CHAPTER II

REVIEW OF RELATED LITERATURE

A careful search and exploration of the related literature with regard to the present study was essential to have an insight into the work already done. The scholar with the available literature has gained valuable methodological hints from their procedures and findings and they were of great importance and help during the course of this study.

Hakkinen et al., (2010) conducted a study to investigate the impact of cardiovascular and musculoskeletal physical fitness level on HRQoL in Finnish young men. In this cross sectional study, the investigator collected data regarding the physical fitness index, including aerobic endurance and muscle fitness, leisure time physical activity (LTPA), body composition, health, and HRQoL (RAND 36) for 727 men [mean (SD) age 25 (5) years]. Associations between HRQoL and the explanatory parameters were analyzed using the logistic regression analysis model. The results showed that, 45% were in the poor category of physical fitness, while 37% and 18% were in the satisfactory and good fitness categories respectively. A higher frequency of LTPA was associated with higher fitness (p < 0.001). Better HRQoL in terms of general health, physical functioning, mental health and vitality were associated with better physical fitness. When the HRQoL of the study
participants were compared with that of the age and gender weighted Finnish general population, both the good and satisfactory fitness groups had higher HRQoL in all areas other than bodily pain. In a regression analysis, higher LTPA was associated with three dimensions of HRQoL, higher physical fitness with two and lower number of morbidities, with all dimensions, while the effect of age was contradictory. The conclusions of this study indicate that higher physical fitness and leisure time physical activity level promotes certain dimensions of HRQoL, while morbidities impair them all. The results highlight the importance of health-related physical fitness while promoting HRQoL.

Mak et al., (2010) conducted a study to investigate the relationship between health-related physical fitness and weight status in Hong Kong adolescents. 3,204 students age between 12-18 years participated in the Hong Kong Student Obesity Surveillance (HKSOS) project in 2006-2007. Anthropometric measures (height, weight) and health-related fitness (push-up, Sit-ups, Sit & reach, 9 minute run) were assessed. Body Mass Index (BMI) was computed to classify participants into normal weight, underweight (Grade I, II/III), overweight and obese groups. The associations of health-related physical fitness with BMI and weight status were examined by partial correlation coefficients and analysis of covariance respectively. The results do indicates that, more boys than girls were overweight or obese (18.0% vs 8.7%), but more girls than boys were underweight (22.3% vs 16.7%). Boys
performed significantly ($P < 0.001$) better in Sit-ups (38.8 vs 31.6 times/min) and 9 minute run (1632.1 vs 1353.2 m), but poorer in Sit & reach (27.4 vs 32.2 cm) than girls. All four physical fitness tests were significantly positively correlated with each other in both sexes, and BMI was only weakly correlated with Sit-ups and Sit & reach tests in boys. Decreasing performance ($P$ for trend $< 0.05$) was observed from normal weight to overweight and obese for push-up, Sit-ups, and 9 minute run in both sexes. From normal weight to Grade I and Grade II/III underweight, decreasing performance ($P$ for trend $< 0.05$) for Sit-ups and Sit & reach in both sexes and for push-up in boys was observed. Based on the results the following conclusions were drawn. The relations between BMI and health-related physical fitness in adolescents were non-linear. Overweight/obese and underweight adolescents had poorer performance in push-up and Sit-up tests than normal weight adolescents. Different aspects of health-related physical fitness may serve as immediate indicators of potential health risks for underweight and overweight adolescents.

Albon, Hamlin and Ross (2010) in the light of declining over time New Zealand children's health and fitness performance (but whether this change is because of deterioration in all children's health and fitness performance or can be attributed to just a certain portion of the population, is unknown). Hence, the investigators conducted this study in which secular trends and distributional changes in health-related and performance-related fitness
components among New Zealand primary school children aged 10 to 14 years between 1991 and 2003 were tracked. Health and performance-related fitness parameters including height, weight, Body Mass Index (BMI), flexibility, standing broad jump, 4x9m agility run, abdominal curl-ups and 550m run were collected up to twice a year from 3306 children (10-14 years old) from a New Zealand school between 1991 and 2003. The results showed that, over the 12 year period, the boys' weight increased by 4.5 kg (95% CL 2.7 to 6.2, or 0.8% per year) and girls' by 3.9 kg (95% CL 2.0 to 5.9, or 0.7% per year). Mean BMI increased by 0.12 kg/m\(^2\) (0.6%) and 0.11 kg/m\(^2\) (0.5%) per year for boys and girls respectively. Children's 550m run performance declined by 1.5% and 1.7% per year for boys and girls respectively. Little difference existed between children located in the highest performing and leanest percentiles in 1991 and 2003, but for children in the poorest performing and fattest percentiles, their results were substantially worse in 2003. These results indicate the deterioration in the health-related and performance-related fitness components of New Zealand 10 to 14 year olds is not homogeneous but skewed towards those children who are the heaviest and have performed worst in fitness tests. Previous research on health-related fitness parameters among children in New Zealand is limited but shows secular trends of increasing body mass in conjunction with deteriorating aerobic fitness performance, muscular endurance and explosive muscular power. Internationally, similar increases in body mass have been observed in children.
since the 1980s. Secular trends of deteriorating health-related fitness performance have also been reported among children around the world, with the most significant decreases observed in aerobic performance. However, trends in health-related variables reported as changes in mean Body Mass Index (BMI) and mean aerobic fitness performance do not reveal possible changes in the distribution of BMI or aerobic performance within the population. Changes in such measures may come about because of a shift in the entire population under investigation or a change in a portion of the population. It is not clear whether New Zealand's entire childhood population is becoming heavier and less aerobically fit or whether only a portion of the children are becoming even heavier and more unfit, with the remaining children showing little secular change.

Yuan et al., (2009) conducted a study to assess the effects of exercise intervention on nurses' health-related physical fitness. Regular exercise that includes gymnastics or aerobics has a positive effect on fitness. In Taiwan, there are not much data which assess the effects of exercise intervention on nurses' health-related physical fitness. Many studies have reported the high incidence of musculoskeletal disorders (MSDs) in nurses. However, there has been limited research on intervention programmes that are designed to improve the general physical fitness of nurses. A quasi-experimental study was conducted at a medical centre in central Taiwan. The subjects were Ninety nurses from five different units of a hospital volunteered to participate.
in this study and participated as an experimental group and a control group. The experimental group was engaged in a three month intervention programme consisting of treadmill exercise. Indicators of the health-related physical fitness of both groups were established and assessed before and after the intervention. The results before intervention shows that, the control group had significantly better grasp strength, flexibility and durability of abdominal muscles than the experimental group (p < 0.05). After the intervention, logistic regression was used to adjust for marital status, work duration, regular exercise and workload and found that the experimental group performed significantly better (p < 0.05) on Body Mass Index, grasp strength, flexibility, durability of abdominal and back muscles and cardiopulmonary function. On the basis of the results, the following conclusions were drawn, which indicates that the development and implementation of an intervention programme can promote and improve the health-related physical fitness of nurses.

Artero et al., (2009) conducted a study to investigate the differences in health-related fitness (20 m shuttle run, handgrip, bent arm hang, standing long jump, shuttle run 4 x 10 m and Sit & reach tests) in 2474 Spanish adolescents (1196 boys and 1278 girls of age 13 to 18.5 years) classed as underweight, normal weight, overweight or obese according to Body Mass Index. Body fat and fat-free mass were derived from skinfold thickness. The prevalence of underweight was higher than obesity in girls (4.8% vs 3.0%,
respectively; P<0.05) and the opposite in boys (3.9% vs 5.8%, respectively; P<0.05). Underweight was associated with a higher performance in the bent arm hang test in girls (P<0.05) and a lower performance in handgrip in both genders (P<0.01) compared with normal weight. Overweight and obese adolescents presented a lower performance in 20 m shuttle run, bent arm hang, standing long jump and shuttle run 4 x 10 m tests (P<0.001), but a higher performance in handgrip strength (P<0.001) compared with normal weight. In weight bearing tests, the association became non significant after adjusting for fat mass. Thus it was concluded that not only overweight and obesity but also underweight seem to be determinants of health-related fitness in adolescents and the associations could be related to differences in body composition.

