questionnaire (25), Symptom - Checklist - 90 R (8), Complaint-List (31), Adjective Mood-Scale (32) and a Visual Analogue Scale for assessing stress-level (10). Statistical analyses show significant improvement in social competence in both training groups; the gym-group reports reduced sexual discomfort, whereas people taking part in yoga-group show a reduction in summarization and body-related anxiety as well as an improvement in physical and emotional well-being. Our
findings support the evidence that physical activity in general improves psychological well-being, however, gym and yoga seem to have different psychological impacts. Future research should focus on comparing the psychological effects of different physical activity interventions in prevention programmes as well as exercise prescriptions in patients with mental illness.

Chen et al. (2009) conducted a study on the effect of yoga exercise intervention on health related physical fitness in school-age asthmatic children to investigate the effect of yoga exercise on the health-related physical fitness of school-age children with asthma. The study employed a quasi-experimental research design in which 31 voluntary children (exercise group 16; control group 15) aged 7 to 12 years were purposely sampled from one public elementary school in Taipei County. The yoga exercise program was practised by the exercise group three times per week for a consecutive seven week period. Each 60-minute yoga session included 10 minutes of warm-up and breathing exercises, 40 minutes of yoga postures, and 10 minutes of cool down exercises. Fitness scores were assessed at pre-exercise (baseline) and at the seventh and ninth week after completion. A total of 30 subjects (exercise group 16; control group 14) completed follow-up. Compared to children in the general population, the study subjects (n = 30) all fell below the 50th percentile in all five physical fitness items of interest. There was no significant difference in scores between the two groups at baseline (i.e., pre-exercise) for all five fitness items. Research found a positive association between exercise habit after school and muscular strength and endurance among asthmatic children. Compared to the control group, the exercise group showed favorable outcomes in terms of flexibility and muscular endurance. Such favorable outcomes remained evident even after adjusting for age, duration of disease and steroid
use, values for which were unequally distributed between the two groups at baseline. 4. There was a tendency for all item-specific fitness scores to increase over time in the exercise group. The GEE analysis showed that yoga exercise indeed improved BMI, flexibility, and muscular endurance. After 2 weeks of self-practice at home, yoga exercise continued to improve BMI, flexibility, muscular strength, and cardio-pulmonary fitness.

**Brown and Gerbarg (2009)** stated that Yoga breathing is an important part of health and spiritual practices in Indo-Tibetan traditions. Considered fundamental for the development of physical well-being, meditation, awareness, and enlightenment, it is both a form of meditation in itself and a preparation for deep meditation. Yoga breathing (pranayama) can rapidly bring the mind to the present moment and reduce stress. In this paper, they reviewed data indicating how breath work can affect longevity mechanisms in some ways that overlap with meditation and in other ways that are different from, but that synergistically enhance, the effects of meditation. They also provided clinical evidence for the use of yoga breathing in the treatment of depression, anxiety, post-traumatic stress disorder, and for victims of mass disasters. By inducing stress resilience, breath work enabled them to rapidly and compassionately relieve many forms of suffering.

**Chaya et.al. (2006)** investigated the net change in the basal metabolic rate (BMR) of individuals actively engaging in a combination of yoga practices (asana or yogic postures, meditation and pranayama or breathing exercises) for a minimum period of six months, at a residential yoga education and research center at Bangalore. The measured BMR of individuals practicing yoga through a combination practices was compared with that of control subjects.
who did not practice yoga but led similar lifestyles. This study shows that there is a significantly reduced BMR, probably linked to reduced arousal, with the long-term practice of yoga using a combination of stimulatory and inhibitory yogic practices.

Madanmohan et.al. (2005) conducted a comparative study of the “Effect of short term (three weeks) training in savitri (slow breathing) and bhasrika (fast breathing) pranayams on respiratory pressures and endurance, reaction time, blood pressure, heart rate, rate-pressure product and double product”. Thirty student volunteers were divided into two groups of fifteen each. Group I was given training in savitri pranayam that involves slow, rhythmic, and deep breathing. Group II was given training in bhasrika pranayam, which is bellows-type rapid and deep breathing. Parameters were measured before and after three-week training period. Savitri pranayam produced a significant increase in respiratory pressures and respiratory endurance. In both the groups, there was an appreciable but statistically insignificant shortening of reaction time. Heart rate, rate-pressure product and double product decreased in savitri pranayam group but increased significantly in bhasrika group. It is concluded that different types of pranayams produce different physiological responses in normal young volunteers.

Harinath et.al. (2004) evaluated “Effects of Hatha yoga and Omkar meditation on cardio respiratory performance, psychological profile, and melatonin secretion”. Thirty healthy men in the age group of 25-35 years volunteered for the study. They were randomly divided in two groups of 15 each. Group 1 subjects served as controls and performed body flexibility exercises for 40 minutes and slow running for 20 minutes during morning
hours and played games for 60 minutes during evening hours daily for 3 months. Group 2 subjects practiced selected yogic asanas (postures) for 45 minutes, and pranayama for 15 minutes during the morning, whereas during the evening hours these subjects performed preparatory yogic postures for 15 minutes, pranayama for 15 minutes, and meditation for 30 minutes daily, for 3 months. Orthostatic tolerance, heart rate, blood pressure, respiratory rate, dynamic lung function (such as forced vital capacity, forced expiratory volume in 1 second, forced expiratory volume percentage, peak expiratory flow rate, and maximum volume ventilation). And psychology profiles were measured before and after 3 months of yogic practices. Serial blood samples were drawn at various time intervals to study effects of these yogic practices and Omkar meditation on melatonin levels. Yogic practices for 3 months resulted in an improvement in cardio respiratory performance and psychology profile. The plasma melatonin also showed an increase after three months of yogic practices. The systolic blood pressure, diastolic blood pressure, mean arterial pressure, and orthostatic tolerance did not show any significant correlation with plasma melatonin. However, the maximum night time melatonin levels in yoga group showed a significant correlation (r=0.71, p<0.05) with well-being score.

Barshankar, et.al. (2003) examined the effect of yoga on cardiovascular function in subjects above 40 years of age. Pulse rate, systolic and diastolic blood pressure and Valsalva ratio were studied in 50 control subjects (not doing any type of physical exercise) and 50 study subjects who had been practising yoga for 5 years. From the study it was observed that significant reduction in the pulse rate occurs in subjects practising yoga (P<0.001). The difference in the mean values of systolic and diastolic blood
pressure between study group and control group was also statistically significant (P<0.01 and P<0.001 respectively). The systolic and diastolic blood pressure showed significant positive correlation with age in the study group (r1 systolic=0.631 and r1 diastolic =0.610) as well as in the control group (r2 systolic =0.981 and r2 diastolic =0.864). The significance of difference between correlation coefficient of both the groups was also tested with the use of Z transformation and the difference was Significant (Z systolic =4.041 and Z diastolic =2.901). Valsalva ratio was also found to be significantly higher in yoga practitioners than in controls (P<0.001). Our results indicate that yoga reduces the age related deterioration in cardiovascular functions.

