Chapter – 2

REVIEW OF LITERATURE
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A. Views regarding impact of sports activities and training on Physical and Physiological Parameters

The idea that exercise is good for the body is an ancient one. Physical activity has been advocated since before the time of Hippocrates. Exercise has a powerful role in maintaining optimum physical health. In fact, the American Heart Association recently recognized that continuing a sedentary lifestyle with a lack of exercise, or physical activity, is just as responsible as smoking, high blood pressure or high cholesterol in contributing to heart disease (Fletcher et al., 1992). Exercise contributes to positive health in two ways. First, long-term participation in physical activity contributes to the prevention of many modern chronic diseases; second, exercise aids in the rehabilitation from modern chronic diseases (Kamen, 2001).

Coronary artery disease presents a significant risk to human health, but the risk can be minimized by the inclusion of a regular exercise program into a person's lifestyle. Factors such as dietary salt, a sedentary life-style, obesity and genetics may produce high blood pressure. However, the tendency toward hypertension can often be minimized by regular exercise. Exercise offers numerous specific solutions to obesity and changing body composition. Exercise scientists are still examining the possible benefits that physical activity may have in minimizing the risk of cancer. These benefits may include possible modifications of the immune system with regular exercise (Kamen, 2001). Exercise is frequently prescribed for diabetics who can help minimize their insulin intake by incorporating a regular physical activity program. In training studies, exercise has been shown to decrease depression (Morgan, 1994) and anxiety (Landers and Petruzzello, 1994).

In a study Blair et al. (2001) concluded that there was an indication of greater longevity and reduced risk of coronary heart disease (CHD), cardiovascular disease (CVD), stroke and colon cancer in more active individuals.
Banerjee *et al.* (1970) examined vital capacity (VC), maximum breathing capacity (MBC), Harvard Step Test score (HST score) and pre-exercise pulse rate of twelve male track athletes and compared with 10 male college students. No significant differences were observed in these two groups in VC, MBC. Athletes showed significantly lower pre-exercise pulse rate and higher HST score than non-athletes.

Serresse *et al.* (1989) compared the anaerobic performance of sedentary individuals, physical education students and athletes of various disciplines and their results indicated that there are differences for the power and capacity measured in predominantly anaerobic test between athletes from different disciplines and sedentary individuals.

Das and Bhattacharya (1995) applied cooper’s 12 min run-walk test and queen’s college test (measurement of VO\textsubscript{2max}) to determine both physical and physiological endurance on distance runners and non-athletes college men aged 18-22 years and reported that the degree of activity plays the major role in determining VO\textsubscript{2max} in all population. Significantly higher values of VO\textsubscript{2max} and endurance in trained group in comparison to untrained group depict the effects of physical training.

Ara *et al.* (2004) studied the effect of physical activity on whole body fat and its regional deposition and the influence of body fat on physical performance in prepubertal children. 63 physically active and 51 non-physically active prepubertal children were examined. Physically active children obtained better results in maximal oxygen uptake, isometric leg extension force, vertical jump and 300 m (anaerobic capacity) and 30 m running test (speed) than those who were non-physically active. A lower percentage of body fat (% BF), whole body fat and regional fat mass were observed in the physically active than non-physically active group. Their results suggested that regular participation in at least 3 hour per week of sports activities and competitions on top of the compulsory physical education program is associated with increased physical fitness, lower body mass and trunkal fat mass in prepubertal boys.

Angyan *et al.* (2005) assessed anthropometric, somatomotor and cardiorespiratory characteristics of athletes and non-athletes. No statistically significant differences were obtained from the comparisons of the body measures of athletes and non-athletes, except
the body height. In contrast, significant differences were found both in the motor performances and cardiorespiratory functions between athletes and non-athletes groups. The body mass index (BMI) and the body fat (%) correlated negatively with static hanging, vertical jumping and balance capability. On the contrary BMI and body fat correlated positively with systolic blood pressure and vital capacity. Their result showed that the effects of regular physical exercise on motor performances and cardiorespiratory functions differentiate better between the athletes and non-athlete subjects than the changes in body measures.

Predel and Tokarski (2005) reported regular, continuous, lifelong physical activities are particularly effective and regular physical activities has an enormous potential with regard to the physical and psychological health maintenance in all life phases.

Pakkala et al. (2005) determined during exercise the maximum related oxygen transport viz, maximum heart rate (max HR), dyspnoic index (DI), oxygen pulse (O2 pulse), recovery heart rate in an athletic and non-athletic group. Significantly higher values in athletes were observed as compared to non athletes regarding the following parameters: \( \text{VO}_2\text{max} \), minute ventilation at \( \text{VO}_2\text{max} \) (\( V_{E\text{ max}} \)), delta heart rate and max O2 pulse where as resting heart rate, DI at \( \text{VO}_2\text{max} \) and recovery heart rate were lower in athletes. Their observations suggested an overall higher cardiopulmonary efficiency in athletes with higher adaptability of cardiovascular system. The better \( \text{VO}_2\text{max} \) observed in athletes very well brings out the roles of exercise in maintaining physical fitness. A faster recovery of the exercise heart rate in athletes also conveys better cardiac performance in athletes and their results also suggested a lesser risk for cardiovascular mortality in the athletic group.

Pongprapai et al. (1994) assessed physical fitness parameters of 259 primary children (average age 9.2 years). They were selected randomly from three groups of children whose weights-for-height were 90-110% (normal 111), >110-120% (overweight 25) and >120% (obesity 123) of reference values for Bangkok children. This study suggested that the promotion of exercise in obese children should be stimulated to better physical fitness and weight reduction.
Destefano et al. (2000) investigated the effect of aerobic and resistance training program (12 week, 2 days/week for 30 min/session), on weight and body composition of fifteen obese boys of age group 9-12 year and concluded that vigorous supervised aerobic training in obese boys had beneficial effects on body composition, fitness and leisure time activities.

Elkins et al. (2004) examined the association of adolescent obesity with participation in sports among 5489 low-income, inner city public school students. For both males and females, participation in an increasing number of athletic activities was associated with lower (body mass index) BMI after controlling for age, grade and playing football. While youth with lower BMI might be more likely to participate in sports, after school sports are a potential opportunity for prevention of obesity in adolescents.

Carrel et al. (2005) examined fifty overweight middle school children with a body mass index (BMI) above 95th percentile for age were randomized to lifestyle-focused, fitness-oriented gym classes (treatment group) or standard gym classes (control group) for 9 months. They concluded that children enrolled in fitness-oriented gym classes showed greater loss of body fat, increase in cardiovascular fitness and greater improvement in fasting insulin level than control subjects. The modification to the school physical education curriculum demonstrates that small but consistent changes in the amount of physical activity has beneficial effects on body composition, fitness and insulin levels in children. Partnering with school districts should be a part of a public health approach to improving the health of overweight children.

Kim et al. (2005) examined the relationship between comprehensive fitness tests and overweight. Their findings supported a cross-sectional inverse relationship between physical fitness and overweight among school-aged children.

Rotstein et al. (1986) evaluated the effect of a 9-week (wk) interval training program on aerobic capacity, anaerobic capacity and indices of anaerobic threshold of 28 preadolescent boys of 10.2 to 11.6 years old and concluded that proper training may improve maximal aerobic power and anaerobic capacity of preadolescent boys.
Chatterjee and Bandyopadhyay (1993) conducted endurance training on a group of 41 East Indian boys aged 10-14 years and was compared with 25 untrained boys of the same age. The investigations included different physical and motor fitness tests and their performance times were also recorded before and after training. They concluded that this particular type of training program did not produce any detrimental effects on 10-14 year-old boys. On the other hand, this type of training did have some influence on improving physiological parameters in this age group of boys when compared with untrained boys of the same age.

Baquet et al. (2002) examined peak VO$_2$ responses of prepubertal children following a 7-week aerobic training. These findings showed that prepubescent children could significantly increase their peak VO$_2$ and maximal shuttle velocity with high intensity short intermittent aerobic exercises.

Duscha et al. (2005) reported that exercising at a level of 19 Km/wk at 40 to 55% of peak consumption VO$_2$ was sufficient to increase aerobic fitness levels, and increasing either exercise intensity or the amount beyond these parameters would yield additional separate and combined effects on markers of aerobic fitness. Therefore, it was appropriate to recommend mild exercise to improve fitness and reduce cardiovascular risk yet encourage higher intensities and amount of additional benefit.

Larsen et al. (2004) reported the higher VO$_{2\text{max}}$ of village boys in Western Kenya than town boys. That was probably due to a higher physical activity level of village boys during secondary school and the daily mean time spent working in the field during secondary school and doing sports were significantly higher in village boys compared to town boys.