Hands et al., (2009) studied on motor competence (measured by the McCarron Assessment of Neuromuscular Development), pedometer determined physical activity and physical fitness (aerobic fitness, muscle strength, muscle endurance, flexibility and body composition) were examined in a cohort of 1585 adolescents (771 girls, 814 boys) of mean age 14.06 years. Significant gender differences were observed for all measures except motor competence. Apart from hip and shoulder flexibility, males outperformed females. For both males and females, motor competence was associated with all fitness measures, physical activity was associated only with aerobic fitness and aerobic fitness was associated with physical activity, motor competence,
BMI and chest pass. Among males, aerobic fitness was also associated with all other fitness tests. The correlations were in general, moderate to weak. The results challenge the current focus on physical activity rather than physical fitness as the preferred intervention.

Powell *et al.*, (2009) in the light of the nationwide epidemic of obesity may be partly due, to the declining levels of physical activity, raising the possibility that other components of health-related physical fitness may also be in decline. Few data were available to describe and monitor the physical fitness of children and youth. The Georgia Youth fitness assessment was conducted to assess health-related fitness in Georgia's fifth and seventh grade students, which provided a baseline from which future progress could be measured, and guide public and private leaders and decision makers. Based on which, the investigator conducted a statewide probability sample study of fifth and seventh grade students designed to enable grade specific comparisons by gender, race/ethnicity and urban/rural status. Ninety three schools (86% response rate) and 5248 students (77% response rate) participated. The measurements taken included aerobic capacity, body composition muscular strength, endurance and flexibility. Physical activity during the most recent 3 days was assessed. The survey was conducted in 2006 and the data were analyzed in 2007-2008. The results showed that fifty two percent of students did not meet the standard for healthy aerobic fitness; 23% did not meet the standard for muscular strength, endurance and
flexibility; 30% were outside the recommended range for BMI. Twenty two percent did not achieve the recommended 60 minutes of daily moderate to vigorous physical activity. All subgroups (e.g., boys/girls, urban/rural) scored poorly. On the basis of the results of the study, it was concluded that substantial numbers of Georgia's fifth and seventh grade students exhibit unhealthy levels of physical fitness. These data are consistent with the suggestion that physical inactivity has led to deficient levels of health-related fitness in more areas than just body composition. Monitoring all components of health-related fitness would provide helpful information about the health of children and youth.

Tremblay et al., (2009) conducted a study on the fitness of Canadian children and youth. The fitness of Canadian children and youth has not been measured in more than two decades, a period during which childhood obesity and sedentary behaviours have increased. This study provides up-to-date estimates of the fitness of Canadian aged 6 to 19 years. Data are from the 2007-2009 Canadian Health Measures Survey (CHMS), the most comprehensive direct health measures survey ever conducted on a rationally representative sample of Canadians. Descriptive statistics for indicators of body composition, aerobic fitness and musculoskeletal fitness are provided by sex and age group, and comparisons are made with the 1981 Canada Fitness Survey (CFS). Fitness levels for children and youth have declined significantly and meaningfully since 1981, regardless of age or sex.
Significant sex differences exist for most fitness measures. Fitness levels change substantially between ages 6 and 19 years. Youth aged 15 to 19 years generally have better aerobic fitness and body composition indicators than 20 to 39 year olds.

Chung, Chung and Chen (2009) conducted a study to compare the physical fitness levels of Hong Kong and mainland Chinese school children and to study the association between any differences and their respective lifestyles. This survey study was done in the light of the background such as Genes and lifestyles are both factors contributing to health. Hong Kong is a Chinese city with distinctive lifestyle features such as a different diet, different entertainment and education from the rest of China. Using samples of the same ethnicity and investigating differences in physical fitness parameters between Hong Kong and mainland Chinese school children might reveal the impact of some lifestyle factors on health. Primary school children (n = 522) acted as subjects and the demographic data were collected by questionnaire while Physical measurements were assessed using standard tests. The result showed significant differences in height, body weight, Sit & reach, long jump, running 50 m and lung capacity. Hong Kong children were found to be taller and heavier at ages 6 and 7 years, but heavier with similar height to that of mainland children at ages 8 to 12 years. Other results showed better physical fitness on the part of mainland children. The investigator's justification of the findings is that, the people of Hong Kong shared the same
ethnicity as the majority of mainland Chinese, the eastern mixed with western diet, education and entertainment of Hong Kong children differs greatly. The findings in terms of physical fitness revealed variations in body build flexibility, cardiovascular function and muscle power between the two groups. Based on the results, it was concluded that lifestyle could possibly be a key factor and predictor of physical fitness, providing strong evidence to support the interaction between lifestyle and genes in their impact on health. Thus, lifestyle could possibly be a key factor and predictor of physical fitness and health outcomes.

Ortega et al., (2008) conducted a study to examine the reliability of a set of health-related physical fitness tests used in the European Union funded Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA). The study was done on lifestyle and nutrition among adolescents, for which, a set of physical fitness tests were taken twice from the selected sample, 2 weeks apart. The subjects were 123 adolescents (69 males and 54 females, aged 13.6+/0.8 years) and were from 10 European cities. The selected variables were flexibility, muscular fitness, speed/agility and aerobic capacity were tested using the back saver Sit & reach, handgrip, standing broad jump, Bosco jumps (squat jump, counter movement jump and Abalakov jump), bent arm hang, 4 x 10m shuttle run, and 20 m shuttle run tests. The results showed that neither systematic bias nor sex differences were found for any of the studied tests, except for the back saver Sit & reach test, in which a borderline
significant sex difference was observed (P=0.044). The Bland Altman plots graphically showed the reliability patterns, in terms of systematic errors (bias) and random error (95% limits of agreement), of the physical fitness tests studied. The observed systematic error for all the fitness assessment tests was nearly 0. Based on the results the following conclusions were drawn such as neither a learning nor a fatigue effect was found for any of the physical fitness tests when repeated. The results also suggest that reliability did not differ between male and female adolescents. Collectively, it can be stated that the reliability of the set of physical fitness tests examined in this study is acceptable. The data provided contribute to a better understanding of physical fitness assessment in young people.

Fogelholm et al., (2008) studied the associations of overweight (OW, BMI =85th percentile) and physical activity (PA) with physical fitness in adolescents. The nationally representative sample was 1120 boys and 1146 girls, aged 15-16 years. Height and weight were self-reported. The level of PA was based on self-reported frequency and duration of sweating during organized and non-organized activity. Fitness was measured by Sit-ups, Sit & reach, five jump, back and forth jumping, ball skills, coordination and endurance shuttle run tests. The fitness index was calculated as the mean of z scores for individual tests. The prevalence of OW was 17.3% in boys and 11.8% in girls. The main effect of PA (in analysis of variance) on all fitness tests was significant (P< or =0.005). The main effect of OW was significant
(P<0.002) for all tests, except for Sit & reach. According to linear regression models, the association between PA and fitness was stronger than that between OW and fitness. Sit-ups, endurance shuttle run and fitness index showed the strongest association with PA (standardized beta coefficients 0.31-0.49). OW was not associated with Sit & reach test (coefficient 0.04) and only weakly with the ball skills test (coefficients 0.10 to 0.12). In conclusion, OW had the most negative association with cardio-respiratory, muscle endurance and explosive power tests.