**Virtanen et.al. (2003)** The purpose of study was to determine whether psychological factors are associated with heart rate variability (HRV), blood pressure variability (BPV), and baroreflex sensitivity (BRS) among healthy middle-aged men and women. A population-based sample of 71 men and 79 women (35-64 years of age) was studied. Five-minute supine recordings of ECG and beat-to-beat photoplethysmographic finger systolic arterial pressure and diastolic arterial pressure were obtained during paced breathing. Power spectra were computed using a fast Fourier transforms for low-frequency (0.01-0.15 Hz) and high-frequency (0.15-0.10 Hz) powers. BRS was calculated by cross-spectral analysis of R-R interval and systolic arterial pressure variability ties. Psychological factors were evaluated by three self-report questionnaires: the Brief Symptom Inventory, and the Toronto Alexithymia Scale. It was found anxiety and hostility are related to reduced BRS and increased low-frequency power of BPV. Reduced BRS reflects decreased parasympathetic outflow to the heart and may increase BPV through an increased sympathetic predominance.
Swami Vivekananda Yoga Research Foundation (2002) conducted a study on yoga and relaxation. In this study, 35 male volunteers whose ages ranged from 20 to 46 years were studied in two sessions of yoga-based guided relaxation and supine rest. Assessments of autonomic variables were made for 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 subjects before and after both types of relaxation. A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation (paired t test). There were comparable reductions in heart rate and skin conductance during both types of relaxation. During guided relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high frequency component increased, suggesting reduced sympathetic activity. Also, subjects with a baseline ratio of LF/HF > 0.5 at baseline showed no such change. The results suggest that sympathetic activity decreased after guided relaxation based on yoga, depending on the baseline levels.

Karuppasamy (2002) conducted a study on “Effect of physical training and asanas on selected physiological variable and motor ability component among college men”. For this study, he selected 30 college men age ranging between 18 to 19 years and divided them in three groups, which underwent six weeks training programme of asana and physical training and a control group that did not do any training. He used ANCOVA and found out that there was significant effect of asana on pulse rate but there is no change in speed.
Carlson (2001) assessed the “Effects of participation in a mindfulness meditation based stress reduction program on mood disturbance and symptoms of stress in cancer outpatients immediately after and 6 months after program completion”. Convenience samples of eligible cancer patients were enrolled after they had given informed consent. All patients completed the Profile of Mood States (POMS) and Symptoms of Stress Inventory (SOSI) both before and after the intervention and 6 months later. The intervention consisted of a mindfulness meditation group lasting 1.5 h each week for 7 weeks, plus daily home meditation practice. A total of 89 patients, average age 51, provided pre-intervention data. Eighty patients provided post-intervention data, and 54 completed the 6-month follow-up. The participants were heterogeneous with respect to type and stage of cancer. Patients’ scores decreased significantly from before to after the intervention on the POMS between the pre and post-intervention scores. Female gender and more education were associated with higher initial SOSI scores, and improvements on the SOSI were predicted by more education and greater initial mood disturbance. This program was effective in decreasing mood disturbance and stress symptoms for up to 6 months in both male and female patients with a wide variety of cancer diagnoses, stages of illness, and educational background, and with disparate ages.

Tran et.al. (2001) conducted a study on the “Effects of Hatha Yoga Practice on the Health-Related Aspects of Physical Fitness”. Ten healthy, untrained volunteers (nine females and one male), ranging in age from 18-27 years, were studied to determine the effects of hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance, flexibility, cardio respiratory fitness, body composition, and
pulmonary function. Subjects were required to attend a minimum of two yoga classes per week for a total of 8-week training program. Isokinetic muscular strength for elbow extension, elbow flexion, and knee extension increased by 31%, 19% and 28% (P<0.05), respectively, whereas isometric muscular endurance for knee flexion increased 57% (P<0.01). Ankle flexibility, shoulder elevation, trunk extension, and trunk flexion increased by 13% (P<0.01), 155% (P<0.001), 188% (P<0.001), and 14% (P<0.05), respectively. Absolute and relative maximal oxygen uptake increased by 7% and 6%, respectively (P<0.01). These findings indicate that regular hatha yoga practice can elicit improvements in the health-related aspects of physical fitness.

Yadev and Das (2001) conducted a study on the Effect of yogic practice on pulmonary functions in young females. Sixty healthy young female subjects (age group 17-28 years) were selected. They had to do the yogic practices daily for about one hour. The observations were recorded by MEDSPIROR, in the form of FVC, FEV-1 and PEFR on day-1, after 6 weeks and 12 weeks of their practice. There was significant increase in FVC, FEV-1 and PEFR at the end of 12 weeks.

Ray, et.al. (2001) undertook a study to observe the beneficial effects of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two groups i.e. yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the five months of the course while control group (21 males and 5 females) did not perform yogic exercises during this period. From the 6th to 10th months of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin
temperature in resting condition: responses to maximal and sub maximal exercise, body flexibility were recorded. Psychological parameters like personality, learning arithmetic and psychomotor ability and mental well being were also recorded. Various parameters were taken before and during the 5th and 10th month of training period. Initially there was relatively higher sympathetic activity in both the groups due to the new work/training environment but gradually it subsided. Later on at the 5th and 10th month, yoga group had relatively lower sympathetic activity than the control group. There was improvement in performance at sub maximal level of exercise and in anaerobic threshold in the yoga group. There was improvement on various psychological parameters like reduction in anxiety and depression and a better mental function after yogenic practices.

Joshi, et.al. (1996) selected thirty three normal male and forty-two normal female subjects, of average age of 18.5 years, underwent six weeks course in ‘pranayam’ and their ventilator lung functions were studied before and after this practice. They had improved ventilator functions in the form of lowered respiratory rate (RR), and increases in the forced vital capacity (FVC), forced expiratory volume at the end of 1st second (DEV 1%), maximum voluntary ventilation (MVV), peak expiratory flow rate (PEFR-lit/sec), and prolongation of breath holding time.

Makwana, et.al. (1998) selected 25 normal male volunteers undergoing a ten weeks course in the practice of yoga have been studied by some parameters of ventilator functions tests. The observations recorded at the end of ten weeks of the course have shown improved ventilatory functions in the form of lowered respiratory rate, increased forced vital capacity, FEVI,
maximum breathing capacity and breath holding time, while tidal volume and % FEV1, did not reveal any significant change. Thus, a combined practice of yoga seems to be beneficial on respiratory efficiency.

**Manjunath and Shirley Telles (2001)** took twenty girls between 10 and 13 years of age, studying at a residential school they were randomly assigned to 2 groups. One group practiced yoga for one hour fifteen minutes per day, 7 days a week, while the other group was given physical training for the same time. Time for planning and for execution and the number of moves required to complete the Tower of London task were assessed for both groups at the beginning and end of a month. These three assessments were separately tested in increasingly complex tasks requiring 2 moves, 4 moves and 5 moves. The Pre Post data were compared using the Wilcoxon Paired Signed Ranks Test. The yoga group showed a significant reduction in planning time for both 2 moves and 4 moves tasks (53.9 and 59.1 percent respectively) execution time in both 4 moves and 5 moves tasks (63.7 and 60.3 percent respectively) and in the number of moves in the 4 moves tasks (20.9 percent). The physical training group showed no change. Hence yoga training for a month reduced the planning and execution time in simple (2 moves) as well as complex tasks (4, 5 moves) and facilitated reaching the target with a smaller number of moves in complex tasks (4 moves).

**Dhanaraj (1974)** studied the effect of yoga and the 5BX fitness plan as selected physiological parameters. The results indicated increases in flexibility after yoga training. Decreases in heart and respiratory rates in basal state were also covered. When yogic training was discontinued for six weeks following
the six-week treatment, a significant decline in the valve of PWC 130, flexibility and breath holding time was noticed.

Moorthy (1982) compared the influence of yogic exercise and non-yogic exercise to find out the minimum muscular fitness on school children. He concluded that yogic exercises were more beneficial than the non-yogic exercises to improve minimum muscular fitness of the school children.

Kocher (1971) studied the effects of short term courses of yogic training for three weeks duration on the mental health and found the yogic practices bringing favourable results.

Kocher and Vijayendra (1972) obtained encouraging results of yogic training for three weeks duration on the two hand co-ordination.