In addition to general health benefits, exercise produces specific adaptations and specific benefits. The specific benefits that accrue during long-term physical activity can differ considerably because each type of exercise produces different benefits. Today, exercise training follows an important principle known as the specificity of training principle - a specificity exercise elicits a specific training response (Kamen, 2001). If the performer's goal is to increase muscular strength, then training needs to be composed
principally of activities that overload the high force, anaerobic systems. However, if the
goal is to increase long-term endurance, then the training regimen needs to be customized
to include low intensity activities that stress the cardiovascular, respiratory and neural
activation patterns, appropriate for long-term performance.

Bencke et al. (2002) studied the possible effects of specificity of training on muscle
strength and anaerobic power of hundred and eighty-four children of both genders in
Denmark from different sports and at different performance levels in relation to growth
and maturation status. Most of the difference between groups in wingate performance
(anaerobic) disappeared when the data were normalized to body mass. The gymnasts
were the best jumpers and their superiority were increased in the more complex motor
coordination tasks like drop jump. The results may indicate some influence of training
specificity, a specially on more complex motor tasks as drop jump and there may be an
effect of training before puberty. Squat jump and counter movement jump may also be
influenced by specific training.

McIntyre (2005) carried out physiological assessment on 29 inter-country Gaelic
footballers, 30 inter-country hurlers and 21 League of Ireland Soccer players. Significant
differences were reported for % body fat, aerobic capacity, flexibility, upper body
strength, upper body strength endurance, abdominal endurance and speed endurance,
while there were no differences recorded for height, weight or speed levels. Soccer
players had lower body fat levels, greater aerobic capacity, greater strength endurance
and greater flexibility compared to both Gaelic footballers and hurlers, possibly due to
specific training and conditioning programs or physical adaptation to match play. The
greater strength of both Gaelic footballers and hurlers and the superior speed endurance
levels of Gaelic footballers also reflect the physical nature of sports.

B. Views regarding Physical Fitness Components

Historically, physical fitness has often been misrepresented, at times identified
exclusively with skill in sports, at other times identified too closely with only one of the
many aspects of physical fitness. For example, in previous decades, fitness for men was
often associated with muscle strength. In recent years, with the popularity of jogging and
other forms of aerobic exercise, many people associated physical fitness almost exclusively with cardiovascular fitness. It is true that each of these is important, but it can not be overemphasized that physical fitness is not a single entity but consists of a number of different characteristics, of which strength and cardiovascular fitness are only two. Many factors contribute to good physical fitness, including heredity, maturation, environment and life-styles such as nutrition. However, these factors are important in physical fitness development and good physical fitness is very much associated with good sports performance.

So, physical fitness is the entire human organism’s ability to function efficiently and effectively. It is made up of different components, each of which contributes to total quality of life. Physical fitness is associated with person’s ability to work effectively, to enjoy leisure time, to be healthy, to resist the hypokinetic diseases and to meet emergency.

In this particular study, the following physical fitness components are the subject of interest. One must follow the tract conventionally from “prelude” of earlier works.

Cardiovascular Fitness

Cardiovascular fitness is frequently considered the most important aspect of physical fitness because it decreases the risk of heart disease. Also, it is important to the effective performance of virtually all types of work and play activities.

Cardiovascular fitness is sometimes referred to as “cardiovascular endurance” because a person who possesses this type of fitness can persist in physical exercise for long periods of time without undue fatigue. It has been referred to as “cardio-respiratory fitness” because it requires delivery and utilization of oxygen, which is only possible if the circulatory and respiratory systems are capable of these functions (Corbin and Lindsey, 1994).

The important facts about cardiovascular fitness are:

1. Good cardiovascular fitness requires a fit heart muscle
2. Good cardiovascular fitness requires a fit vascular system.
3. Good cardiovascular fitness requires a fit respiratory system and fit blood
4. Good cardiovascular fitness requires fit muscle tissue capable of using oxygen.

The term aerobic fitness has also been used as a synonym for cardiovascular fitness because aerobic capacity is considered to be the best indicator of cardiovascular fitness and aerobic exercise is the preferred method for achieving it.

Several tests can be done with a minimum of equipment for measurement of cardiovascular fitness. The Harvard step test (HST) was introduced by Brouha et al. (1943) from Harvard Fatigue Laboratory in USA to select army personnel during World War II. Later with the development of sports, exercise physiology and ergonomics, the HST has been given much attention to select highly physically active persons who will be capable of doing hard work so that they may be recruited in various sports and games or appropriate industrial occupations. It is widely regarded as a useful test of fitness for strenuous exercise in young men and with appropriate modifications in young women. The merit of the Harvard Step test in assessing the physical performance capacity of an individual depends on its simplicity and versatility of the test. The dynamic fitness, which is very important in athletes can be measured by Harvard Step test (HST). Further that HST has become well known to study cardiovascular fitness by American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) who recommended this test to study health related physical fitness program in youth (Safrit, 1986).

Harvard Step test has been appreciated to be a good measure of cardiovascular fitness (Frank et al. 1953). This test was modified by adjusting the height of the subject with the height of stool (Committee on exercise & physical fitness, 1967).

Banerjee and Chatterjee (1983) assessed the physical fitness in Indian adolescent boys of 13-19 yr by Harvard step test and found out the correlation between the physical fitness index (PFI) with maximal oxygen uptake (VO2max). PFI showed strong correlation with VO2max per kg body weight and the correlation improved considerably when the subjects were divided into two body weight group. Viz., <45 & 45 kg. The regression lines between PFI and VO2max per kg body weight were found to be distinctly different for the above two body weight groups. It appeared that the step test could be used without any modification for assessing the physical fitness in Indian adolescent boys of 45 kg.
body weight. While the same test procedure can be extended to the higher subjects the interpretation limits of the score need to be reclassified for their subjects.

Chatterjee and Mitra (2001) showed a correlation between physical fitness score with different morphological parameters and \( \text{VO}_{2\text{max}} \). Their study was carried out on 20 non-athlete female and 15 athletes of age group 20-24 years. The study revealed that the athlete group possesses a high PFI score because of high \( \text{VO}_{2\text{max}} \) and low body weight, fat % and endomorphy component with respect to other group.

Chatterjee et al. (2002) also observed a moderately high positive correlation between PFI and maximal oxygen consumption (\( \text{VO}_{2\text{max}} \)) expressed both in absolute value and per kilogram body weight in female athletes of different sports activities except for sprinters who exhibited lower relationship for \( \text{VO}_{2\text{max}} \) ml/kg/min. Positive correlation of PFI with for \( \text{VO}_{2\text{max}} \) ml/kg/min in female athletes indicated the merit of the test as a measure of physical fitness in trained women of Bengal, eastern part of India.

Bandyopadhyay and Chattopadhyay (1981) observed insignificant negative correlation values among height, weight and physical fitness index (PFI) for boys aged 17-23 years but correlation for age was positive.

Chatterjee et al. (1993) also showed almost similar correlation values between PFI and age, height and weight of Indian adolescent boys. In this study, it was presumably due to PFI being measured by adjusting stool height (Committee on Exercise & Physical fitness, 1967) instead of fixed stool height studied by Banerjee and Chatterjee (1983). Correlation between stool height and PFI \((r = -0.19)\) in the previous study was low and negative but significantly \((p<0.001)\) due to a large number of subjects.

Sokolov et al. (1980) reported that the role of hereditary and environmental factors in the reaction of the human cardiovascular system to physical loading. Under conditions of muscle activity, regulation of cardiovascular system is primarily under the control of genetic factors. At the end of work period, when signs of fatigue appear, environmental factors play a determining role in the variability of indices of the cardiovascular system. At the 10th minutes of rest arterial blood pressure and pulse variability are determined by environmental factors and genetic factors respectively.
Environmental factor is an important determinant of physical fitness in terms of PFI score. Similar observations were obtained by different investigators in different terms like treadmill performance, aerobic performance (Demeersman et al., 1984; Klissouras, 1975) and physical work capacity (Engstrom and Fischbein, 1977).

Chatterjee et al. (1993) reported that genetic and environmental influence of major fitness measurements might affect by age and age related changes in physical characteristics.

Elbel et al. (1958) observed that HST score is inversely related with pre-exercise pulse.

Chatterjee et al. (2002) conducted a modified Harvard step test (using 17” stool) on 67 Bengalee (Indian) female athletes who participated in nine different sports activities to investigate their PFI. The highest value of the PFI was achieved by long distance runner followed by the pentathletes, javelin throwers and the swimmers. The lowers of the PFI was attained by the basketball players.