Ortega et al., (2008) conducted a study on health-related physical fitness according to chronological and biological age in adolescents. Physical fitness has been proposed. The aim of the present study was to determine the levels of several health-related physical fitness components with respect to chronological and biological age (sexual maturation status) in Spanish adolescents. Physical fitness was measured in a sample of Spanish adolescents (N=2 859: 1 357 males, 1502 females) from the AVENA study, by means of the following tests; sit and reach, handgrip, standing broad jump, bent arm hang, 4x10 m shuttle run, and 20 m shuttle run. Percentage body fat, fat free mass and leisure time physical activity were used as confounders. Adolescents were classified according to chronological age and biological age (measured by Tanner stages). All the analyses were adjusted for the above mentioned confounders. Muscular fitness was higher in older adolescents than in younger adolescents. Cardio respiratory fitness was higher in younger
compared to late puberty. In males, cardio respirator fitness was higher in younger adolescents, but no differences were observed when it was analysed according to sexual maturation status. Normative data for several health-related physical fitness components according to chronological and biological age are provided in this report. Discrepancies between biological and chronological age analysis were higher for cardio respiratory fitness than for muscular fitness.

Towar et al., (2008) conducted a study to determine the prevalence of overweight and obesity and its association with physical activity and fitness among boys attending a private school in Bogotá, Colombia. 655 boys between 7 and 18 years self-reported their physical activity habits and underwent anthropometric (weight, height, fat percentage by bioelectrical impedance) and physical fitness measurements (PACER, Sit & reach, curl-ups, push-ups and hand dynamometry). The association between weight status and physical activity and fitness were assessed by logistic regression models. The outcome was that 38% of the boys were overweight according to the BMI of the Colombian population (WHO criteria), 17.7% according to international BMI cut-offs and 16.9% showed values of % fat over 25 (Fitness gram criteria). A relation was found between being overweight and having poor performance in the aerobic fitness test (adjusted OR: 3.7, IC 95%: 1.6-8.3) and reported not walking or riding a bicycle for atleast 30 minutes, 5 times a week (OR adjusted 3.6, IC 95%: 1-13.0). These results did not change
when different criteria to define overweight was applied. The best level of
agreement for overweight classification was found between fat % and the
international BMI cut-offs (kappa=0.616, p<0.001). Overweight was not
associated to TV watching time, video games or use of internet. The final
conclusion was that, the prevalence of overweight was high in this population
of school aged boys. There was a significant relationship between poor
physical fitness, low levels of physical activity and overweight. It is important
to encourage and monitor children's levels of physical activity as well as the
results of fitness test for the prevention of overweight and related cardio-
metabolic complications.

Aires et al., (2008) conducted a study to establish physical fitness (PF)
levels in a school population of 11 to 18 year old students and analyse
differences according to Body Mass Index (BMI) status in overweight This
being a cross sectional study, the sample comprise of 636 children and
adolescents (mean age of 14.5+/1.5 years), 288 boys (45.3%) and girls 347
(54.7%). Six tests from Fitness gram battery were used as an objective
measure of physical fitness. Overweight/ Obesity status was determined using
age and sex adjusted cut-off points. The results showed that both girls and
boys with obesity performed a significantly reduced number of tests in
healthy fitness zone suggesting a decrease of performances in strength and
cardiovascular fitness, from normal weight status to overweight and from
overweight to obesity. Boys and girls with obesity are likely to be Under HFZ
than normal weight. The results suggest that obese and overweight children have low Physical Fitness level compared to normal weight peers. A large number of children with normal weight were identified as well as unfit. These data also showed that a low BMI level would significantly improve some PF component.

Ortega et al., (2008) conducted a study to determine the levels of several health-related physical fitness components with respect to chronological and biological age (sexual maturation status) in Spanish adolescents. Physical fitness was measured in a sample of Spanish adolescents (N. = 2859; 1357 males, 1502 females) from the AVENA study, by means of the following tests: Sit & reach, handgrip, standing broad jump, bent arm hang, 4 x 10 m shuttle run, and 20 m shuttle run. Percentage body fat, fat free mass and leisure-time physical activity were used as confounders. Adolescents were classified according to chronological age and biological age (measured by Tanner stages). All the analysis were adjusted for the above mentioned confounders. The results showed that, muscular fitness was higher in older adolescents than in younger adolescents. Cardio-respiratory fitness was higher in younger when compared to older females, as well as in early puberty compared to late puberty. In males, cardio-respiratory fitness was higher in younger adolescents, but no differences were observed when it was analysed according to sexual maturation status.
Ortega et al., (2008) conducted a study to examine the reliability of a set of health-related physical fitness tests used in the European Union funded Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study on lifestyle and nutrition among adolescents. A set of physical fitness tests were performed twice in a study sample, 2 weeks apart, by the same researchers. The subjects were a total of 123 adolescents (69 males and 54 females, aged 13.6+/0.8 years) from 10 European cities participated in the study. Flexibility, muscular fitness, speed/agility and aerobic capacity were tested using the back saver Sit & reach, handgrip, standing broad jump, bosco jumps (squat jump, counter movement jump and Abalakov jump), bent arm hang, 4 x 10 m shuttle run and 20m shuttle run tests. The results indicated that the ANOVA analysis showed neither systematic bias nor sex differences for any of the studied tests, except for the back saver Sit & reach test, in which a borderline significant sex difference was observed (P=0.044). The Bland Altman plots graphically showed the reliability patterns, in terms of systematic errors (bias) and random error (95% limits of agreement), of the physical fitness tests studied. The observed systematic error for all the fitness assessment tests was nearly 0. Neither learning nor a fatigue effect was found for any of the physical fitness tests when repeated. The results also suggest that reliability did not differ between male and female adolescents. Collectively, it can be stated that, the reliability of the set of physical fitness
tests examined in this study is acceptable. The data provided contribute to a better understanding of physical fitness assessment in young people.

Volbekiene and Griciute (2007) have found that in the light of socioeconomic transformation over the previous decade have identified among Lithuanian children a less active lifestyle and a decline in fitness. Accordingly, the investigators conducted a study to analyse the differences in health-related fitness among under 12, under 14 and under 16 year old Lithuanian boys and girls from 1992 to 2002. The height and weight of the children were measured, and the Eurofit test battery was used to analyse the children's fitness. For the analyses of differences, 2,009 children aged 12 (n = 697), 14 (n = 733), and 16 (n = 579) years were tested. The results showed that boys and girls of all three age groups performed better in the Sit & reach test (12.4-19.8%, p<0.001) and in the 20 m shuttle run test (30.0-46.0%, p<0.001) but did fewer Sit-ups (3.5-7.3%, p<0.05) in 1992 when compared with the results in 2002. The girls' performance was better in the broad jump test (4.9-5.5%, p<0.001) in 1992 than in 2002. These differences were not significantly influenced by weight, Body Mass Index (BMI), and "height+BMI". From the results, it was concluded that there was a marked decrease in aerobic fitness and flexibility and a slight increase in abdominal muscle endurance among Lithuanian schoolchildren. Leg muscular power decreased slightly in girls but remained unchanged in boys. A decrease in daily physical activity is the most likely contributing factor to the decrease in
aerobic fitness and flexibility and PE reform has not been able to compensate for this effect.