Giri (1966) using a set of yogic exercise studied the effects of the programme for 6 weeks on the five tests of National Physical Efficiency. He found a significant improvement among the experimental group in all the five sets as a result of yogic training. However when the group discontinued the practice of yogic exercises for the same period of 6 weeks, the effect gained was significantly lost.

Gharote and Ganguly (1976) reported that a yogic training for 3 weeks showed an improvement of 36.8 percent in minimum muscular fitness in comparison to 20 percent improvement in the case of other training.
Posadzki P and Parekh S. (2009) conducted a study on Yoga and physiotherapy: a speculative review and conceptual synthesis. This article presents the potential integration of yoga and physiotherapy when considering the essence of their underlying concepts. Within the scope of this article the existence of several similarities between these two 'concepts' has been suggested. Researchers, physiotherapists and their patients as well as yoga practitioners can obtain valuable and additional arguments through the cross-fertilization of ideas across presented studies united by shared, underlying concepts. The practice of yoga is based on the following assumptions: complexity and multidimensionality, various positive influences on an individual's wholeness through the mind, body, and the relationships between them. These assumptions may have the potential to contribute towards the practice of physiotherapy and its underlying principles. The essence of physiotherapy as a multifaceted process requires teamwork and efforts of various specialists like psychologists, sociologists, occupational therapists and nurses if patients are to benefit. Ideally, the physiotherapist should possess knowledge from these areas of science in order to professionally care about patients. Therefore, it can be suggested that basic similarities exist between yoga and physiotherapy in terms of multidisciplinarity and complexity of holistic care. Such conceptual enrichment may be a useful source of inspiration for physiotherapists concerned about their patients' overall health on a daily basis. The authors emphasize the usefulness of yoga practice in clinical units and explain how the essence of Ayurvedic knowledge might be extrapolated and incorporated into theoretical principles of physiotherapy process. The justification of the studies included is also presented.
Benavides S and Caballero J. (2009) conducted a study on Ashtanga yoga for children and adolescents for weight management and psychological well being: an uncontrolled open pilot study the objective of this pilot study was to determine the effect of yoga on weight in youth at risk for developing type 2 diabetes. Secondarily, the impact of participation in yoga on self-concept and psychiatric symptoms was measured. A 12-week prospective pilot Ashtanga yoga program enrolled twenty children and adolescents. Weight was measured before and after the program. All participants completed self-concept, anxiety, and depression inventories at the initiation and completion of the program. Fourteen predominately Hispanic children, ages 8-15, completed the program. The average weight loss was 2kg. Weight decreased from 61.2+/−20.2kg to 59.2+/−19.2kg (p=0.01). Four of five children with low self-esteem improved, although two had decreases in self-esteem. Anxiety symptoms improved in the study. Ashtanga yoga may be beneficial as a weight loss strategy in a predominately Hispanic population.

Javnbakht M, et.al. (2009) conducted a study on effects of yoga on depression and anxiety of women Yoga has often been perceived as a method of stress management tool that can assist in alleviating depression and anxiety disorders. This study sought to evaluate the influence of yoga in relieving symptoms of depression and anxiety in women who were referred to a yoga clinic. The study involved a convenience sample of women who were referred to a yoga clinic from July 2006 to July 2007. All new cases were evaluated on admission using a personal information questionnaire well as Beck and Spielberger tests. Participants were randomly assigned into an experimental and a control group. The experimental group (n=34) participated in twice weekly yoga classes of 90 min duration for two months. The control group
(n=31) was assigned to a waiting list and did not receive yoga. Both groups were evaluated again after the two-month study period. The average prevalence of depression in the experimental group pre and post Yoga intervention was 12.82+/-7.9 and 10.79+/-6.04 respectively, a statistically insignificant decrease (p=0.13). However, when the experimental group was compared to the control group, women who participated in yoga classes showed a significant decrease in state anxiety (p=0.03) and trait anxiety (p<0.001). Participation in a two-month yoga class can lead to significant reduction in perceived levels of anxiety in women who suffer from anxiety disorders. This study suggests that yoga can be considered as a complementary therapy or an alternative method for medical therapy in the treatment of anxiety disorders.

2.2. STUDIES ON PHYSICAL EXERCISE

Su and Huang et.al. (2009) conducted a study on Optimizing Heart Rate Regulation for Safe Exercise. Safe exercise protocols are critical for effective rehabilitation programs. This paper aims to develop a novel control strategy for an automated treadmill system to reduce the danger of injury during cardiac rehabilitation. We have developed a control-oriented nonparametric Hammerstein model for the control of heart rate during exercises by using support vector regression and correlation analysis. Based on this nonparametric model, a model predictive controller has been built. In order to guarantee the safety of treadmill exercise during rehabilitation, this new automated treadmill system is capable of optimizing system performance over predefined ranges of speed and acceleration. The effectiveness of the proposed
approach was demonstrated with six subjects by having their heart rate track successfully a predetermined heart rate.