Traditionally cardiorespiratory fitness has been evaluated by the amount of oxygen (O₂) that can be taken up by the working muscles during maximal exercise. Thus the determination of VO₂max is essential in evaluating on individual’s capacity to perform aerobic work (Åstrand and Ryhming, 1954).

The maximum oxygen consumption (VO₂max) has been widely studied in various populations because of its close relationship with athletic fitness and an ideal index for the assessment of endurance work capacity. It is well established that the cardiovascular fitness of an individual is very necessary to carry out daily task, requiring physical exercise and longevity (Åstrand and Rodahl, 1977; Patnaik et al., 1990).

Aerobic capacity or maximum oxygen uptake (VO₂max) was defined as the highest attainable rate of aerobic metabolism during the performance of dynamic muscular work that exhausts the subject with in 5-10 minutes (Lange et al., 1971; Chatterjee et al., 1979) and it has been widely accepted to be a reliable and valid measure of cardiorespiratory fitness (Åstrand and Rodahl, 1970; Chatterjee et al., 1979), which can be distinguish a
non-athlete from an athlete by showing higher values of VO\textsubscript{2max} in the latter (Chatterjee et al., 1991; Das and Bhattacharya, 1995).

Exercise physiologists have agreed that the ability to perform hard physical work is related to the maximal capacity of the cardiovascular and respiratory system to take up, transport and give off oxygen utilization (Taylor et al., 1955; Hettinger et al., 1961). Subject, who possess higher values of maximum oxygen uptake, have the capacity to yield larger amounts of energy and are capable of performing better in athletic and other field activities. Thus maximum oxygen uptake determination is one of the very important criteria to assess the oxygen transport system or the cardiopulmonary efficiency (Taylor et al., 1955). It provides a statement of an individual’s capacity for aerobic energy transfer. Maximal aerobic power is limited by the central circulation. It is obvious that stroke volume is a very important factor. Also VO\textsubscript{2max} is directly proportional to another important factor, the oxygen content of the arterial blood.

VO\textsubscript{2max} is a measure of the functional limit of the cardiorespiratory system and the single most valid index of maximal exercise capacity. VO\textsubscript{2max} has been expressed either in absolute value, i.e., in liter per minute (l/min) or as relative values, i.e., ml per kg of body weight per minute (ml/kg /min) or liters per unit of body surface area per minute (l/m\textsuperscript{2}/ min). The absolute value of VO\textsubscript{2max} is one of the best indices of an individual’s cardiorespiratory fitness to transport oxygen to working muscles (Taylor et al., 1955). Furthermore, it is useful when changes in maximal aerobic capacity of children are assessed during the period of prepuberty to adolescence (Yamaji, 1992). The VO\textsubscript{2max} value in ml/kg/min should be considered when the performance of the cardiorespiratory fitness is examined (Chatterjee et al., 2005a).

Banerjee et al. (1982) determined maximal oxygen uptake (VO\textsubscript{2max}) in 95 boys, 10 to 19 year (yr) of age, by uphill treadmill running test. The mean value of VO\textsubscript{2max} increased from 0.96 l/min at 10yr to 2.22 l/min at 19 yr, showing rapid spurts of increase at 13 to 16 yr of age. VO\textsubscript{2max} per kilogram of body weight showed mean values varying between 40.9 to 46.9 ml/kg/min in different age group, the peak being observed at 17-18 yr of age. The logarithmic relationship of VO\textsubscript{2max} with height revealed its increase in proportion to height.
Buchard and Lortie (1984) proposed that in human inter individual differences for both VO_{2max} and endurance performances were primarily associated with age, sex, exercise habit and heredity.

Andersen (1994) reported that in the adolescent population VO_{2max} related negatively to blood pressure after adjustment for body weight, physical activity, other fitness measures and sex, but physical activity or other fitness measures did not relate. Lower blood pressure was found with higher VO_{2max} until levels of 50 and 45 ml/kg/min in boys and girls respectively.

Hickson et al. (1978) wanted to determine the effect of endurance exercise training on the time course of the increase in VO_{2max} toward steady state in response to sub-maximal constant load work. Their study indicated that the increase in VO_{2max} toward steady state occurred more rapidly in the trained than in the untrained rate both at the same absolute and the same relative work rates.

In a study Shibayama and Ebashi (1980) concluded that the well trained had excellent capability as regards physical resources and high adaptability to exercise and accordingly they showed more rapid acceleration of physiological functions than the untrained and could maintain high efficiency for oxygen supply throughout the whole course of exercise. Although the relative physiological work load seemed to be similar in both trained and untrained, the level of oxygen intake was distinctly higher in the trained than in the untrained.

Dasgupta and De (1991) studied cardiopulmonary efficiency in 18 Indian medical students and 19 state level athletes by estimating maximal oxygen uptake and other parameters related to oxygen transport, following graded exercise on a treadmill. From their study it was observed that athletes show significantly higher values of VO_{2max} than non-athletes and therefore, have higher aerobic capacity or physical work capacity which enabled them to sustain higher workloads. Higher VO_{2max} observed in athletes was due to higher stroke volume and arteriovenous oxygen differences. Their findings also indicated that values for max minute ventilation (V_E) did not differ significantly between the two groups. It thus appeared that athletes who had higher capacity of increasing V_E during
exercise were more economical in the energy expenditure, since all of the additional oxygen thus gained by increasing $V_E$ would be required for work breathing.

Das and Bhattacharya (1995) showed in their study that the degree of activity plays the major role in determining $VO_{2max}$ in all population and their observations, namely, significantly higher values of $VO_{2max}$ and endurance in the trained group in comparison to those of the untrained group depict the effects of physical training.

Sutton (1992) reported that an increase in exercise capacity depends on the magnitude of increase in maximum aerobic capacity. Central and peripheral factors may limit oxygen uptake. They suggested that central oxygen delivery depends on cardiac output and maximal arterial oxygen content. Peripheral extraction of the delivered oxygen is expressed as a $VO_2$. With increasing intensities of exercise, they suggested that the respiratory system may become limiting in some trained individuals. They concluded that maximal oxygen uptake depends on all components of the oxygen transporting system but stroke volume appeared to be the prime determinant in the trained subjects.

According to Saltin and Åstrand (1967), various inter-dependent factors like energy output (from aerobic and anaerobic processes), neuromuscular function (strength and techniques), and psychological factors influence the physical performance. These factors play quite different roles in various sports events. The maximal oxygen intake is a measurement of the maximal motor power by aerobic processes. The aerobic work capacity, thus is a dominant factor for good performance in endurance events like long-distance runners.

Joussellin et al. (1984) also reported that sports with high energy requirements showed high $VO_{2max}$ ml/kg/ min.

Chatterjee et al. (1991) reported that the long distance runners were superior to all categories of sports participants for their $VO_{2max}$ ml/kg/ min.

Huttunen et al. (1986) observed that weight reduction among obese and non-obese children increased their $VO_{2max}$ value in ml. kgL/BM/min. This was probably because of loss of fat weight that in turn led to with drawl of fat induced inhibitory action towards $O_2$ utilization of body musculature.
Sharp et al. (1992) also observed that $\text{VO}_{2\text{max}}$ was positively correlated with fat free mass and negatively correlated with adiposity.

Chatterjee et al., (2005a) evaluated the cardiorespiratory fitness in terms of maximum, oxygen uptake ($\text{VO}_{2\text{max}}$) in obese boys of West Bengal, India. Absolute $\text{VO}_{2\text{max}}$ was significantly higher among obese boys because of higher values of body mass and lean body mass, which in turn exhibited significant correlation with $\text{VO}_{2\text{max}}$. But $\text{VO}_{2\text{max}}$ per kg of body mass was significantly higher among non-obese boys but the $\text{VO}_{2\text{max}}$ per unit of body surface area was significantly higher in obese group. $\text{VO}_{2\text{max}}$ is largely dependent on body mass and lean body mass whereas excessive fat mass imposes unfavorable burden on cardiac function and oxygen uptake by working muscles. This indicates that reduced oxygen utilization by adipose tissue during exercise reduces the overall $\text{VO}_{2\text{max}}$.

Chatterjee et al. (2005a) studied the $\text{VO}_{2\text{max}}$ in junior male footballers of India. Results revealed that the mean $\text{VO}_{2\text{max}}$ value of junior footballers was 52.17 ± 5.19 ml/kg/min.

Htay et al. (1976) reported in their study that maximal oxygen uptake of the 19-24 years aged Burmese women of rural area was higher than urban area and this study showed a higher respiratory fitness in rural group.