Bovet, Auguste and Burdette (2007) has in the light of coming season many studies examining the relationship between physical fitness and obesity in children and have had mixed results despite their interrelationship making intuitive sense. They later examined the relationship between physical fitness, overweight and obesity in a large sample of adolescents in the Republic of Seychelles (Indian Ocean, African region). All students of four grades of all secondary schools thus a total of 2203 boys and 2143 girls from a total of 4599 eligible students aged 12-15 years performed nine physical fitness tests. These tests assessed agility, strength and endurance and included the multistage shuttle run, a validated measure of maximal oxygen uptake. Weight and height were measured, Body Mass Index (BMI) calculated and "overweight" and "obesity" were defined based on the criteria of the International Obesity Task Force. Later "lean" weight was defined as age and sex specific BMI <10th percentile. Age and sex specific percentiles for each fitness test were calculated. "Good" performance was defined as a result >or=75th percentile. The prevalence of overweight (including obesity) was 11.2% (95% confidence interval: 9.9-12.4) in boys and 17.5% (15.9-19.1) in girls. For 7 of the 9 tests, the relationship between BMI and fitness score, as assessed by locally weighted regression, was characterized by a marked inverse J shape. Students with normal body weight achieved "good"
performance markedly more often than overweight or obese students on 7 of
the 9 tests of fitness and more often than lean children. For example, good
performance for the multistage shuttle run was achieved by 25.6% (SE: 2.1)
of lean students, 29.6% (0.8) of normal weight students, 7.9% (1.3) of
overweight students and 1.2% (0.9) of obese students. On the basis of the
results, the investigator concluded that a strong inverse relationship between
fitness and excess body weight in adolescents. Improving fitness in
adolescents, likely through increasing physical activity, might need special
interventions that are responsive to the ability and needs of overweight
children.

Hussey et al., (2007) conducted a study to investigate the relationship
between the time spent in specific intensities of activity and inactivity, cardio-
respiratory fitness and body composition in children. A cross sectional study
was conducted in a random sample of 12 schools. Height, weight and waist
circumference were measured in 224 children aged 7 to 10 years. Cardiorespiratory fitness was estimated by the 20 m multistage running test, and
physical activity was measured over 4 days by the RT3 (a triaxial
accelerometer) and later the time spent during each day in moderate and
vigorous intensities of activity was calculated. Body composition and fitness
data were obtained for 224 children and activity data for 152 children. The
results do indicates that, boys were found to take part in about twice as much
vigorous and hard activity as girls (mean (95% confidence interval) 64.3 (53.2
to 75.4) min in boys compared with 37 (33.1 to 40.9) min in girls; p<0.001).
In boys there was significant difference between those defined as normal,
overweight and obese in the time spent in vigorous activity (p<0.05), but no
such difference was found in girls. A significant negative correlation between
waist circumference and time spent in vigorous activity (r = 0.31, p<0.05) was
found in boys but not in girls. The duration of time spent by the sedentary
group was positively correlated with waist circumference in boys (r = 0.33,
p<0.01) but not in girls. In both boys and girls there were significant negative
correlations between fitness and both Body Mass Index (r = 0.274, p<0.001)
and waist circumference (boys: r = 0.503, p<0.01; girls: r = 0.286, p<0.01).
From the results, it was concluded that body composition in boys was
inversely related to fitness and to vigorous activity and was positively related
to inactivity. In girls, body composition was related to fitness but not to
specific components of physical activity.

Ara et al., (2007) conducted a study to determine the relationship
between physical activity (PA) levels and adiposity. The secondary purpose
was to assess the effect of physical fitness and living area on adiposity. The
cross sectional study was carried out in a regional representative sample of
1068 children of 7 to 12 years of age. Anthropometric and physical fitness
values (including BMI, aerobic capacity, strength levels, velocity assessment,
and flexibility) were measured in all children. The results showed that, the
prevalence of being overweight and obese in the entire sample was 31% and
6%, respectively. No difference between urban and rural children was found. The proportion of boys who were classified as overweight and obese was similar in physically active and sedentary (non-physically active) groups. However, physically active girls tended to show lower obesity prevalence when compared with their sedentary counterparts (p = 0.06). In girls, the sum of 6 skinfolds thickness (SSF) measurements was lower in the physically active group when compared with the non-physically active group (p < 0.05); however, this effect was not observed in boys. Multiple regression analysis revealed that the level of physical activity (PA) had a significant effect on BMI and SSF in boys but not in girls, while maximal oxygen uptake (VO2max) was significantly related to adiposity in both sexes. Based on the results, it was concluded that regular participation in at least 2 hours per week of sports activities on top of the compulsory education programme is associated with better physical fitness and lower whole body adiposity. Among children included in this study, among all physical fitness variables, VO2max showed the strongest relationship with BMI and fat mass assessed by means of skinfold measurement.

Brunet, Chaput and Tremblay (2007), conducted a study to evaluate physical fitness and body composition of children involved in the 'Québec en Forme' (QEF) Project and to compare data obtained to the reference values of the 1981 Canada Fitness Survey (CFS). The subjects were 1140 children (591 boys and 549 girls) of first (7 years), second (8 years) and fourth (10 years)
grade from primary schools in the City of Trois Rivières (Québec). Body Mass Index (BMI) and waist circumference (WC) were measured, apart from physical fitness variables such as standing long jump, 1 min speed Sit-ups and speed shuttle run. The results showed that prevalence of overweight in children ranged between 20 and 30%, which represents a substantial increase compared to the 1981 CFS. The relationship between BMI and WC was highly significant in boys and girls (r=0.90 and 0.86, respectively, P<0.0001). The negative correlations between BMI or WC and the performance in all physical fitness tests were mostly significant in children of both genders (0.16 < or = r < or = 0.45, at least P<0.05) and these relationships were significantly greater in older children (P<0.05). Based on the 1981 CFS, only 4.7-14.1% of QEF boys still performed in the upper quartile of the distribution (fit boys), whereas 32.1-69% performed not much higher than the lower quartile (unfit boys) for each fitness test. In girls, the relative fitness decrease observed in 2003 was more pronounced since only 1-9.9% of subjects performed in the upper quartile of the distribution compared to 42.8-81.4% who did not perform higher than the lower quartile of the 1981 reference scores of the CFS. From the results, it was concluded that BMI and WC are negatively correlated with physical fitness and that these associations are more pronounced in older children. Furthermore, physical fitness of our cohort, especially in girls, was much lower than what was documented in the 1981 CFS in subjects of the same age. This study thus emphasizes the necessity to
develop early interventions to improve physical fitness in children and to prevent the increase of childhood obesity.