**Church et.al. (2009)** Conducted a study on Exercise Without Weight Loss Does Not Reduce C-Reactive Protein Numerous cross-sectional studies have observed an inverse association between CRP and physical activity. Exercise-training trials have produced conflicting results, but none of these studies were specifically designed to examine CRP. The objective of the Inflammation and Exercise study (INFLAME) was to examine whether aerobic exercise training without dietary intervention can reduce CRP in individuals with elevated C-reactive protein (CRP). The study was a randomized, controlled trial of 162 sedentary men and women with elevated CRP (>/>=2.0 mg/L). Participants were randomized into a non-exercise control group or an exercise group that trained for 4 months. The primary outcome was change in CRP. The study participants had a mean (SD) age of 49.7 (10.9) years and a mean body mass index of 31.8 (4.0) kg/m. The median (IQR) and mean baseline CRP levels were 4.1 (2.5, 6.1) and 4.8 (3.4) mg/L, respectively. In the exercise group, median exercise compliance was 99.9%. There were no differences in median (IQR) change in CRP between the control and exercise groups (0.0]-0.5, 0.9] versus 0.0]-0.8, 0.7] mg/L, p=0.4). The mean (95% CI) change in CRP adjusted for gender and baseline weight was similar in the control and exercise groups with no significant difference between groups (0.5]-0.4, 1.3] versus 0.4 [-0.5, 1.2] mg/L, p=0.9). Change in weight was correlated with change in CRP. Exercise training without weight loss is not associated with a reduction in CRP.
Opie and Knuuti (2009) conducted a study on the adrenergic-fatty acid load in heart failure. The hypothesis proposed is that heart failure (HF) is associated with a reactive hyperadrenergic state that increases circulating plasma free fatty acids (FFAs), which leads to impaired glucose metabolism and insulin resistance. We propose that increased FFA-induced mitochondrial uncoupling and substantial oxygen wastage is closely associated with the generation of reactive oxygen species, inflammatory markers, and the development of insulin resistance. The therapeutic aims of metabolic therapy are as follows: 1) to decrease hyperadrenergic drive; 2) to inhibit lipotoxicity and glucotoxicity; and 3) to increase glucose uptake by muscle. These aims are achieved, respectively, by the following: 1) the use of beta-adrenergic blockade and all measures that relieve the mechanical load on the heart; 2) the use of drugs that inhibit fatty acid oxidation (trimetazidine, perhexiline), although without clinical evidence that the heart is their major site of action in HF; and 3) increase of the transport of glucose into the cells by exercise and metformin. Of these measures, only data concerning the reduction of mortality as the result of exercise are available. Of all the other measures, there are substantial positive data on the use of trimetazidine that demonstrate metabolic and clinical benefit with almost no side effects, but data from a large outcome trial are lacking. Our data suggest a major extracardiac site of trimetazidine action. Ranolazine, which inhibits the late sodium inward current, requires testing in human HF. Insulin to reduce hyperglycemia and FFAs is untested in HF, with incretins such as glucagon-like peptide-1 on the horizon. Other future therapies may include malonyl-coenzyme a regulators to inhibit fatty acid oxidation, fish oil omega-3, and activators of protein kinase C-epsilon.
Aberg et.al. (2009) conducted a study on during early adulthood, a phase in which the central nervous system displays considerable plasticity and in which important cognitive traits are shaped, the effects of exercise on cognition remain poorly understood. We performed a cohort study of all Swedish men born in 1950 through 1976 who were enlisted for military service at age 18 (N = 1,221,727). Of these, 268,496 were full-sibling pairs, 3,147 twin pairs, and 1,432 monozygotic twin pairs. Physical fitness and intelligence performance data were collected during conscription examinations and linked with other national databases for information on school achievement, socioeconomic status, and sibship. Relationships between cardiovascular fitness and intelligence at age 18 were evaluated by linear models in the total cohort and in subgroups of full-sibling pairs and twin pairs. Cardiovascular fitness, as measured by ergometer cycling, positively associated with intelligence after adjusting for relevant confounders (regression coefficient b = 0.172; 95% CI, 0.168-0.176). Similar results were obtained within monozygotic twin pairs. In contrast, muscle strength was not associated with cognitive performance. Cross-twin cross-trait analyses showed that the associations were primarily explained by individual specific, non-shared environmental influences (>80%), whereas heritability explained <15% of covariation. Cardiovascular fitness changes between age 15 and 18 y predicted cognitive performance at 18 y. Cox proportional-hazards models showed that cardiovascular fitness at age 18 y predicted educational achievements later in life. These data substantiate that physical exercise could be an important instrument for public health initiatives to optimize educational achievements, cognitive performance, as well as disease prevention at the society level.
Huebschmann et al. (2009) conducted a study on women with type 2 diabetes who perceive harder effort during exercise than nondiabetic women. Regular exercise is a cornerstone of diabetes treatment; however, people with type 2 diabetes (T2D) are commonly sedentary. It is possible that a harder rate of perceived exertion (RPE) during exercise for those with T2D as compared with nondiabetics may be a barrier to physical activity. This study examined RPE (Borg scale, ordinal range 6-20) during submaximal exercise at identical absolute work rates to test the hypothesis that women with T2D demonstrate harder RPE during exercise than nondiabetic controls. In a prespecified analysis of existing data from equivalently sedentary women, RPE during submaximal exercise was compared among women with uncomplicated T2D (n = 13, mean body mass index (BMI) 34.2, mean hemoglobin A1c 9%), overweight controls (OC, n = 13, mean BMI 30.7), and normal-weight controls (NWC, n = 13, mean BMI 23.1). Subjects performed three 7 min, constant-load exercise tests at 20 W and 30 W. Mixed-effects general linear modeling was used to test for differences in mean RPE estimates among groups with and without adjustment for relative work intensity, age, habitual physical activity, or BMI. Subjects with T2D perceived harder effort during bicycling exercise than controls, as measured by RPE at 20 W and 30 W (p < 0.05 for T2D vs. OC and for T2D vs. NWC). Adjusting for relative work intensity eliminated significant group RPE differences at 30 W, but group RPE differences at 20 W remained significant. Harder perceived effort during exercise may be a barrier to physical activity for those with T2D.

Kim and Lee (2009) conducted a study on Physical activity and abdominal obesity in youth. Childhood obesity continues to escalate despite considerable efforts to reverse the current trends. Childhood obesity is a
leading public health concern because overweight-obese youth suffer from comorbidities such as type 2 diabetes mellitus, nonalcoholic fatty liver disease, metabolic syndrome, and cardiovascular disease, conditions once considered limited to adults. This increasing prevalence of chronic health conditions in youth closely parallels the dramatic increase in obesity, in particular abdominal adiposity, in youth. Although mounting evidence in adults demonstrates the benefits of regular physical activity as a treatment strategy for abdominal obesity, the independent role of regular physical activity alone (e.g., without calorie restriction) on abdominal obesity, and in particular visceral fat, is largely unclear in youth. There is some evidence to suggest that, independent of sedentary activity levels (e.g., television watching or playing video games), engaging in higher-intensity physical activity is associated with a lower waist circumference and less visceral fat. Several randomized controlled studies have shown that aerobic types of exercise are protective against age-related increases in visceral adiposity in growing children and adolescents. However, evidence regarding the effect of resistance training alone as a strategy for the treatment of abdominal obesity is lacking and warrants further investigation.

Brutseart and Parra (2006) have found that variation in human athletic performance is determined by a complex interaction of socio cultural, physiological, and proximate physiological factors. Human physiological trait variance has both an environmental and genetic basis, although the classic gene environment dichotomy is clearly too simplistic to understand the full range of variation for most proximate determination of athletic performance. E.g. body composition, in other words, gene and environment interact, not just over the short term, but also over the life time of an individual with performance effects on the adult phenotype. To further complicate matters
gene and environment may also be correlated. That is, genetically gifted individuals may be identified as children and begin training pulmonary, cardiovascular and muscles systems at an early critical age. This review covers evidence in support of a genetic basis to human athletic performance with some emphasis on the recent explosion of candidate gene studies. In addition, the review covers environmental influence on athletic performance with an emphasis on irreversible environmental effects, that may occur during critical periods of development either before conception (epigenetic effects) during foetal life (foetal programming) or during childhood and adolescence. The importance of gene environment interaction (GxE) as a means of understanding variation in human physiological performance is emphasized and studies that integrate genetics with developmental biology have to be promoted.

Shaver (1982) stated that the speed is mainly determined by the characteristics of the muscles fibers, arrangement of the bone and the attachment of bones by ligaments, tenders and adequate muscles strength. It primarily depends on the slow twitch fibers and fast twitch fibers. Fast twitch fibers are generally characterized by high anaerobic capacity, rapid contraction, short fatigue time and ability to generate a relatively large force. Slow twitch fibers have high aerobic capacity, slow contractile rate, long fatigue time and ability to generate low force. Due to training, the involvement of fast twitch fibers, enzymes, co-enzymes, actin, myosin and other myofibril proteins were greatly increased. It helps to increase the reaction time, movement time, stride length and stride frequencies. Hence there was significant improvement in speed.