Yu et al. (2004) studied the association between air pollution and cardiopulmonary fitness among 821 school children aged 8 to 12 from districts with different air quality in Hong Kong. Their parents completed a respiratory questionnaire, and the maximum oxygen uptake ($\text{VO}_{2\text{max}}$) of the children was assessed using the multistage fitness test. Children in the high pollution district had a significantly lower $\text{VO}_{2\text{max}}$ than those in low pollution district (27.9 ml/ kg/min Vs 29.8 ml/ kg/min). Habitual physical exercise was associated with a higher $\text{VO}_{2\text{max}}$ in the low pollution district but not in the high pollution district. Air pollution adversely affected the $\text{VO}_{2\text{max}}$ in children, and physical exercise in a polluted environment might not have beneficial effect on cardiopulmonary fitness.

Though aerobic exercise is considered to be the preferred method of building cardiovascular fitness, anaerobic exercise can contribute to its development through
increased heart rate and blood flow. Most experts agree that the primary contribution of anaerobic exercise to cardiovascular fitness is associated with improved delivery of oxygen in blood. Improvement of $O_2$ utilization with in the cells seems to be specially associated with aerobic exercise (Corbin and Lindsey, 1994).

Sersesse et al. (1989) compare the performance of sedentary individuals, physical education students and athletes of various disciplines in 10s and 90s maximal cycle ergometer test. Mean values of the 10s power and capacity and the 90s capacity tests were significantly higher in sprinter than in sedentary groups. Sprinters performed significantly better than marathon runners only in the 10s capacity and power. Body builders and sedentary subjects had similar results in the 90s capacity test. Their results indicated that there are differences for the power and capacity measured in predominantly anaerobic tests between athletes from different disciplines and sedentary individuals.

Houmand et al. (1991) studied that the anaerobic systems influence middle distance performance in runners of similar abilities.

Can et al. (2004) studied certain morphological characteristics and measured some performance variables of women soccer players. They reported that women soccer players showed less fat content, less lean body mass than sedentary women. Anaerobic power, leg muscle power and agility were higher in athletes than non-athletes.

Luebbers et al. (2003) examined the effects of 2 plyometric training programs, equalized for training volume, followed by a 4 week recovery period of no plyometric training on anaerobic power and vertical jump performance. Physically active, college-aged men randomly assigned to either a 4-week ($n=19$) or a 7-week ($n=19$) program. Vertical jump height, vertical jump power and anaerobic via the Margaria staircase test were measured pretraining (PRE), immediately post training (POST), and 4 weeks post training (POST 4). Anaerobic power improved in the 7-week group from PRE to POST but not the 4 week group. Anaerobic power significantly improved PRE to POST4 in both groups. There were no significant differences between the 2 training groups. 4 week and 7 week plyometric programs are equally effective for improving vertical height, vertical jump power and anaerobic power when followed by a 4-week recovery period.
However, a 4 week program may not be as effective as a 7 week program if the recovery period is not employed.

Kasabalis et al. (2005) evaluate the anaerobic power of elite male volleyball players, using the Wingate anaerobic test and examined the relationship between anaerobic power and jumping performance. Athletes (n=56) and non-athletes (n=53) were divided into three age groups: Adults (18-25yr), juniors (15-16yr) and youth (10-11yr). Measurements of height, body mass, vertical jump and Wingate scores indicated higher values for athletes. The specific training effects of anaerobic power were more pronounced at the age of 10-11 years than for non-athletes. These results indicated that vertical jump may predict the maximal anaerobic power and could be used by coaches as a practical and easy to apply field screening test for evaluation in volleyball training.

Bencke et al. (2002) investigated the possible effects of specificity of training on muscle strength and anaerobic power in children from different sports and at different performance levels in relation to growth and maturation status. Hundred and eightyfour children of both gender participating either in swimming, tennis, team handball or gymnastics were recruited from the best clubs in Danmark. According to performance level and talent, children were divided into Elite and non-elite group. The anaerobic performances were assessed by Wingate test and jumping performance in squat jump, counter movement jump and drop jump from two heights. Most of the differences between groups in Wingate performance disappeared when the data were normalized to body mass. The gymnasts were the best jumpers. The results may indicate some influence of training specificity on performance and there may be an effect of training before puberty.

Apostolidis et al. (2004) studied to describe the physiological and technical characteristics of elite young basketball players and to examine the relationship between certain field and laboratory tests among these players. Thirteen male players performed a run to exhaustion on the treadmill, the Wingate test and 2 types of vertical jump. Field tests such as control, dribble, defensive movement, speed dribble, speed running, shuttle run and dribble shuttle run were conducted. These players presented a moderate VO$_{2\text{max}}$ and anaerobic power. The significant correlation between mean power and certain field
tests indicated that these tests could be used for the assessment of anaerobic capacity of young basketball players.

**Flexibility**

Flexibility is a measure of motion available of a joint or group of joints. As a component of physical fitness, flexibility may be interpreted as the potentiality of an individual to move the body and its various parts without undue strain to the articulations and muscle attachments. Flexibility has long been recognized as an important factor in athletic proficiency. The definition of this term is most frequently given as “the range of movement about a joint”. However, one must not fail to recognize that the degree of joint flexibility is dependent upon physiological characteristics underlying the extensibility of the muscles and ligaments surrounding the joint. In addition to noting that flexibility is significant in performing skills, the recent advancements in physical medicine and rehabilitation have indicated the importance of flexibility as it is related to general physical fitness. Particularly, if a person maintains a satisfactory degree of flexibility, he is less susceptible to certain muscular injuries.

Exactly how much flexibility an individual should possess has not, as yet, been scientifically demonstrated. In the Kraus-Weber floor touch test, which involves the extensibility of the erector spinae, gluteal, hamstring and gastrocnemius muscles, a passing grade is the ability to touch the floor. The only reported validity for this test is the evidence gained from examination of numerous patients by the medical people who have assisted Kraus (Mathews, 1973).

Wells and Dillon (1952) published a Sit and Reach test with a horizontal and elevated scale that provided scores in negative and positive units.

The most comprehensive technique was evaluated for measuring objectively the flexibility of thirty joint movements. The instrument employed in making the measurements is called the Leighton flexometer (Mathews, 1973).

Johnson (1966) modified the Wells and Dillon test, which resulted in all positive scores by merely lining a student’s heels on the 115 inch mark of yard stick and having the student reach as far down the stick as possible.
There are two types of flexibility tests:-

1) Relative flexibility tests, those designed to be relative to the length or width of a specific body part. These tests measures not only the movement but also length per width of an influencing body part.

2) Absolute flexibility test, those where the movement in relation to an absolute performance goal measures.

Specific flexibility training procedures involving static stretch methods have been studied with significant gains (Kusinitz and Clifford 1958; March-Bank and William, 1970). Although no significant difference was found between the two methods. In recent years, however physical educators and athletic trainers have favored the static stretch method, claiming less chance for muscle tears and strains.

Dinkheller (1960) observed that students with a longer trunk and arm measurement have a significant advantage on the Hip Flexor test.

Flexibility does not exist as a single general characteristic but rather as a highly specific ability to the individual joints of the body (Dickinson, 1968; Harris, 1969).

Like other components of physical fitness, flexibility can be improved through training. Numerous independent studies, revealed significantly improvement as a result of regular training (Bennett et al., 1956; Shaw Terrance, 1968).

Hupprich and Siger Seth (1950) measured the flexibility in 12 joints in girls and concluded that the flexibility tended to increase in most joints until age 12.

Chatterjee et al. (1993) observe that major influence of age on the physical and motor fitness like flexibility (sit and reach), vertical jump (sergeant vertical jump) in boys participated since 14-15 years. They reported that the major spurs in flexibility and vertical jump in between 14-15 years in Indian school-going boys and thereby their values decreased gradually with age.

Koslow (1987a) studied the sit and reach flexibility measure for boys and girls aged 3 to 8 years. Analysis of variance indicated that 3-4 years were significantly more flexible than subjects aged 5 to 8 years. Also girls were significantly more flexible than boys across the 3 age groups.
Again Koselow (1987) showed the bilateral flexibility in the upper and lower extremities as related to age and gender. The subjects were 320 males and females ranging in age from 9 to 21 years. Results indicated that shoulder joint flexibility of males varied across ages. Also dominant shoulder joint flexibility measures of 17 and 21 years old females were significantly greater than dominant shoulder joint flexibility measures of the 17 to 21 years old males. Result pertaining to the lower extremity flexibility measures indicated that flexibility was greatest in 17 and 21 years old males and females. In addition flexibility measures pertaining to the non-dominant lower extremities of the 17 and 21 years old males were significantly greater than the dominant lower extremities of males with in the same age groups.

Tyrance (1958) showed that there was some correlation between flexibility and specific extremes of body type.