Mikkelsson et al., (2006) conducted a study to find out the relationship between adolescent physical fitness and adult health-related fitness. Forty five subjects (20 males, 25 females) participated in physical fitness tests in 1976 and again in 2001. The adolescent physical fitness tests were distance running (2,000 m for boys or 1,500 m for girls), 50 m run, Pull-ups (boys) or flexed arm hangs (girls), shuttle run, a 30 sec Sit-up test, standing broad jump, hand grip test, and Sit & reach test. The adult health-related physical fitness index (APFI) stratified by sex was formed by summing the z scores of a bicycle ergometer test, Sit-up test, hand grip test and Sit & reach test. Height and weight adjusted correlations between adolescence and adulthood for exactly similar tests for men and women were, respectively, 0.74 (95% CI, 0.44-0.89) and 0.53 (95% CI, 0.17-0.76) in Sit & reach tests, 0.41 (95% CI, 0.04 to 0.72) and 0.55 (95% CI, 0.20-0.78) in Sit-up tests, and 0.53 (95% CI, 0.11-0.44) and 0.44 (95% CI, 0.05-0.71) in hand grip tests. When all adolescent tests were put in regression analysis together with BMI in 2001, the significant explanatory factors for APFI were distance running ability and the Sit & reach test for men and Sit-up test, flexed arm hang and BMI in 2001 for women.
Frey and Chow (2006) in the light of the negative impact of obesity on physical fitness and motor abilities has been documented in youth of various ages; however, this issue has not been explored in youth with mild intellectual disabilities (ID). Youth with ID are considered more overweight, less physically fit and less motor proficient than peers without ID, so it is important to determine if these variables are associated in this population. Accordingly, the investigator conducted a study in 2006 to examine the relationship between Body Mass Index (BMI), physical fitness and motor skills in a large sample of youth with mild ID. A systematic, stratified sampling method was used to select 444 youth with mild ID, aged 6-18 years, from eight special education schools in Hong Kong. Physical fitness was assessed using items from the national Hong Kong assessment: 6 (ages 6-8 years) or 9 (ages 9-18 years) minute run, Sit-ups, isometric push-up, Sit & reach and sum of skinfold. Functional motor skills were assessed in 244 youth from the fitness sample using the Test of Gross Motor Development II. Besides, the subjects were categorized into normal or overweight/obese BMI groups based on international cutoff points. The results showed that approximately 20% of the sample was classified as overweight/obese (average BMI normal = 17.47+/2.69; overweight/obese = 24.78+/4.05). ANCOVA controlling for age and gender revealed group differences in the run (P = 0.001) and push-ups (P = 0.05), but not in the motor or other fitness variables. After controlling for age and gender, BMI was correlated with the
run \((r = 0.27, P < 0.001)\) and push-ups \((r = 0.18, P = 0.008)\). Age and gender were entered as the first block in hierarchical regression and accounted for most of the variance in all dependent variables, except Sit & reach. The inclusion of BMI in the second block added to the model for run and push-ups only \((\text{delta}R^2 \text{ run} = 0.04, \text{push-ups} = 0.03, P < 0.001)\). Based on the results, it was concluded that overweight/obesity is minimally associated with aerobic fitness and muscular strength in youth with mild ID. BMI did not impact other fitness measures (Sit-ups and Sit & reach) or motor skills in the sample. The undesirable level of overweight/obesity in this sample requires increased attention and immediate intervention.

Cheng et al., (2006) conducted a study to examine the prevalence of childhood and adolescent obesity in Taiwan and to investigate the association between excess weight, physical fitness and blood pressure. The subjects were a total of 13,935 children and adolescents aged 6-18 years (boys: 7031, girls: 6904) were involved in the 1999 survey and 24,586 (boys: 12,367, girls: 12,219) were available in the 2001 survey. The various selected variables such as weight, height, systolic and diastolic blood pressures and health-related fitness tests (bent-leg curl-ups, Sit & reach test and step test) were measured. The results showed overall prevalence of obesity (including overweight) in boys were 19.8% in 1999 and 26.8% in 2001. It was lower in girls with 15.2% in 1999 and 16.5% in 2001. The normal weight group performed better \((P < 0.05)\) than the overweight/obese group in all fitness tests.
except in the 2001 Sit & reach test where there were no differences between
the two groups. The risk of hypertension increased nearly two times for the
overweight/obese fit group and nearly three times for the overweight/obese
unfit group compared to the normal weight fit group (adjusted odds ratio
(AOR)=1.93, 95%CI=1.514-2.451 and AOR=2.93, 95%CI=2.493-3.454,
respectively). Based on the results, it was concluded that the findings
demonstrated an increasing trend in overweight/obesity prevalence for
Taiwanese youth even in a 2 year period. The overweight/obese youngsters
tend to have poorer muscular strength and cardiovascular endurance than the
normal weight group. The overweight/obese and unfit group had a greater risk
of hypertension than other groups. However, this risk was significantly lower
if obese/overweight children had a higher than average level of cardiovascular
fitness.

Mota et al., (2006) conducted a study to examine differences of cardio-
respiratory fitness (CRF) among weight groups and the associations of CRF
with obesity (Body Mass Index) in a sample of young children. Anthropometric data (height, body mass and two skinfolds) were collected for
255 healthy children aged 8-10 years (127 boys and 128 girls). Children were
placed in three groups (nonobese, overweight and obese), using Body Mass
Index (BMI) sex and age specific cutoff points. Cardio-respiratory fitness was
assessed with a 1 mile run test. Participants were divided into two groups such
as fit and unfit, according to age and sex specific scores defined by
FITNESSGRAM. The prevalence of overweight (30.5% vs. 29.1%) and obesity (13.2% vs. 12.6%) was at the same magnitude for boys and girls. Overall, 109 children (42.7%) were overweight and obese. Sums of skinfolds, weight and BMI were significantly lower (P < 0.05) in lean boys and girls compared to their overweight and obese counterparts. Regarding height, no significant differences were found in girls, while in boys, significant differences were only found between non-obese and obese. No differences were found in obesity groups according to CRF in boys, while significant differences were found for girls (P < 0.01). Logistic regression analysis showed that girls who were overweight (odds ratio = 0.05, P = 0.000) or obese (odds ratio = 0.09, P = 0.001) were likely to be unfit. No significant results were found in boys. Overweight and obese children presented higher sums of skinfolds and weight compared with their lean counterparts. Increased BMI was significantly associated with lower CRF in girls. Thus, our data clearly showed potential gender differences of body composition in CRF, which would be of great clinical significance. Therefore, even at young ages, at least for girls, the beneficial impact of low BMI values on CRF is shown with important clinical and public health implications.

Leyk et al., (2006) in the light of a sedentary lifestyle in westernized countries in conjunction with a hypercaloric diet has caused an increase in the number of obese adults. Moreover, recent studies suggest that the prevalence of overweight in children increased during the last decade. However, the
literature has to be interpreted with some caution, since the majority of epidemiological studies examining health; fitness and obesity rely on self-reported data rather than measurements. A further limitation is that most of the studies examine either physical activity or nutrition and only a few deal with both aspects simultaneously. In the present study the investigator analyzed both aspects in more than 58,000 persons aged between 17 and 26 years. All of them were applicants for the German Bundeswehr, which accepts only volunteers with school leaving certificates and a Body Mass Index (BMI) below 30 kg/m$^2$. The admitted subjects performed a Physical Fitness Test (PFT) consisting of 5 simple tests (shuttle run, Sit-ups, push-ups, standing broad jump and Cooper test). For 23,000 subjects additional measurements of body height and body weight as well as information about their education level were available and these data were combined with the PFT results. The results showed a large deficit in the physical fitness of young adults, as more than 37 % of the participants failed to pass the PFT, with failure rates of the male volunteers increasing significantly since 2001. While the female volunteers showed virtually constant body weight and BMI, the corresponding values of men increased monotonously between the age of 17 and 26 years. Besides, it was found that Physical Fitness was positively and BMI negatively correlated with education level. The present findings suggest that body weight increases and fitness decreases in non-obese young adults in Germany. Despite the correlations between BMI and physical fitness the
terms "overweight" and "physically unfit" should not be regarded as synonyms.

Santilla et al., (2006) conducted this population based study which described fitness profiles in aerobic capacity (N = 387088) during the years 1975-2004, muscle performance (N = 280285) from 1982 to 2003 and body anthropometry (N = 324911) from 1993 to 2004 among the Finnish conscripts at the age of 20 yr. Endurance performance was tested by the 12 min running test. Muscle fitness tests consisting of Sit-ups, push-ups, Pull-ups, a back muscle test and standing long jump were scored to muscle fitness index (MFI). The results showed that, the mean body mass of the conscripts increased from 70.8 to 75.2 kg (P < 0.01) during the years 1993-2004. The mean distance of the conscripts' 12 min running test increased first by 4% from 1975 to 1979, but after it had decreased by 12% (from 2760 m to 2434 m, P < 0.001) when compared with the year 2004. MFI increased during the first decade of the follow-up, but thereafter, the number of conscripts who achieved excellent and good MFI decreased from 66.8 to 41.2% (P < 0.001) during the years 1992-2004. The physical ability of the conscripts to meet military service declined during the last 15 years.