2.3. STUDIES ON PHYSIOLOGICAL VARIABLES
**Orso et.al. (2009)** conducted a study on heart rate in coronary syndromes and heart failure. In the past 2 decades, there have been growing evidences that resting heart rate might be a marker of risk or even a risk factor for cardiovascular morbidity and mortality. This article reviews current evidences concerning the relation between heart rate and patients' outcome in different clinical settings such as acute coronary syndromes, left ventricular systolic dysfunction, and heart failure. The relationship between resting heart rate and the development of coronary artery disease, as well as all-cause and cardiovascular mortality has been found to be strong, graded, and independent from other risk factors. Several lines of research indicate that heart rate plays an important role in the pathophysiology of atherosclerosis and in the clinical manifestations of coronary artery disease and that it is an independent prognostic factor in all coronary syndromes. The prognostic value of elevated heart rate in patients with heart failure has been tested in several clinical trials evaluating pharmacologic heart rate-lowering agents (e.g. beta-blockers). It is difficult to determine which percentage of the clinical benefit obtained with beta-blockers is related to induced bradycardia because cardiac slowing is only one of the effects of these drugs. In the beautiful trial, a subgroup analysis conducted in patients with resting HR more than 70 beats per minute showed that treatment with ivabradine was able to improve outcome. According to the results presented in this review, we can conclude that heart rate is a predictor of death in both stable coronary artery disease and acute coronary syndromes. Elevated heart rate is also able to negatively predict clinical outcomes in patients with heart failure. However, it is still unclear if heart rate reduction per se can improve prognosis.
Thorin and Thorin-Trescases (2009) conducted study on Vascular endothelial ageing, heartbeat after heartbeat. The vascular endothelium starts to age at the first heartbeat. There is no longer a need to demonstrate that an increased resting heart rate--above 70 b.p.m.--is associated with the onset of cardiovascular events and reduces lifespan in humans. Each cardiac cycle imposes a mechanical constraint on the arteries, and we would like to propose that this mechanical stress damages the vascular endothelium, its dysfunction being the prerequisite for atherogenesis. Consequently, reducing heart rate could protect the endothelium and slow the onset of atherosclerosis. The potential mechanisms by which reducing heart rate could be beneficial to the endothelium are likely a combination of a reduction in mechanical stress and tissue fatigue and a prolongation of the period of steady laminar flow, and thus sustained shear stress, between each systole. With age, irreparable damage accumulates in endothelial cells and leads to senescence, which is characterized by a pro-atherogenic phenotype. In the body, the highest mechanical stress occurs in the coronary vessels, where blood only flows during diastole and even reverses during systole; thus, coronary arteries are the prime site of atherosclerosis. All classical risk factors for cardiovascular diseases add up, to accelerate atherogenesis, but hypertension, which further raises mechanical stress, is likely the most damaging. By inducing flow through the arteries, the heart rate determines shear stress and its stability: mechanical stress and the associated damage induced by each systole are efficiently counteracted by the repair capacities of a healthy endothelium. The maintenance of a physiological, low heart rate may be key to prolonging the endothelial healthy lifespan and thus, vascular health.
Baker et al. (2009) conducted study on Resting heart rate and the development of antisocial behavior from age 9 to 14: genetic and environmental influences. The genetic and environmental basis of a well-replicated association between antisocial behavior (ASB) and resting heart rate was investigated in a longitudinal twin study, based on two measurements between the ages of 9 and 14 years. ASB was defined as a broad continuum of externalizing behavior problems, assessed at each occasion through a composite measure based on parent ratings of trait aggression, delinquent behaviors, and psychopathic traits in their children. Parent ratings of ASB significantly decreased across age from childhood to early adolescence, although latent growth models indicated significant variation and twin similarity in the growth patterns, which were explained almost entirely by genetic influences. Resting heart rate at age 9-10 years old was inversely related to levels of ASB but not change patterns of ASB across age or occasions. Biometrical analyses indicated significant genetic influences on heart rate during childhood, as well as ASB throughout development from age 9 to 14. Both level and slope variation were significantly influenced by genetic factors. Of importance, the low resting heart rate and ASB association was significantly and entirely explained by their genetic covariation, although the heritable component of heart rate explained only a small portion (1-4%) of the substantial genetic variance in ASB. Although the effect size is small, children with low resting heart rate appear to be genetically predisposed toward externalizing behavior problems as early as age 9 years old.

Palatini (2009) conducted study on Elevated heart rate: a "new" cardiovascular risk factor. A number of epidemiologic studies and several experimental lines of research point to high heart rate as a main risk factor for
cardiovascular disease. However, translating research into clinical practice has been a challenge throughout medical history. From the present symposium, it appears clear that this is particularly the case for heart rate. The complex nature of atherogenesis makes it difficult to establish the role of a putative risk factor because of the correlations and complex interactions among factors. The pathogenetic mechanisms for the connection of resting heart rate with atherosclerosis and cardiovascular morbidity have been elaborated extensively in the chapter papers of this symposium, suggesting that there is a causal relationship between heart rate and cardiovascular mortality. The benefit of heart rate reduction has been proved in patients with coronary artery disease or congestive heart failure. Until now it has been difficult to determine whether modulation of heart rate is beneficial also in patients free of cardiac diseases. This concern, however, does not in any fashion suggest that health care professionals should pay less attention to this clinical variable. The impressive amount of available epidemiologic data show support for the continued effort to raise awareness of the clinical importance of resting heart rate among health care professionals.

Nummila Amero and Rusko (1992) had supported the study to investigate whether the sprint training, induced changes in the different components of aerobic performance capacity can be determined by the maximal anaerobic running power test. During the training period, VO2 max increased, the correlation analysis revealed that the high volume of speed endurance training influenced negatively VO2 max and blood lactate concentration. The volume of the interval training at low intensity correlated positively with the change of VO2 max, the volume of speed training was
found to be advantages for the changes in VO2 max. It was concluded that the results of the test reflect the sprint training, induced changes in the anaerobic performance capacity.

Shaver (1982) stated that anaerobic power is required to a high intensity exercise of short duration. That does not depend upon the body’s ability to supply oxygen. Anaerobic power is generally characterized by strong contraction from activities that requires energy at such rates from the breakdown at ATP, CP and Glycolysis systems that aerobic metabolism cannot provide. The varied intensities and frequencies of circuit training would have increased the breakdown of the ATP, CP and Glycolysis systems. The increased capacity of the ATP and CP is due to the increased storage of both ATP and CP that is found in the muscles following the different intensities and frequencies of circuit training. Also there was increase in the level of enzyme activity in the ATP and CP systems. This enzyme is called as creatine kinese and it is responsible for the oxidation of CP. Which, when it is broken down, release energy for resynthesis of ATP. The maximal intensities of strength will increase activity in Aerobic enzymes such as PKF and LDH. It is assumed that PKF participates in the regulation of blood flow of substance through the glycoltic pathways. The athlete with the great, demand of an aerobic power had a significantly higher buffer in the skeletal muscles than the sedentary people. It may be due to sufficient intensities to increase the above physiological process. Hence there is significant improvement in aerobic power.

Gentry and Roy (1973) studied the effect of nine weeks aerobic jogging programmed on selected cardiovascular functions of the 15 college male
students ranging from 18-22 years; the training program consisted of jogging or walking for a specified distance, five times per week. The result indicated significant decreases in resting diastolic blood pressure and steady state heart rates with no change occurred in exercise cardiac output, resting and exercise cardiac index and resting heart rate.

**Rowlands et.al. (1999)** found “the relationship between activity levels, aerobic fitness, and body fat in 8- to 10-yr-old children”. The relationships between children's activity, aerobic fitness, and fatness are unclear. Indirect estimates of activity, e.g., heart rate (HR) and recall may mask any associations. The purpose of this study was to assess these relationships by using the Tritrac-R3D, a pedometer, and heart rate. Thirty-four children, ages 8-10 yr, participated in the study. The Tritrac and pedometer were worn for up to 6 days. HR was measured for 1 day. The activity measured by Tritrac or pedometer correlated positively to fitness in the whole group (Tritrac, r = 0.66; pedometer, r = 0.59; P < 0.01) and in boys and girls separately (P < 0.05) and correlated negatively to fatness in the whole group (r = 0.42, P < 0.05). In contrast, HR did not correlate significantly to fitness, and HR of >139 beats/min correlated positively to fatness in girls (r = 0.64, P < 0.05). This suggests that HR is misleading as a measure of activity. This study supports a positive relationship between activity and fitness and suggests a negative relationship between fatness and activity.

**Schultz et.al. (1994)** stated that iron is the important for the normal function of red blood cells, myoglobin and the cytochrome system. Iron deficiency may compromise adaptation to altitude. We hypothesized that intensive oral iron therapy would maintain iron stores during altitude training.
Twenty five runners with normal initial iron stores participated in a four to eight week training programme. Ten runners lived at 150 m and ten lived 2500 m where they are consumed 20 mg of dietary iron daily. Five of the runners lived for a four weeks at 150 m and then four weeks at 2500m. While at 150m they were supplemented to 80mg/day and while at 2500m to > 20 mg/day. Dietary intake was measured by 3- day logs (competition) and venous blood was drawn for hematocrit (spun) and serum ferrite (RIA) before and after each four week exposure. ANOVA interaction P< 0.01 mean SD we conclude that an iron intake of > 200 mg/ day of elemental iron required to maintain ferrite levels during altitude exposure in training athletes.