Broer and Galles (1958) observed that for persons of average build, the relation of trunk plus arm length to leg length and of weight to height was not important factors affecting the ability to perform toe touch.

Mathews et al. (1959) determined the relationships among the flexibility tests in the anteroposterior plane and the selected anthropometric measures with the results of having significant relationship between flexibility tests and measure of body length but not between the flexibility of hip joint and length of body segments and that the flexibility was independent of lower limb length.

Nomura et al. (1985) observed that Japanese students had poor strength, flexibility, endurance in spite of good physique and power. The physique factor was related to the degree of involvement in sports activities at the college sports clubs and physical activity habits could be evaluated by endurance test.

Gabbard and Tandy (1988) suggested that some biological and cultural factors might be responsible for higher values of flexibility in boys.

Warburton et al. (2001) reported that flexibility is positively associated with morbidity and high levels of musculoskeletal fitness are associated with positive health status.
Palamarchuk (1986) suggested that environmental factors could alter flexibility while underlying morphology remained constant.

Ozdirenc (2005) investigated the effects of environmental factors, lifestyle and leisure time activities on physical fitness of 98 rural and 74 urban healthy children (aged 9-11 years) in Turkey. Their results showed that body mass index and skinfolds thickness were higher in the urban children. There were no significant differences in the hip-waist ratio or the hip and waist circumference between the two groups. In cardiopulmonary and motor fitness, no difference was found between the two groups. In contrast, flexibility and muscle endurance were significantly higher in the rural children. The children living in the urban areas were more inactive and obese, which resulted in a decrease in their flexibility and muscle endurance fitness.

**Agility, Leg muscle power, Speed**

Agility is a kind of physiological aptitude, which enables an individual to rapidly change body position. Agility is an important ability in the world of sports.

In the past, generally it was used to be believed that agility was almost entirely dependent upon one's heritage. But however, measurement and research revealed that it could be improved through practice, training and instruction (Lafuze, 1951; Bennett, 1956).

Speed is defined as the ability to perform a movement in a short period of time.

Naturally, the age, sex and characteristics of the subjects should be the major consideration in selecting tests of speed.

Power may be defined as the capacity of the individual to release maximum force in the shortest period of time is exemplified in the vertical jump, the broad jump, the shot put and other movements against a resistance in a minimum of time. Leg power is an essential component for success in sports and athletic performance. Therefore the leg power measurement may help athletes, coaches, athletic trainers and rehabilitation specialists in selecting, treating and training athletes for a specific sports (Shetty, 2002).
In studying age, height and power the following findings have been reported.

1. The Sargent jump was found to be a better means of classifying girls for individual athletic performance. Since age, height and weight alone were found to be of little value for such classification (Adams, 1934).

2. Power measures were not found to increase or decrease with the increase age and growth of junior high girls enrolled in ungraded classes (Burley, 1961).

In testing primary grade children, Seils (1951) found a moderately high positive correlation between physical growth and agility performance in boys and girls.

Espenschade (1947) noted that both boys and girls increase in agility performance up to 14 years of age, after which girls seem to decline while boys rapidly gain in agility performance.

Solley (1957) found no significant evidence to support the claim that boys who are big for their or small for their age may be expected to perform better of worse on agility items.

Pissance et al. (1983) determined the contribution of age, sex and body composition to children’s motor performance or selected basic motor tasks such as, agility power, speed, balance. It was seen that age was a significant factor in predicting performance.

Iiike et al. (1985) observed the variation of strength, endurance and agility performance in different age groups of subjects, who participated in sports badge program of East Germany. The study revealed that peak performances were to be found at different stages of life e.g. at the age of 10-13 years with female subjects endurance run at the earliest and at the age of 30-34 years with male subjects shooting. Significant difference appeared at the starting levels of 9 years old subjects as well as performance level of subjects older than 65 years.

Espenschade (1963) recorded that weight was negatively related to 50-yard dash and vertical jump.

Montoye et al. (1972) also reported that shorter height had a negative influence on 50-yard dash and shuttle run test.
According to Chatterjee et al. (1993) Bangalee boys were inferior in dash and shuttle run test scores to their American counterparts due to their shorter height and due to shorter stature Bangalee boys showed lower values in sergeant vertical jump test than American and Belgian boys.

Beunan et al. (1983) showed that at all ages the fattest boys had greater body dimensions, but attained poorer results in most motor fitness test items.

Malina and Buschang (1985) suggested that the reduced stature had a negative influence on jumping ability.

Bale et al. (1992) observed the effect of age, height and body mass on motor performance during adolescence (13-18 years). 103 boy and 65 girl athletes were measured for motor performance and anthropometric variables. Motor performances included tests of strength, muscular endurance, flexibility, aerobic capacity, anaerobic power, speed and agility. Their results suggested that growth would appear to contribute significantly to enhanced motor performance with age and its effect may be different in boys than in girls.

Chatterjee et al. (2004) evaluated the vertical jump test score (VJT) in school going boys (n=53) and girls (n=35) of 10-14 years age. Statistical analysis of the result depicted significantly higher VJT score among boys than of girls and correlation statistics revealed positive correlation of age with height, body weight and VJT scores both in boys and girls.

Coksevim and Caksen (2005) evaluated exercise performance and cardiorespiratory capacity in adolescents (both boys and girls) by using some tests such as ball throw with right and left hands, vertical jump, long jump without prior motion, pull up and flexibility and agility tests and spirometric tests. There was significant difference in all tests between males and females and although females were superior in 60 and 200-meter race, male were superior in agility, horizontal bar, ball throwing with right hand, long jump and vertical jump.

Markovic et al. (2005) assessed the fitness profile of elite creation female taekwondo athletes and determined the physical, physiological and motor characteristics.
They reported that the performance of taekwondo female athletes primarily depends on the anaerobic alactic power, explosive power, expressed in the stretch shortening cycle movements, agility and aerobic power.

Babin et al. (2001) analyzed the efficacy of specially programmed physical and health education on the motor development. 633 children aged 7 years volunteered for this study, divided into control group consisting of 140 boys and 137 girls attending standard program of physical and health education and in experimental group consisting of 184 boys and 172 girls attending specially programmed physical and health education. A battery of 12 motor tests has been used on two occasions separated by nine month interval. Analysis of time-changes pointed to the significantly greater quantitative changes in experimental group compared with control group of children. In boys, the changes are obtained for the tests of aerobic endurance, static strength, flexibility, speed, explosive strength of sprint and throw type and equilibrium, and in girls, they are for aerobic endurance, static strength, explosive strength of throw and sprint type, flexibility, repetitive strength, speed and equilibrium.

Stone et al. (2003) reported that to improve jumping power output, improving maximum strength should be a primary component of training programs and that strength should shift from lighter to heavier.

Alriesson et al. (2003) concluded from their study that dance training has a positive effect on speed and agility and on joint mobility and muscle flexibility in flexion-extension and lateral flexion of the spine in young cross country skiers.

Deane et al. (2005) reported that a hip flexor resistance training program improved sprint and agility performance for physically active and untrained individuals.

Vanezis and Lees (2005) investigated the contribution made by the lower limb joints to vertical jump performance by good and poor performers of the counter-movement jump. Two groups of players were selected who were found to be good and poor jumpers, respectively. Better jumpers demonstrated greater joint moments, power and work done at the ankle, knee and hip and as a result jumped higher under both conditions. It appears that the superior performance of the better jumpers was due to greater muscle capability in terms of strength and rate of strength development in all lower limb joints rather than
to technique, which differed less noticeably between the groups. It concluded that the muscle strength characteristics of the lower limb joints are the main determinant of vertical jump performance with technique playing a smaller role.

**Hand muscle strength and muscular endurance measurement**

In the seventeenth century, French anthropologists developed and used dynamometers for measuring strength. Sargent first emphasized measuring strength when he was a medical student at Yule and developed the intercollegiate strength test in 1873. This test was used extensively in the nineteenth century by Universities (Jana, 2002).

Jones (1949) observed that the grip strength scores of yearly maturing boys were greater than the average maturity groups. Clarks and Esslinger (1958) suggested from his study that, if pubescence was retarded, a temporary diminution of motor force resulted. However, he emphasized that increase in strength did take place during rapid maturation.

Gabbard and Patterson (1980) observed the relationship and comparison of grip strength and hang time to sum of skin fold measures, body weight and height among children 3-5 years of age. Analysis of correlation matrix indicated that weight, height and selected skinfold thickness measurements were not practical indicators of grip strength and muscular endurance.