Monyeki et al., (2005) conducted a study to determine the relationships between the body composition characteristics, Body Mass Index (BMI), Sum of skinfolds (SSF), % body fat (%BF), fat-free mass (FFM) and waist to hip
ratio (WHR) and nine physical fitness items in undernourished rural primary school children in Ellisras, South Africa. The study was done on 462 boys and 393 girls who were aged 7 to 14 years. Apart from that, five body composition measures the nine physical fitness test items assessed were standing long jump, bent arm hang, Sit-ups, 10 x 5 m shuttle run, 50 m sprint, 1600 m run, flamingo balance, Sit & reach and plate tapping. The results showed that BMI was highly correlated with FFM (r = 0.7, P < 0.001). In line with the findings from Western countries, regression coefficients (B) showed that children with higher BMI or SSF performed worse in bent arm hang (girls, B = 0.84, P < 0.001, and B = 0.06, P = 0.02, respectively) and in 1600m run (B = 6.68, P < 0.001). BMI was significantly associated with flamingo balance (B = 0.26, P = 0.04). WHR was positively associated with bent arm hang (B = 9.37, P = 0.03), and inversely with Sit & reach (B = 7.48, P = 0.01). In contrast, significant relationships were found between BMI and standing long jump (B = 0.74, P = 0.04), Sit & reach (B = 0.51, P < 0.001), flamingo balance (B = 0.26, P = 0.04) and plate tapping (B = 19, P = 0.01). SSF was significantly associated with Sit & reach (B = 0.04, P = 0.03). Significant inverse associations were found between FFM and bent arm hang (girls, B = 0.06, P = 0.05), 1600 m run (girls, B = 2.33, P = 0.003) and 50 m run (boys, B = 0.11, P = 0.006). FFM was significantly associated with standing long jump (boys, B = 0.99, P < 0.001; girls, B = 0.73, P < 0.001), flamingo balance (B = 0.17, P < 0.001), and with Sit & reach (boys, B = 0.59,
P = 0.03). From the results, it was concluded that among the undernourished children, body composition was significantly related to physical fitness, but is not always in the expected direction. It is therefore important to note that in this population, BMI should not be interpreted as a measure of fatness/overweight, but rather as an indicator of muscle mass.

Beets and Pitetti (2005) conducted a study to compare health-related fitness variables of high school students (14 to 19 years old; 120 males, 67 females) participating in physical education (PE) and school sponsored sports (SSS) to students participating solely in PE. Cardiovascular fitness, the primary variable of interest was measured using the 20 meter shuttle run (number of completed laps). Secondary analysis compared upper body strength (90 degrees push-ups), flexibility (Sit & reach) and Body Mass Index (BMI kg/m2). Comparisons were made between students participating in 1-2 SSS and > or = 3 SSS for males and 1 SSS and > or = 2 for females to students participating solely in PE. Males participating in 1-2 SSS (mean (+/ SD) 20MST 63.80 +/- 25.61) and > or = 3 SSS (81.13 28.26) completed significantly (p < .001) more laps than males participating solely in PE (44.18 +/- 19.09). Females participating in 1 SSS (37.33 +/- 15.53) and > or = 2 SSS (49.48 +/- 19.83) completed significantly (p = .02) more laps than females participating solely in PE (23.50 +/- 7.96). Significant differences in number of 90 degrees push-ups was observed between males participating in > or = 3 SSS (49.41 +/- 12.90) and males participating solely in PE (37.63 +/- 11.79, p =
.006). No significant differences existed for males on BMI (p = .223) or theSit & reach (p = .145) and for females on 90 degrees push-ups (p = .79), Sit &reach (p = .579) and BMI (p = .122). As the number of SSS increase,significant increases are observed in cardiovascular fitness, with youthparticipating solely in PE exhibiting the lowest levels of cardiovascular fitnessin comparison to youth participating in PE and SSS.

Hong and Hamlin (2005) studied the Physique and physical fitnesslevels of 343 South Korean and 260 New Zealand 11 to 12 year old schoolchildren who were measured between 2000 and 2001 and added to previousdata to investigate secular trends and contemporary patterns in these health-related variables. Secular trend data suggest that South Korean children aregrowing taller at a faster rate but are also increasing in body mass faster thanNew Zealand children. Contemporary South Korean children hadsignificantly higher Sit & reach and broad jump scores compared to New Zealand children, however aerobic fitness was similar between the cohortsexcept for 11 year old New Zealand girls who took significantly longer tocomplete the 550m run. Contemporary South Korean and New Zealandchildren's physique is similar at present but if current trends continue, South Korean children will become more obese than their New Zealandcounterparts. An increase in South Korean children's fat mass will also have adetrimental effect on their currently superior fitness levels and overall health.
Monyeki et al., (2005) conducted a study to determine the relationships between the body composition characteristics, Body Mass Index (BMI), Sum of skinfolds (SSF), % body fat (%BF), fat-free mass (FFM) and waist To hip ratio (WHR). Besides, nine physical fitness items in undernourished rural primary school children in Ellisras, South Africa. The cross sectional study consisted of 462 boys and 393 girls aged between 7 and 14 years of age. Five body composition measures namely: BMI, SSF, %BF, FFM and WHR were assessed and nine physical fitness test items were assessed namely standing long jump, bent arm hang, Sit-ups, 10 x 5 m shuttle run, 50 m sprint, 1600 m run, flamingo balance, Sit & reach and plate tapping. The results showed that, BMI was highly correlated with FFM (r = 0.7, P < 0.001). In line with findings from Western countries, regression coefficients (B) showed that children with higher BMI or SSF performed worse in bent arm hang (girls, B = 0.84, P < 0.001, and B = 0.06, P = 0.02, respectively) and in 1600m run (B = 6.68, P < 0.001). BMI was significantly associated with flamingo balance (B = 0.26, P = 0.04). WHR was positively associated with bent arm hang (B = 9.37, P = 0.03) and inversely with Sit & reach (B = 7.48, P = 0.01). In contrast, significant relationships were found between BMI and standing long jump (B = 0.74, P = 0.04), Sit & reach (B = 0.51, P < 0.001), flamingo balance (B = 0.26, P = 0.04) and plate tapping (B = 19, P = 0.01). SSF was significantly associated with Sit & reach (B = 0.04, P = 0.03). Significant inverse associations were found between FFM and bent arm hang (girls, B =
0.06, \( P = 0.05 \)), 1600 m run (girls, \( B = 2.33, P = 0.003 \)) and 50 m run (boys, \( B = 0.11, P = 0.006 \)). FFM was significantly associated with standing long jump (boys, \( B = 0.99, P < 0.001 \); girls, \( B = 0.73, P < 0.001 \)), flamingo balance (\( B = 0.17, P < 0.001 \)), and with Sit & reach (boys, \( B = 0.59, P = 0.03 \)). Based on the results, it was concluded that undernourished children, body composition was significantly related to physical fitness, but not always in the expected direction. It is therefore important to note that in this population, BMI should not be interpreted as a measure of fatness/overweight, but rather as an indicator of muscle mass.