**Bolton and Renfrow (1979)** conducted research study on Personality Characteristics Associated with Aerobic Exercise in Adult Females. Using an index of aerobic conditioning. Twenty seven adult female joggers and Twenty five non exercisers were identified. During individual interviews with each subject, basic demographic data were obtained and blood pressure, vital capacity, resting pulse rate, and body fat were measured. All subjects completed Form A of the Sixteen Personality Factor Questionnaire (16PF). Statistically significant differences occurred on two primary factors, and one secondary dimension of the 16PF. The probability of three marginally significant differences out of 24 comparisons is well within the range of expected chance fluctuation. Thus, the study provided no evidence that personality characteristics are predisposing factors in the adoption of an aerobic jogging program by young adult females. The only statistically significant training effect was lower pulse rate; blood pressure, vital capacity, and body fat were similar for the two groups. Finally, the results of this study of females were compared to those of a previous investigation of male joggers.
Selvam and Sudha (2008) conducted a study on the effect of aerobic exercise on selected physiological variables among college girls. For this study aerobic exercise uses large muscle group’s rhythmically and continuously and elevates the heart rate and breathing period for a sustained period. Common examples include walking, jogging/running, swimming, rowing, stair climbing, bicycling, cross country, step and dance exercise and squash. The experimental group underwent training for five days/week. To achieve these purpose 60 girls were selected between 18 to 20 years. The researcher used analysis of covariance for interpreting the results. The results for the study reveal that aerobic exercise has a significant effect in the improvement of the physiological variables resting pulse rate, breath holding time, vital capacity and respiratory rate.

Selvalakshmi (2007) conducted a study on the effect of varied aerobic training programme on obese women working in the companies. For the purpose of the study aerobic refers to a variety of exercise that stimulates heart and lung activity for a time period, sufficiently long to produce beneficial changes in the body (Cooper, 1970). The collected data on the cardio respiratory parameter prior to and after 12 weeks of varied aerobics training were statistically analyzed using analysis of covariance. The result on vital capacity showed significant improvement due to varied exercises, whereas no significant improvement in resting pulse rate.

Fox (1993) stated that power is a function of force and time. Leg power depends upon body power and muscular strength. The ability to develop considerable power is a prime factor in athletic success. Power is the
performance of work expressed per unit of time. The ability to jump, sprint, put the shot, or perform fast starts are few examples of athletes converting energy to power. The term explosive has been associated with this anaerobic metabolism.

Renstrom (1993) stated that muscle strength is the static or dynamic torque which a muscle can produce at a specific limb position and velocity, and is a function of the muscles cross sectional area, number of activated muscle fibers, angle of insertion into the bone and rate of motor unit recruitment. Muscle length is related to muscle strength and an over stretched muscle may not have adequate torque at the point in the range of motion where it is needed.

Hazeldine (1987) stated that the optimum speed of a repetition will vary depending on the muscle group being used and the specific requirements of the sport or activity. If the movement is speeded up, this will make the exercise shorter and less effective as a strength builder. Doing faster repetitions is likely to produce a more dynamic kind of strength, mainly through adaptation by the nervous system and the neurogenic effects. It will be slower movements which will tend to strengthen the muscles more effectively.

Kakkinen (1993) supported that the exercise changes in a physical fitness profile during a 22 week official competition season. Specific explosive type strength training (1-2 sessions per week) was utilized throughout the season. The study showed significant (P -0.05) increase in the leg explosive power.
Craig (1990) supported that the circuit training weight training programme improved the upper body and leg strength. The subjects were performed circuit weight training programme 3 times per week and consisted of 2 sets 12 stations. There was significant improvement in upper body strength and leg strength.

Helfand M, et.al (2009) Conducted a study on emerging risk factors for coronary heart disease: a summary of systematic reviews conducted for the U.S. Preventive Services Task Force. Traditional risk factors do not explain all of the risk for incident coronary heart disease (CHD) events. Various new or emerging risk factors have the potential to improve global risk assessment for CHD. To summarize the results of 9 systematic reviews of novel risk factors to help the U.S. Preventive Services Task Force (USPSTF) evaluate the factors' clinical usefulness. Results from a MEDLINE search for English-language articles published from 1966 to September 2008, using the Medical Subject Heading terms cohort studies and cardiovascular diseases in combination with terms for each risk factor. Studies were included if the participants had no baseline cardiovascular disease and the investigators adjusted for at least 6 Framingham risk factors. Study quality was evaluated by using USPSTF criteria and overall quality of evidence for each risk factor by using a modified version of the Grading of Recommendations, Assessment, Development, and Evaluation framework. Each factor's potential clinical value was evaluated by using a set of criteria that emphasized the importance of the effect of that factor on the reclassification of intermediate-risk persons. 9 systematic reviews were conducted. C-reactive protein (CRP) was the best candidate for use in screening and the most rigorously studied, but evidence that changes in CRP level lead to primary prevention of CHD events is inconclusive. The other
evaluated risk factors were coronary artery calcium score as measured by electron-beam computed tomography, lipoprotein (a) level, homocysteine level, leukocyte count, fasting blood glucose, periodontal disease, ankle-brachial index, and carotid intima-media thickness. The availability and validity of the evidence varied considerably across the risk factors in terms of aggregate quality, consistency of findings, and applicability to intermediate-risk persons in the general population. For most risk factors, no studies assessed their usefulness for reclassifying intermediate-risk persons. Because of lack of access to original data, no firm conclusions could be drawn about differences in risk prediction among racial and ethnic groups. The review did not emphasize within-cohort comparisons of multiple risk factors. The current evidence does not support the routine use of any of the 9 risk factors for further risk stratification of intermediate-risk persons.

Kamath SS, et.al. (2009) conducted a study on effects of airway pressure release ventilation on blood pressure and urine output in children. Increased intrathoracic pressures during airway pressure release ventilation (APRV) may compromise systemic venous return resulting in decreased cardiac output and renal perfusion. We sought to study the short-term effect of APRV on blood pressure (BP) and urine output (UO) in children with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS). Retrospective cohort study. All patients with ALI/ARDS who were admitted to our Pediatric Intensive Care Unit (PICU) between 1/00 and 06/04, and who were ventilated with APRV (for at least 12 hr) for worsening oxygenation while on conventional ventilation (CV). Medical records were reviewed for patients' demographics, Pediatric Risk of Mortality (PRISM III) score, admitting diagnosis, ventilator settings, gas exchange data, heart rate (HR),
central venous pressure (CVP), blood pressure (BP), UO, and use of other therapies [sedatives, pressors, inotropes, and intravenous fluid (IVF)]. Eleven patients met our inclusion and exclusion criteria with a mean age of 6.2 +/- 4.8 years (range: 1-15 years), a weight of 35.5 +/- 29.5 kg (range: 12-90 kg), and a PRISM score of 18.4 +/- 9.6 (range: 2-36). Within 10 hrs of APRV, patients' mean airway pressure (Paw) increased from 16.1 +/- 6.6 to 21.1 +/- 5.5 cm of H(2)O (P = 0.04). Despite a higher Paw there were no differences in HR, CVP, BP, UO, IVF and use of other therapies while on CV or APRV (P > 0.10). In children with ALI/ARDS, despite a higher Paw, APRV does not affect BP or UO. Pediatr Pulmonol. (c) 2009 Wiley-Liss, Inc.