Gabbard (1982) observed the relationships and difference between selected upper limb and anthropometric measurement to strength and endurance among children aged 4-6 years. Relationship analysis revealed no significant correlation between strength and endurance scores and selected upper limb measurements. Analysis between other variables indicated that the 4 years old was the only group which presented significant correlations (0.66 to 0.55), having time/ skin fold grip with height, weight and skin fold.

Sartorio et al. (2002) evaluated maximum hand grip (HG) strength, body composition and main anthropometric variables in 278 children aged 5-15 years divided into 3 age groups. A curvilinear relation was detected between HG strength and age. The increase in HG strength after 11 year appears to be steeper in males as compared with that found in females. A multiple linear regression analysis indicated that HG was positively correlated with body mass index (BMI), body surface area (BSA), stature and
fat free mass (p<0.001 for all correlations) with out differences between genders, while a negative correlation was found between HG strength and % body fat (BF). Their study indicated that the age dependent increase HG strength as well as the between gender differences are strongly related to changes of fat free mass (FFM) values occurring during childhood.

Corlett (1988) studied the strength development of Taiwan's children (Botswana) of age group 7-12. The measurements included height, weight, arm circumference and maximum grip strength. Urban children were superior in grip strength, even when strength was normalized for body weight and circumference. Power function analysis of variance revealed different strength development patterns for urban and rural children. The urban superiority in strength was greatest at earlier ages and less noticeable at older ones. The result was odds with what is known about daily activity levels, growth patterns and body composition of Botswana children.

Pena Reyes et al. (2003) compared physical fitness of school children in urban and rural community in Southern Mexico. Fitness measurements (standing long jump, 35yard [32 m], grip strength, sit and reach, timed sit-up, distance run) were taken on 355 rural (175 boys and 184 girls) and 324 urban (163 boys, 161 girls) school children, 6-13 years of age. Urban children were significantly taller and heavier than rural children. Absolute grip strength did not consistently differ between rural and urban children but when adjusted for age and body size, strength was greater in rural children.

Nomura et al. (1985) observed that Japanese students had poor strength, flexibility, endurance in spite of good physique and power. The physique factor was related to the degree of involvement in sports activities at college sports clubs and physical activity habits could be evaluated by endurance tests.

Nomura et al. (1987) discussed the relationship between the daily activity pattern from a viewpoint of energy consumption and several sub-domains of physical condition for male students. It was concluded that on sub-domains of physical fitness that tested muscular strength and endurance, working students values were better than that for non-working student.
Faigenbaum et al. (2002) compared the effects of 1 and 2 days per week of strength training on upper body strength, lower body strength and motor performance ability in 21 girls and 34 boys between the ages 7.1 and 12.3 years. One repetition maximum (1 RM) strength on the chest press and leg press, handgrip strength, long jump, vertical jump and flexibility were assessed at baseline and post training. Only participants who strength trained twice per week made significantly greater gains in 1 RM chest press strength compared to the control group. Their finding supported the concept that muscular strength can be improved during the childhood years and favor a training frequency of twice per week for children participating in an introductory strength training program.

Chilima and Ismail (2001) examined the relationship between the nutritional status and handgrip strength of older people in rural Malawi. Ninety-seven males and 199 females participated in this study. Selected anthropometric measurements were taken and nutrition indices were computed using standard equations. Handgrip strength was measured using an electronic grip strength dynamometer. The mean handgrip strength (in kg) for men was significantly higher than for women. In addition, there was a significant decline in handgrip strength with age in both sexes. Furthermore, handgrip strength was positively correlated to the following nutritional status indicators: BMI in males and in females, mid-upper arm circumference (MUAC) in males and in females and arm-muscle area (AMA) in males and in females. After controlling for potential confounders, namely sex, height and age, the correlations between handgrip strength and the nutrition indices were still significant. Their results supported the hypothesis that poor nutritional status was associated with poor handgrip strength. Malawian males had both lower handgrip strength and lower arm muscle area than their counterparts from industrialized countries. However, Malawian females had similar handgrip strength despite lower arm muscle area, in comparison with women from industrialized countries, reflecting perhaps their higher level of physical activity.

Pieterse (2002) investigated the association between nutritional status and handgrip strength in older Rwandan refugees. The study reported that handgrip strength was positively correlated to BMI (body mass index) and AMA (arm muscle area). The relative risk of impaired handgrip strength in individuals with poor nutritional status (BMI<18.5 kg/m²) compared with those of adequate nutritional status was 1.75. After
controlling for potential confounders (sex, age and height), BMI remained a significant
contributor to the variation in handgrip strength. Poor nutritional status was associated
with poor handgrip strength independent of sex, age and height, in this refugee
population. This indicated that underweight older people were likely to have more
difficulties in functioning independently in the community.

Kenjle et al. (2005) studied to evaluate the use of handgrip as an index of nutritional
status of 6-10 year old children. A significant high correlation (p<0.01) was observed
between grip strength and age for both sexes. Boys had a higher grip strength than girls at
all ages. Grip strength was significantly correlated with height, weight, mid arm
circumference, triceps skin fold, arm fat and arm muscle areas (p<0.01). Grip strength
was found to be a specific measure of lean body mass (74 to 94%), but sensitivity was
quite low (about 25%). Their study concluded that grip strength may have a potential
value as an additional test for nutritional assessment in field situations and clinical
settings.

C. Views regarding effect of air pollution on health status of
school-going growing children

Air pollution has become such a pervasive problem across the country that there are
virtually no places left unaffected. About half of the World's population now lives in
urban areas because of the opportunity for a better quality of life. Many of those urban
centers are expanding rapidly, leading to the growth of megacities, which are defined as
metropolitan areas with populations exceeding 10 million inhabitants. These
concentrations of people and activity are exerting increasing stress on the natural
environment, with impacts at urban, regional and global levels. In recent decades, air
pollution has become one of the most important problems of megacities. Initially, the
main air pollutants of concern are sulfur compounds, which were generated mostly by
burning coal. Today, photochemical smog-induced primarily from traffic, but also from
industrial activities, power generation, and solvents – has become the main source of
concern for air quality, while sulfur is still a major problem in many cities of the
developing world. (Molina and Molina, 2004).
Certain populations may be particularly vulnerable to the effects of polluted air such as children, people with asthma, diabetes or acute with pre-existing heart and lung conditions (Sharman, 2005).

Asgari et al. (1998) compared in their study between the pulmonary function of children in Tehran and children in a rural town in Iran. The association between higher pollutant concentrations and reduced pulmonary function in this urban-rural comparison suggested that there was an effect of urban air pollution on short-term lung function and for lung growth and development during the preadolescent year. Van Roosbroeck et al. (2006) reported that in Amsterdam children living near busy roads were found to have a 35% higher personal exposure to ‘soot’ than children living at an urban background location, despite that all children attended the same school that was located away from busy road. Gillissen et al. (2006) reported that fine particles (particulate matter = PM) may cause worsening of asthma and other respiratory diseases, reduce lung function development in children, potentially increased the risk of premature death in the elderly and enhance mortality from cardiac diseases. Because of the small size PM2.5 is seen to be even more hazardous than PM10.

The effect of air pollution on asthmatic symptoms were assessed in a prospective cohort study of 3,049 school children in 8 different communities in Japan. Respiratory symptoms in these children were evaluated by questionnaires. These findings suggest that air pollution, including, nitrogen dioxide, may be an important factor in the development of asthma among children on urban districts (Shima et al., 2002).

The health effects in growing children of long term exposure to a polluted atmosphere were of deep concern. The atmosphere of south Mexico city was characterized by a complex mixture of air pollutants, including ozone, particulate matter and aldehydes. Radiological evidence suggested that small-airway disease could be present in clinically healthy, tobacco unexposed children of south Mexico City (Villarreal-Calderon et al., 2002).

Delfino et al. (2003) showed that air toxics in the pollutant mix from traffic and industrial sources may have adverse effects on asthma in growing children of 10-16 years old. Hazardous air pollutants (HAP) are compounds shown to cause cancer or other adverse health effects. Reynolds et al. (2003) suggested in their study that there is an
association between increased childhood leukaemia rates and high HAP exposure. Rios et al. (2004) reported that in Brazil, the prevalence of asthma in adolescents was directly related to atmospheric pollution. Kim (2004) stated that children and infants are among the most susceptible to many of the air pollutants. In addition to associations between air pollution and respiratory symptoms, asthma exacerbations and asthma hospitalisations, recent studies have found links between air pollution and preterm birth, infant mortality, deficits in lung growth, and possibly, development of asthma.

Nikic et al. (2005) examined the effect of current level of air pollutants on health of 1395 children in the city of Nis and Niska Banja and revealed that in the more polluted of studied zones, the prevalence of some respiratory symptoms (cough with cold and phlegm) and the lower respiratory tract diseases were significantly higher than in less polluted environments.