Ara et al., (2004) conducted a study to find out the effect of physical activity on whole body fat (BF), its regional deposition and the influence of body fatness on physical performance in pre-pubertal children. In this Cross sectional study, a total of 114 boys (9.4+/1.5 y, Tanner I-II), randomly sampled from the population of Gran Canaria (Spain), 63 of them physically active (PA – at least 3 hour per week during the previous year) and 51 non-physically active (non-PA). Body composition (DXA), anthropometric variables (body circumferences and skinfolds) and physical fitness were determined in all subjects. The PA obtained better results in maximal oxygen uptake, isometric leg extension force, vertical jump (muscular power) and 300 m (anaerobic capacity) and 30 m running tests (speed) than the non-PA. A lower percentage of body fat (% BF) (4 U less, \( P<0.05 \)), whole BF mass (36% less, \( P<0.05 \)) and regional fat mass (28%, 25% and 30% less in the trunk, legs

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and arms, respectively, all P<0.05) was observed in the PA compared to the non-PA. The waist and hip circumferences correlated more closely with both the fat mass accumulated in the trunk region and the % BF (r=0.81-0.95, P<0.001) than the waist to hip ratio (WHR). The WHR correlated with the percentage of the whole fat mass accumulated in the trunk (PFT) (r=0.52-0.53, P<0.001). In both groups, the PFT increased curvilinearly with the % BF, regardless of the level of physical activity. ANCOVA analysis revealed that total and regional fat masses explained less than 40% of the difference in performance between the PA and non-PA group. The mean speed in the 30 m running test (V30) combined with the height and whole body mass has predictive value for the BF mass (R=0.98, P<0.001). The % BF may be estimated from the Body Mass Index (BMI) and V30 (% BF=8.09+2.44.BMI (kg m(2)) 5.8.V30 (m s(1)), R=0.94, P<0.001) in prepubertal boys. Based on the results, it was concluded that, regular participation in at least 3 hour per week of sports activities and competitions on top of the compulsory physical education programme is associated with increased physical fitness, lower whole body and trunkal fat mass in prepubertal boys.

Koutedakis and Bouziotas (2003) conducted a study to assess the current national Physical Education curriculum in relation to selected motor and cardiovascular health-related fitness parameters. A sample of 84 Greek school boys (mean (SD) age 13.6 (0.3) years, height 160.7 (8.6) cm, weight 50 (10.8) kg) volunteered. Forty three indicated participation only in school
PE classes and habitual free play (PE group). The remaining 41 were involved in extracurricular organised physical activities in addition to school PE and habitual free play (PE+ group). The subjects underwent anthropometric, motor (flexibility, balance, standing broad jump, hand grip, Sit-ups and plate tapping) and cardiovascular health-related (percentage body fat, aerobic fitness, and physical activity) fitness assessments. The results showed that children in the PE group had inferior motor and cardiovascular health-related fitness profiles compared with those in the PE+ group. Body fat (20.3 (8.8) v 13.9 (3.5); p<0.001), aerobic fitness (34.7 (3.7) v 43.9 (4.2); p<0.001) and time spent in intensive physical activity (0.2 (0.2) v 0.7 (0.3); p<0.001) showed the greatest differences between the two groups. Some of the pupils in the PE group were lower than the levels proposed to be necessary to combat future health risks. Adjustments for confounding variables showed a decrease in the significance of motor fitness, but not in cardiovascular health-related parameters. From the results, it was conducted that the national PE curriculum for Greek secondary schools does not achieve the required levels of motor and cardiovascular health-related fitness and should be reconsidered.

Westerstahl et al., (2003) investigated changes over time in body dimensions, muscular and aerobic fitness in a representative sample of 16 year old girls and boys in secondary schools in Sweden from 1974 to 1995 (n = 855). Height and weight were measured and five tests were performed: run walk, two hand lift, Sargent jump, Sit-ups, and bench-press. The results
showed that, in 1995, girls and boys had higher Body Mass Index (BMI) than in 1974. Girls and boys performed less well in bench-press, Sit-ups and run walk tests in 1995. Boys, but not girls, performed better in Sargent jump in 1995 than in 1974. Girls and boys performed better in two hand lift in 1995 than in 1974. However, after adjustment for body dimensions, there were no differences in performance in two hand lift or run walk tests between 1974 and 1995. Based on the results, the conclusions do show that there was a decreased aerobic fitness and an increased maximal static strength among adolescents in Sweden between 1974 and 1995. These changes were partly due to increased BMI. However, decreased daily physical activity level cannot be excluded as a contributing factor to the decreased aerobic fitness. The reduced performance in muscular endurance in 1995 was not related to increased BMI. Instead, it is suggested that, it is to be related to a specific decrease in hip flexion and arm muscle endurance.

Nielsen and Anderson (2003) conducted a study to analyze the association of fitness and fatness with blood pressure (BP) and hypertension. This was a cross sectional study of 13,557 boys and girls 15-20 years of age. Fitness was estimated from a shuttle run test, fatness from Body Mass Index (BMI) and BP was measured sitting after 5 min of rest. Other lifestyle variables were self-reported. The results indicated that the boys had a higher systolic BP (SBP) than girls. A low physical fitness level and high BMI were independently associated with a high BP and risk of having hypertension in
both girls and boys. Interaction was found between BMI and fitness. In a stratified analysis an odds ratio (OR) of 3.99 was found for hypertension in girls with a BMI > 25 kg m\(^2\) compared to lean girls if all had a low fitness level and an OR of 2.14 for a high BMI in girls with a high fitness level. In boys, OR for high versus low BMI were 3.23 in the low fit and 2.34 and 2.50 in the middle and upper tertile of fitness, respectively. On the basis of the results obtained, it was concluded that fitness and BMI were independently associated to BP and BMI was found to be a stronger predictor of hypertension in those with low fitness level, especially in girls.

Deforche et al., (2003) conducted a study to assess different aspects of physical fitness and physical activity in obese and non-obese Flemish youth. A random sample of 3214 Flemish schoolchildren was selected and divided into an "obese" and "non-obese" group based on Body Mass Index and Sum of skinfolds. Physical fitness was assessed by the European physical fitness test battery and physical activity was estimated by a modified version of the Baecke Questionnaire. The results indicate that, obese subjects had inferior performances on all tests requiring propulsion or lifting of the body mass (standing broad jump, Sit-ups, bent-arm hang, speed shuttle run, and endurance shuttle run) compared with their non-obese counterparts (p < 0.001). While on the other hand, the obese subjects showed greater strength on handgrip (p < 0.001). Both groups had similar levels of leisure time physical activity; however, non-obese boys had a higher sport index than their
obese counterparts (p < 0.05). Results of this study shows, that obese subjects had poorer performances on weight bearing tasks, but did not have lower scores on all fitness components. To encourage adherence to physical activity in obese youth, it is important that activities are tailored to their capabilities. Results suggest that, weight bearing activities should be limited at the start of an intervention with obese participants and alternative activities that rely more on static strength should be used.

Pena, Tan and Malina (2003) compared the physical fitness of school children resident in an urban Colonia and in a rural indigenous community in Oaxaca, Southern Mexico. Two measures of performance-related fitness (standing long jump, 35 yard dash [32 m]) and four measures of health-related fitness (grip strength, Sit & reach, timed Sit-ups, distance run) were taken on 355 rural (175 boys, 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. Explosive power (standing long jump) and abdominal strength and endurance (timed Sit-ups) were better in urban than in rural children without and with adjustment for age and body size. Urban-rural differences in running speed (dash) and flexibility (Sit & reach) varied by age group and sex. Younger rural children and older urban girls performed better in the distance run, whereas older rural and urban boys did
not differ in endurance. The size advantage of urban children does not necessarily translate into better levels of performance and health-related physical fitness. The observed differences may be related to activity habits associated with school Physical Education and lifestyle in the respective communities.