2.4. STUDIES ON ANTHROPOMETRIC VARIABLES

Innes (2005) conducted a study on Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: a systematic review of published literature regarding the effects of yoga, a promising mind-body therapy, on specific anthropometric and physiologic indices of cardiovascular disease (CVD) risk and on related clinical endpoints. We performed a literature search using 4 computerized English and Indian scientific databases. The search was restricted to original studies (1970 to 2004) evaluating the effects of yoga on CVD or indices of CVD risk associated with the insulin resistance syndrome (IRS). Randomized controlled trials (RCTs), nonrandomized controlled trials, uncontrolled (pre and post) clinical trials, and cross-sectional (observational) studies were included if they met specific criteria. Data were extracted regarding study design, setting, population size and characteristics, intervention type and duration, comparison group or condition, outcome assessment, data analysis
and presentation, follow-up, and key results, and the quality of each study was evaluated according to specific predetermined criteria. We identified 70 eligible studies, including 1 observational study, 26 uncontrolled clinical trials, 21 nonrandomized controlled clinical trials, and 22 RCTs. Together, the reported results of these studies indicate beneficial changes overall in several IRS-related indices of CVD risk, including glucose tolerance and insulin sensitivity, lipid profiles, anthropometric characteristics, blood pressure, oxidative stress, coagulation profiles, sympathetic activation, and cardiovagal function, as well as improvement in several clinical endpoints. Collectively, these studies suggest that yoga may reduce many IRS-related risk factors for CVD, may improve clinical outcomes, and may aid in the management of CVD and other IRS-related conditions. However, the methodological and other limitations characterizing most of these studies preclude drawing firm conclusions. Additional high quality RCTs are needed to confirm and further elucidate the effects of standardized yoga programs on specific indices of CVD risk and related clinical endpoints.

Stuempfle (2009) conducted a study on Ponderal somatogram analysis of girth measurements by position in division III college football players. Somatograms assessed body composition in four groups of Division III collegiate football players: offensive line (OL), defensive line (DL), offensive backs (OB), and defensive backs (DB). Ponderal somatograms evaluate body size and shape by converting muscular (shoulders, chest, biceps, forearm, thigh, and calf) and nonmuscular (abdomen, hips, knee, ankle, and wrist) girths into ponderalequivalent (PE) values. Anthropometric measurements, including stature, body mass, girths, and percent body fat by densitometry were collected in 82 players (22 OL, 12 DL, 20 OB, and 28 DB) during preseason camp. PE
values were calculated for each girth as PE, kilograms = (girth, cm / k) x stature, decimeters, where k = k constant from Behnke's reference man. PE values were compared to body mass to indicate overdevelopment (PE > body mass) and underdevelopment (PE < body mass). OL was significantly heavier than DL (+15.6 kg), OB (+25.2 kg), and DB (+22.4 kg). OL percent fat was significantly greater than DL (+5.9%), OB (+9.0%), and DB (+9.3%). Similar differences occurred in girths and PE values by position. Muscular components were generally overdeveloped, with the greatest overdevelopment in the biceps (OL + 16.0 kg, DL + 19 kg, OB + 14.2 kg, and DB + 16.2 kg). Nonmuscular abdomen, hips, and knee were generally overdeveloped, with the greatest overdevelopment in the OL abdomen (+19.3 kg). Nonmuscular ankle and wrist were underdeveloped. Ponderal somatograms provide a relatively quick and simple method to translate girth measurements into ponderal equivalent values that seem to be position-specific among offensive and defensive linemen and backs. Somatograms provide an appraisal of body composition that helps coaches and athletes monitor the effectiveness of strength and conditioning programs.

Gabbett (2009) conducted a study on Physiological and anthropometric correlates of tackling ability in rugby league. This study investigated the relationship between physiological and anthropometric qualities and tackling ability in rugby league players. Twelve rugby league players (mean +/- SD age, 24.4 +/- 3.5 years) underwent a standardized 1-on-1 tackling drill in a 10-m grid. Video footage was taken from the rear, side, and front of the defending player. Tackling proficiency was assessed using standardized technical criteria. In addition, all players underwent measurements of anthropometry (stature, body mass, sum of 7 skinfolds, arm, chest, waist, gluteal, thigh, and calf girths,
and biepicondylar humerus and femur breadths), somatotype (endomorphy, mesomorphy, and ectomorphy), acceleration (5- and 10-m sprint), change-of-direction speed (modified 505 test), lower-body muscular power (vertical jump), and upper-body muscular power (overhead medicine ball throw). Differences in tackling ability and physiological and anthropometric qualities between the best (N = 6) and worst (N = 6) tacklers were compared using the Cohen effect size (ES) statistic. Eta coefficients (eta) were used to determine the relationships among physiological and anthropometric qualities and tackling proficiency. Better tacklers were older (ES = 1.9), more experienced (ES = 1.0), shorter (ES = 1.2), lighter (ES = 2.3), and leaner (ES = 1.3) than players with poor tackling proficiency. Better tacklers also had greater levels of mesomorphy (ES = 0.3), acceleration (ES = 2.3), and change-of-direction speed (ES = 0.5) than poor tacklers. The strongest correlates of tackling ability were age (eta = 0.70), skinfold thickness (eta = -0.68), body mass (eta = -0.72), waist girth (eta = -0.79), gluteal girth (eta = -0.74), and level of endomorphy (eta = -0.65). These findings demonstrate that well-developed physiological and anthropometric qualities contribute to effective tackling ability in rugby league players.

**Weiss, et. al. (2000)** compared several indices that might be used to depict muscle size. Four groups of men were exposed in heavy resistance training designed to elicit differential hypertrophic adaptations following 21 sessions of squat training. Tests used to represent muscle size included body weight, thigh girth, net thigh girth, and quadriceps femoris and hamstring thicknesses via B-mode ultrasound. It was observed that muscle mass change following heavy-resistance training is dependent upon both the training intervention and tool used for measurement.
Arrese AL and Ostáriz ES (2006) determined whether the sum of skinfold thicknesses and specific single skinfold sites were related to competitive running performance in homogeneous groups of male and female elite athletes. In total, 184 top-class runners (130 males and 54 females) volunteered to participate in the study. Skinfolds were measured at the following sites: biceps, triceps, subscapular, pectoral, iliac crest, abdominal, front thigh and medial calf. Runners were classified into groups in accordance with their best performance times. Correlation analysis and partial correlation coefficients that controlled for age and weight were applied to each single skinfold, the sum of six skinfolds (excluding biceps) and the extremity (sum of triceps, front thigh, medial calf) to trunk (sum of subscapular, iliac crest, abdominal) ratio and performance. Performance was rated by the scoring procedures of the International Amateur Athletics Federation. In male runners, the pectoral, iliac crest, abdominal, biceps, triceps, subscapular skinfolds and the sum of six skinfolds were not associated with performance score for any of the distances. High correlations were found between the front thigh ($r = 0.78$, $P = 0.000$) and medial calf ($r = 0.55$, $P = 0.018$) skinfolds and 1500 m run time, and between the front thigh ($r = 0.59$, $P = 0.014$) and medial calf ($r = 0.57$, $P = 0.017$) skinfolds and 10,000 m run time. In female runners, the front thigh and medial calf skinfolds were highly correlated with 400 m run time ($r = 0.71$, $P = 0.022$ and $r = 0.81$, $P = 0.005$, respectively). The results of this study indicate that skinfold thicknesses in the lower limb are positively associated with running time over several distances, and may be a useful predictor of athletic performance.