Mikhailova (2005) assessed the health status of organized preschool children living under varying man-made pollution. Fewer healthy children and more ailing children, more children with dysfunctions of organs and systems, and more sick children, as well as more physically retarded children were detected in the higher man-made loaded district of an industrial town.

Denisova et al. (2005) analyzed the actual nutrition in 301 school children (142 children and 159 adolescents), the state of ambient air and the health status of the population in 5 districts of the town of Orekhovo-Zuyevo. They concluded that non-balanced diets and ambient air pollution have been ascertained to negatively affect human health.

Nascimento et al. (2006) estimated the association between pneumonia admissions of children and increased air pollutants in southeastern Brazil and reported three air pollutants (SO₂, O₃ and PM10) had lagged effects on children's health and also increase pneumonia admission rate.

Ruchirawat et al. (2007) reported that urban air pollution resulting from traffic is a major problem in many cities in Asia, including Bangkok, Thailand. Their study indicated that children living in a mega city such as Bangkok may have an increased
health risk of the development of certain diseases due to exposure to genotoxic substances in air pollution compared to children living in suburban or rural areas.

Air pollution has serious impacts on public health, causes urban and regional haze. In India, it has no exception. Awasthi et al. (1996) in their study showed the association between ambient air pollutants (AAP) and respiratory symptoms complex (RSC) in preschool children from 28 slums (anganwadi centres) of Lucknow, north India, between the ages of 1 month to 4.5 yr and concluded that to improve the respiratory health of preschool children, ambient air SPM and SO₂ levels should be kept as low as possible.

Sharma et al. (2004) assessed the relationship between daily changes in respiratory health and particulate levels with diameters of less than 10 microgram (PM 10) and less than 2.5 micron (PM2.5) in Kanpur, India and concluded that an increase of 100 microg/m³ of the pollutant PM10 could reduce the mean peak expiratory flow rate of an individual by approximately 3.2 l/min.

Like many other magacities in the world the ambient air quality of Kolkata is also being deteriorated day by day. Lahiri et al. (2000) investigated pulmonary responses of children (age group of 6-17 yr) chronically exposed to ambient air pollution in Calcutta. The study demonstrated that children inhaling grossly polluted air of Calcutta suffered from adverse lung reactions and genetic abnormality in the exposed tissues. The particulate matter, particularly less than 10 micron in size, can pass through the natural protective mechanism of human respiratory system and plays an important role in genesis and augmentation of allergic disorders. The status of air pollution in Kolkata has been evaluated and a questionnaire survey was conducted by Ghosh et al. (2005) to estimate the allergic symptoms and exposure to assess the respiratory disorders. The data were analyzed to evaluate the critical situation arising out of the emission of air pollutants and the impact on human health due to respirable diseases to middle class sub-population (activity-wise) in the area were assessed. The investigators of this study concluded that air pollution had significant effects on exacerbation of asthma, allergy and other respiratory diseases.
D. Views regarding effect of air pollution on Athletes

McCafferty (1981) showed three reasons why athletes are at special risk of inhaling pollutants. Firstly, there is a proportionate increase in the quantity of pollutants inhaled with increase in minute ventilation \((V_e)\) during exercise. Secondly, a large fraction of air is inhaled through the mouth during exercise, effectively bypassing the normal nasal mechanisms for the filtration of large particles and soluble vapours. Thirdly, the increased air flow velocity carries pollutants deeper into the respiratory tract.

Nicholson and Case (1983) showed that strenuous exercise in heavy traffic for 30 minutes can increase the level of carboxyhaemoglobin (COHb) 10 fold, which is the equivalent of smoking 10 cigarettes.

Shephard (1984) reported that carbon monoxide and ozone levels expected in Los Angeles in summer could affect the athletes performance in endurance events at the Olympic games. Carbon monoxide might also impair psychomotor abilities and peroxy acetyl nitrate (PAN) caused visual disturbances. Beside these two pollutants nitrogen oxides was responsible for pulmonary edema, sulfur dioxide caused death due to respiratory failure and only illness that were likely to be more frequent than usual among young athletes exposed to high levels of these pollutants were upper respiratory tract infections.

Schelegle and Adams (1986) conducted a study on ten highly trained endurance athletes. They were randomly exposed to filtered air, and to 0.12, 0.18 and 0.24 ppm (ozone) \(O_3\), while performing a one-hour competitive stimulation protocol on a cycle ergometer. They all completed the protocol when exposed to filtered air, where as one, five and seven subjects did not complete the protocol when exposed to 0.12, 0.18 and 0.24 ppm \(O_3\) respectively.

Pierson et al. (1986) expressed that during exercise, as oral breathing replaces nasal breathing, a corresponding increase in penetration of sulphur dioxide (SO\(_2\)) into the intrathoracic airways exacerbates the effect.
Hopkins (1990) showed the effects of raised CoHb on exercise performance and was the cause of lower VO$_2$max, anaerobic threshold and oxygen pulse (VO$_2$/ heart rate), and a significantly higher heart rate and pulse pressure.

Stamford (1990) reported air temperature and humidity influenced the degree of symptoms experienced, with cold dry air producing a faster and more intense response to SO$_2$ than warm moist air. It was possible that SO$_2$ might be one of the triggers for exercise induced bronchospasm. The overall incidence of exercise induced bronchospasm across all sports and sexes in a recent survey of Olympic winter sport athletes was reported as 23%.

Neher and Koenig (1994) suggested that athletes should be encouraged to train in the early morning, when photochemicals are usually at their lowest level.

COMEAP's report (1995) on non-biological particles and health recognized that exercise might have a variable effect on particle size and pattern of respiration.

There have been very few studies examining the relation between exercise and particulate matter less than 10 μm in diameter or PM10 inhalation. Carlisle and Sharp (2001) reported that personal exposure to PM10 of people exercising at the roadside in the city was higher than that of the sedentary person and those exercising in rural locations.

Carlisle and Sharp (2001) also reported that cycling in urban areas results in higher personal exposure to volatile organic compounds (VOCs) than cycling in rural areas. According to their report athletes should therefore keep away from smoking environments and avoid car journeys in congested traffic before competition and training, as the temporarily accumulated carbon monoxide (CO) may reach levels that will have detrimental effects on athletes on athletic performance.

Kunzli (2002) reported that habitual exercise in highly polluted localities, such as alongside busy road ways, may increase the overall intensity, duration and frequency of exposure, all of which are relevant to the evaluation an individual's risk profile for disease.
Das et al. (2005) conducted a study to examine whether environmental pollutants had any effect on selected motor ability variables in school-going boys (both football players and untrained boys) of age group 14-16 years in West Bengal and their results concluded that environmental pollutants might have an impact on agility power irrespective of the fact whether the boys were under regular physical training or not.

E. Views regarding nutritional status of school-going boys involved in regular exercise

Nutritional status or nutrienture is the condition of health of an individual as influenced by nutrient intake and utilization in the body. It can be determined with the help of clinical examination of symptoms of nutritional deficiencies, dietary intake, anthropometry and laboratory investigations.

Assessment of the nutritional status of a community helps to estimate the magnitude and map the geographic distribution of malnutrition.

Man needs a wide range of nutrients to lead a healthy and active life and these are derived through the diet he consumes daily. The components of his diets must be chosen judiciously to provide all the nutrients he needs in adequate amounts and in proper proportions. The amount of each nutrient that is required by man depends upon his age and physiological status. Adults need nutrients for maintaining constant body weight and ensuring proper body function. Infants and young children who are growing rapidly require nutrients not only for maintenance but also for growth. They require relatively more nutrients (2-3 times) per kg body weight than adults (Indian Council of Medical Research, 1998). Body weight and height of children reflect their state of health and growth rate. Physical growth, in terms of weight and height, is considered an important parameter reflecting the pattern of growth and development in a community (Khan et al., 1990).

It is very well known that health and nutrition are most important contributory factors for human resource development in the country. India has been classified by the World Bank as a country with a low-income economy with per capita GNP (gross national product) of US $35. It ranks 135th in terms of human development out of 174
countries. Among the Indian population, about 40% in the rural and 30% in the urban areas are estimated to be below the poverty line, which is defined as the expenditure needed to obtain, on the average, 2400 kcal per capita per day in the rural areas and 2100 kcal in urban areas. Long-term malnutrition leads to short adult stature, increased risk of morbidity and mortality and reduced work output (National Institute of Nutrition, 1998).

The school-aged period is nutritionally significant because this is the prime time to build up body stores of nutrients in preparation for rapid growth of adolescence. This period is quite vulnerable and considered to be special risk group. Malnutrition during this period can interfere with school performance, impair body function, working ability and physical growth (Sunita and Jain, 2005). Body requirements of calories are increased steadily. Greatest nutrient need for boys is between 12-15 years and for girls is 10-13 years. With the profound growth of adolescence there are increased demands for energy, protein, minerals and vitamins. The increased requirements of protein would meet demands of growth. Many of our school children consume inadequate diet and so they are malnourished. Calcium and iron are particularly needed during adolescence. Bone growth demands calcium, iron needed for haemoglobin synthesis necessitated by the considerable expansion of blood volume and for myoglobin needed for muscle growth (Srilakshmi, 2002). Children’s height is an important indicator of nutritional status and health of populations (Drachler et al., 2002). Anthropometric measurements of Indian children up to 14 years belonging to well-to-do groups have shown that they grow at rates similar to those of children in the developed countries (Vijaya Raghvan et al., 1971). But if we notice that protein energy malnutrition (PEM), micronutrient deficiencies such as vitamin A deficiency (VAD), iron deficiency disorders (IDA), iodine deficiency disorders (IDD) and vitamin B-complex deficiencies are the nutrition problems frequently encountered, particularly among the poor. Both clinical and sub-clinical undernutrition are widely prevalent even during early childhood. About 1-2% of preschool children suffer from severe and florid forms of PEM like Kwashiorkor and marasmus. Country wide surveys indicate that more than a half of the Indian preschool children (1-5 years) suffer from sub-clinical undernutrition as indicated by low weight for age [<75% of National Centre for Health statistics (NCHS) median weight for age]. About 65% of them are stunted (low height for age), which indicates that under-nutrition is of long duration.
Persistent under-nutrition throughout the growing phase of childhood leads to short stature in adults. Vitamin A deficiency also increased the risk of disease and death in children. More than 50% of preschool children also suffer from anaemia (National Institute of Nutrition, 1998). Thus these conditions adversely affect workout put and learning ability of children.

Gupta (1989) reported that deficiencies of vitamin B complex and vitamin A as well as clinical anemia were common in rural school children (5-17 years old) in villages of Ghat silica as subdivision in Singhbhum district of Bihar State, India. Convulsion disorders, myopia were less common than in urban school children. Their study suggested that nutritional supplementation in schools, regular medical check ups of school children and health education of the community on small family norms could improve the overall health status of rural children.

Khan et al. (1990) measured anthropometric parameters of 776 males and 236 females in the age group of 5-15 years. The comparison made separately for boys and girls showed that the values for both sexes and in all age groups were less than the ICMR (Indian Council of Medical Research) standard and an influence is drawn that rural school children of middle and low socio-economic status are shorter and lighter as compared with even their own counterparts on whom the ICMR values are based.

Devi et al. (1997) assessed the nutritional status of children from both urban and semi-urban areas of Manipur, India. When US (Harvard) standard was used, 64% were classified as having low weight – for age and 66% had protein-energy malnutrition. Malnutrition was more prevalent among girls than boys.

Yadav and Singh (1999) assessed the dietary intake and nutritional status in children of the tribal areas of Bihar. Average intake of energy and other nutrients was lower in all groups as compared to recommended dietary allowances (RDA). Calorie deficiency was 38% where as protein deficiency was about 19%. The level of malnutrition was not very different in rural and urban areas and they concluded that nutritional status and dietary intakes of tribal children in Bihar was very poor.

Ray et al. (2000) carried out a cross-sectional study in a tribal community of West Bengal to study the dietary pattern, household food security and nutritional profile of
under-five children. It was observed that average calorie consumption was 2236 with 48% food insecure families. Cereals, starchy food and green leafy vegetables consumption was higher than the recommended daily allowances while pulses (scarce supply at fair price shops), milk, oil and sugar were less than recommended daily allowances. Nearly 11% Kcal were coming from alcohol consumption. Prevalence of malnutrition in the children under-five years of age was 80.90% and 9.26% were suffering from severe grades. More severely malnourished children were observed in the age group of 12-23 months, among female children, in the families where mothers were working and also in the families where numbers of sibling were 2 or more.

Venkaiah et al. (2002) studied current diet and nutritional status of rural adolescents in India. They selected 120 villages in rural areas of nine states and reported that the major occupation of the heads of households surveyed was agriculture and the per capita income per month was about Rs.250/- at 1996-1997 prices. The prevalence of undernutrition was higher in boys than in girls. The intakes of micronutrients such as vitamin A and riboflavin were woefully inadequate.

Bose and Mukhopadhyay (2004) studied the level of undernutrition among 502 students, 10-16 year old Bengalee boys in an urban area about 20 kms from Kolkata city center and reported that the overall rate of undernutrition was 37.65%. The rates of undernutrition varied between 19.3% among 16 years olds to 53.4% at age 14 years. There was a consistent increase in the rate of undernutrition from 10(36.5%) to 14 years (53.4%). Thereafter, there was a steady incline at age 15 (36.8%) and 16 (19.3%) years.

There is unanimous agreement that regular exercise is essential for optimal function of the human body and optimal fitness and performance are influenced by many factors of lifestyle and training. Nutritional status is an important factor which influence the performance of an individual. Energy needs also increase because of the elevated energy expenditure with physical activity. Fluid intake to ensure the replacement of water and minerals (electrolytes) lost in sweat is important. Acute issues such as heat illness and chronic concerns that include impaired growth and development, and the risk of injuries that include stress fractures may be an outcome of inadequate nutrition during physical training (Petrie et al., 2004).
Burke (2001) reported that each athlete has unique energy requirements, which underpin their ability to meet total nutritional goal. They should use their energy budget to choose foods that provide macronutrient and micronutrient needs for optimal health and performance. Practical advice may help athletes to achieve energy intake challenges.

Burke et al. (2003) undertook a dietary survey of 167 Australian Olympic team athletes (80 females and 87 males) competing in endurance sports (n=41), team sports (n=31), sprint or skill based sports (n=67) and sports in which athletes were weight-conscious (n=28). Analysis of their 7 days food diaries provided mean energy intakes, nutrient intakes and eating patterns. Higher energy intakes relative to body mass were reported by male athletes compared with females and by endurance athletes compared with other athletes. Endurance athletes reported substantially higher intakes of carbohydrate (CHO) than other athletes and were among the athletes most likely to consume CHO during and after training sessions. Athletes undertaking weight conscious sports reported relatively low energy intakes and were least likely to consume CHO during a training session or in the first hour of recovery.

Butterworth et al. (1994) showed the relationship between cardiorespiratory fitness, physical activity and dietary quality in a group of 20 to 40 years old women (n=34) who varied widely in levels of physical activity. Intake of energy (kcal/kg body weight) was higher for the more physically active and fit women, leading to a significant increase in most nutrients consumed per kilogram of body weight.

Chatterjee et al. (2005) assessed nutritional status and motor performance level of junior footballers and sprinters of Kolkata. Diet survey was carried out by oral questionnaire method and nutritive values were calculated. Agility, leg muscle power, speed, hand muscle and strength endurance were measured. Their findings revealed that football players were poor in nutritional status when compared with sprinters. Results concluded that motor performance level was affected by nutritional status of boys and they required a lot of carbohydrate and fat rich food to meet their calorie demand and also the iron rich food to prevent the iron deficiency anaemia.

Ziegler (1982) suggested that nutritional analysis and nutritional support of the youngster participating as an athlete remain an important aspect of any organized
competition program. It is not only critical to recognize the greater caloric, protein and water requirements of children and their lesser energy stores, but it is equally important to adequately advise and formulate a safe and logical dietary regimen for these athletic children. The physician caring for such competing children needs to be fully aware of the nutritional ramifications of athletic competition, especially as they apply to the growing child.

Bar-Or (2001) reported that while nutritional issues are similar for all athletes irrespective of age, children have several physiological characteristics that distinguish them from adults and require specific nutritional considerations. These age or malnutrition-related differences include a greater need for protein intake, to support growth, a greater need for calcium intake, to support bone accretion, a higher energy cost of activities that include walking and running, lower losses of sodium and chloride in sweat, and greater thermoregulatory strain at any given level of hypohydration.

Unnithan and Goulopooulou (2004) suggested that exogenous carbohydrate drinks could be considered for the young athlete engaged in both endurance exercise and high-intensity exercise. Monitoring of the energy intake during resistance training in the pediatric athlete need to be considered, as there is evidence to suggest that energy deficits may occur. If decrements in exercise performance are noted, then serum ferritin and haemoglobin concentrations should be monitored, as non anemic iron deficiency is prevalent the pediatric athlete.