Knechtle B, et.al. (2008) investigated the association of anthropometric parameters to race performance in ultra-endurance runners in a multistage
ultra-endurance run. In total, there were 19 male Caucasian ultra-endurance runners (mean (SD) 46.2 (9.6) years, 71.8 (5.2) kg, 179 (6) cm, BMI 22.5 (1.9) kg/m(2)). Determination of body mass, body height, length of lower limbs, skin-fold thicknesses, circumference of limbs, body mass index (BMI), percentage skeletal muscle mass (%SM), and percentage body fat (%BF) in 19 successful finishers in order to correlate anthropometric parameters with running performance. A significant association of upper arm circumference with the total running time was found (p<0.05, r² = 0.26). No significant association was found with the directly measured anthropometric properties body height, body mass, average skin-fold thickness and the circumference of thigh and calf (p>0.05). Furthermore, no significant association was observed between the running time and the calculated parameters BMI, %BF, and %SM (p>0.05). In an ultra-endurance run over 1200 km within 17 consecutive days, circumference of the upper arm was the only factor associated with performance in well-experienced ultra-endurance runners. Body mass, BMI, body height, length of limbs, skin-fold thicknesses, circumference of limbs and the calculated percentage body composition of skeletal muscle mass and body fat showed no association with running performance.

Legaz Arrese A, et.al. (2005) determined skinfolds values in male and female top-class runners who competed in different distances in order to identify the association of sex and event with fatness and distribution of subcutaneous fat. Eight skinfolds were measured on male (n=130) and female (n=56) top-class runners. Sum of 6 skinfolds and extremity/trunk fat ratio was calculated. Runners were distributed into groups according to the event in which they obtained their best performance. The skinfolds values found in our athletes were very low. Female runners obtained higher values in extremity
skinfolds than male runners; the differences in chest, biceps and abdominal skinfolds are only significant in short duration events; no differences were found in suprailiac and subscapular skinfolds. In both sexes, all skinfolds showed significantly lower values among marathon runners; no differences were found in skinfolds values among runners competing in distances ranging from 100 m to 10,000 m. Extremity/trunk fat ratio was not related to event. The lower skinfold values found in all groups of runners may be due to a high performance; this analysis shows that a slight excess of fat is not beneficial in order to obtain a high performance in any distance. Fatness is only associated to marathon events, probably due to the fact that these runners are engaged in higher training volume and that only in this event fat metabolism prevails in training and competition. Distribution of subcutaneous fat may be more dependent on biological or environmental factors unrelated to type of training.

Keogh JW, et.al. (2007) examined the anthropometric dimensions of power lifters across various body mass (competitive bodyweight) categories. Fifty-four male Oceania competitive power lifters (9 lightweight, 30 middleweight, and 15 heavyweight) were recruited from one international and two national power lifting competitions held in New Zealand. Power lifters were assessed for 37 anthropometric dimensions by ISAK (International Society for the Advancement of Kinanthropometry) level II and III accredited anthropometrists. The power lifters were highly mesomorphic and had large girths and bony breadths, both in absolute units and when expressed as Z(p)-scores compared through the Phantom (Ross & Wilson, 1974). These anthropometric characteristics were more pronounced in heavyweights, who were significantly heavier, had greater muscle and fat mass, were more endo-mesomorphic, and had larger girths and bony breadths than the lighter lifters.
Although middleweight and heavyweight lifters typically had longer segment lengths than the lightweights, all three groups had similar Zp-scores for the segment lengths, indicating similar segment length proportions. While population comparisons would be required to identify any connection between specific anthropometric dimensions that confer a competitive advantage to the expression of maximal strength, anthropometric profiling may prove useful for talent identification and for the assessment of training progression in power lifting.

Giampietro M, Pujia A, and Bertini I., (2003) examined the anthropometric features and body composition of athletes practising karate at a high and medium competitive level. Our study was carried out on a sample of 35 subjects practising karate and aged from 16.0 to 32.5 years. This sample was divided into two groups: group 1 ( n=14 elite athletes) and group 2 ( n=21 amateur athletes). Various anthropometric measurements were taken (weight, height both standing and sitting, diameters, circumferences and skinfold thickness) from which different anthropometric indices were calculated (body mass index, Scelic and Grant indices, arm muscle circumference and area), and the somatotype was then determined. The body composition of each subject was assessed using the skinfold technique and the Jackson-Pollock (J-P) and Sloan-Weir (S-W) equations. The two groups of athletes showed very similar measurements regarding anthropometric characteristics. Only the Scelix index presented a significantly different value in the two groups (49.6+/−1.3 for group 1 vs. 51.1+/−1.3 for group 2; p<0.01). Group 1 showed a mesomorphic-ectomorphic somatotype, while the amateur athletes presented a balanced mesomorphic type. Moreover, a lower percentage of fat mass was more frequent in the first group (J-P=8.1+/−2.4%; S-W=8.9+/−3.3%) than in the
second one (J-P=9.8+/−1.6%; S-W=11.2+/−3.7%), although the differences between the two groups were not significant. We conclude that group 1 is characterized by a slightly prominent vertical development of the skeletal frame. This could be an anthropometric characteristic that is best suited to meet the specific functional requirements of this sport. Moreover, both groups of athletes are characterized by a low percentage of fat mass, particularly the elite group.

Leone M, Lariviere G, and Comtois AS., (2002) identified anthropometric and biomotor variables that discriminated among groups of elite adolescent female athletes aged 14.3 +/- 1.3 years (mean +/- s) from four different sports (tennis, n = 15; swimming, n = 23; figure skating, n = 46; volleyball, n = 16). The anthropometric variables included body mass, height, bi-epicondylar breadth of the distal extremity of the humerus and femur, maximal girth of the calf and biceps and the sum of five adipose skinfolds. The biomotor variables were maximal aerobic power, muscular endurance and flexibility of the trunk. Discriminant analysis revealed three significant functions (P < 0.05). The first discriminant function primarily represented differences between figure skaters and all other groups of athletes. The other two underlined anthropometric and biomotor differences between swimmers and volleyball players and between tennis players and swimmers, respectively. After validation, the analysis showed that 88% of the athletes were correctly classified in their respective sports. Our model confirms that elite adolescent female athletes show physical and biomotor differences that clearly distinguish them according to their particular sport.
Knechtle B, et.al. (2007) investigated the influence of anthropometric variables on race performance in ultra-endurance triathletes in an ultratriathlon. The "World Challenge Deca Iron Triathlon 2006" in Monterrey, Mexico, in which everyday for 10 consecutive days athletes had to perform the distance of one Ironman triathlon of 3.8 km swimming, 180 km cycling and 42.195 km running. Eight male ultra-endurance athletes (mean (SD) age 40.6 (10.7) years, weight 76.4 (8.4) kg, height 175 (4) cm and body mass index (BMI) 24.7 (2.2) kg/m2). Direct measurement of body mass, height, leg length, skinfold thicknesses, limb circumference and calculation of BMI, skeletal muscle mass (SM), percentage SM (%SM) and percentage body fat (%BF) in order to correlate measured and calculated anthropometric variables with race performance. Race time was not significantly (p>0.05) influenced by the directly measured variables, height, leg length, body mass, average skin fold thicknesses, or circumference of thigh, calf or upper arm. Furthermore, no significant (p>0.05) correlation was observed between race time and the calculated variables, BMI, %SM and %BF. In a multistage ultra-triathlon over 10 Ironman triathlon distances in 10 consecutive days, there was no effect of body mass, height, leg length, skinfold thicknesses, limb circumference, BMI, %SM or %BF on race performance in the only eight finishers.

2.5. SUMMARY OF THE LITERATURES

The investigator, in his attempt to review related literature, has made extensive coverage of selected variables on yoga and physical exercises in relation to physical fitness, physiological and anthropometric variables. The reviews have been listed variable-wise and attempts have been made to review latest studies conducted on the subject.