Levin et al., (2003) conducted a study to investigate associations of underweight and overweight with physical activity among high school students in the United States. A national representative sample of 15,349 US high school students participated in the 1999 Youth Risk Behavior Survey out of which 13,295 were included in this analysis. Five measures of physical activity were examined as dichotomous variables: (1) vigorous intensity physical activity (>=3 vs <3 sessions lasting at least 20 minutes each per week); (2) moderate intensity physical activity (>=5 vs <5 sessions lasting at least 30 minutes each per week); (3) strength training (>=3 vs <3 sessions per week); (4) enrollment in Physical Education (yes or no); and (5) sports participation (yes or no). Using Body Mass Indexes, students were categorized by percentiles as underweight (<=5th percentile), at risk for underweight (5th to <=15th percentiles), normal weight (15th to <85th percentiles), at risk for overweight (>=85th to <95th percentiles), or overweight (>=95th percentile). Potential associations between physical activity and Body Mass Index were examined using logistic regression. The results on several measures showed adolescent boys who were underweight or
overweight were less likely to be physically active than boys of normal weight (eg, odds ratio [OR], 0.23; 95% confidence interval [CI], 0.12-0.45; and OR, 0.75; 95% CI, 0.61-0.93; for boys who were underweight and overweight respectively for strength training). Adolescent girls who were overweight or at risk for overweight were less likely (OR, 0.62; 95% CI, 0.50-0.78; and OR, 0.63; 95% CI, 0.46-0.85; respectively) to be involved with sports than girls of normal weight; and girls who were underweight were less likely (OR, 0.44; 95% CI, 0.22-0.91) to be enrolled in Physical Education. From the results, it was concluded that, weight status among high school students is correlated with selected physical activity behavior, especially among adolescent boys. Interventions to increase physical activity for high school students should target adolescents of all shapes and sizes and may best be achieved by school policies requiring Physical Education or after school sports.

Huang and Malina (2002) conducted a study was to evaluate the cross sectional relationship between BMI and a physical fitness index (PFI) based on four indicators of fitness in a national sample of Taiwanese youth. Height, weight and four measures of physical fitness (Sit-ups completed in 60 seconds, standing long jump, Sit & reach and 800 or 1600 m run/walk) were measured in a national sample of 102,765 Taiwanese youth 9-18 yr of age: 50,940 girls and 51,825 boys. BMI was calculated for each subject. Within each sex specific half year age group, students were classified into five BMI
categories based on national percentiles: very low, BMI < 5th percentile; low, BMI ≥ 5th but < 15th percentiles; normal, BMI ≥ 15th but < 85th percentiles; high, BMI ≥ 85th but < 95th percentiles; and very high, BMI ≥ 95th percentiles. Z scores based on sex and age specific means and standard deviations were calculated and the sum of z scores for the four fitness tests was used as a PFI. Differences in PFI between BMI categories within each sex specific half year age group were compared with ANOVA with Bonferroni adjustments. Sex specific regressions of PFI on BMI, using a nonlinear quadratic model were done in four broader age categories. The results do indicated that, relationship between BMI and PFI are nonlinear and vary with age from late childhood through adolescence. With increasing age during adolescence, the relationship becomes parabolic, and the peaks of the parabola are sharper in adolescent boys than girls. Based on the results, the investigator concluded that PFI declines in a curvilinear manner with increasing BMI among youth 9-18 yr of age, but the slope of the relationship varies with age.

Chen et al., (2002) constructed Body Mass Index (BMI) norms for children and adolescents from a reference population that includes obese and slim subjects. The validity of these norms was found to be influenced by the observed secular increase in body weight and BMI. It was hypothesized that the performance of children in health-related physical fitness tests would be negatively related to increased BMI's, and therefore fitness tests might be
used as criteria for developing a more appropriate set of BMI norms. They evaluated the existing data from a nation-wide fitness survey for students in Taiwan (444652 boys and 433555 girls) to examine the relationship between BMI and fitness tests. The fitness tests used were 800/1600m run/walk, standing long jump, bent leg curl-ups and the Sit & reach test. The BMI percentiles developed from the subgroup whose test scores were better than the 'poor' quartile in all four tests were compared with those of the whole population and linked to the adult criteria for overweight and obesity. The BMI's were significantly related to the results of fitness testing. A total of 43% of students had scores better than the poorest quartile in all of their tests. The upper BMI percentile curves of this fitter subgroup were lower than those of the total population. The 85\textsuperscript{th} and 95\textsuperscript{th} BMI percentile values of the fitter 18 year old students were 23.7 and 25.5 kgm\textsuperscript{2} for boys, 22.6 and 24.6 kgm\textsuperscript{2} for girls and this linked well with the adult cut-off points of 23 and 25 kgm\textsuperscript{2}, which have been recommended as the Asian criteria for adult overweight and obesity. Hence, the BMI norms for children and adolescents could be created from selected subgroups that have better physical fitness. The investigator expected that the new norms based on this approach will be used not only to assess the current status of obesity or overweight, but also to encourage activity and exercise.

Huang and Malina (2002) studied the relationship between physical activity and health-related physical fitness was evaluated in 282 Taiwanese
adolescents 12-14 years of age. The subjects were randomly selected from the 7th, 8th and 9th grades in two junior high schools in Taiwan. Physical activity was estimated as total daily energy expenditure and energy expenditure in moderate to vigorous physical activity from 24 hour activity records for three days, two week days and one weekend day. Health-related fitness was assessed as the One mile run (cardio-respiratory endurance), timed Sit-ups (abdominal strength and endurance), Sit & reach (lower back flexibility) and subcutaneous fatness (sum of the triceps, subscapular, suprailiac and medial calf skinfolds). Physical activity is significantly and positively correlated with One mile run performance and the Sit & reach test, but not with Sit-ups and subcutaneous fatness. Overall, the strength of the relationships between estimated energy expenditure and specific fitness items in the total sample vary from low to moderate, with only 1% to 12% of the variance in fitness variables being explained by estimated energy expenditure. Comparisons of active versus inactive and fit versus unfit adolescents provide additional insights. The more active (highest quartile) are also more fit in cardio-respiratory endurance and in the Sit & reach test than the less active (lowest quartile) and the more fit in the One mile run (better time, lowest quartile) and the Sit & reach (highest quartile) are more active than the less fit in each item, respectively.

Muller et al., (2002) conducted a study to compare variables of metabolism, physical activity and fitness to body composition in normal and
overweight children in a cross sectional study design. Body composition was assessed by anthropometric measurements and bioelectrical impedance analysis in forty eight prepubertal children (age 5-11 years, thirteen normal weight, thirty five overweight). Total energy expenditure (EE) was measured by combination of indirect calorimetry (for measurement of resting EE) and individually calibrated 24 h heart rate (HR) monitoring. Activity related EE and physical activity level (PAL) were calculated. Time spent with min by min HR>FLEX HR was also used as a marker of moderate habitual and vigorous activities. Aerobic fitness (O2 pulse (O2 consumption :HR at sub maximal steady state heart rate), sub maximal O2 consumption (VO2submaximal), RER at a HR of 170 beats per min) was determined by bicycle ergometry. Muscle strength of the legs (maximal isometric strength of musculus quadriceps and of musculus ischiocruralis (Fa max and Fb max respectively)) were measured by computer tensiometry. When compared with normal children, overweight children had higher skinfold thicknesses (sum of skinfold thicknesses at four sites +160 %), fat mass (+142 %), waist (+24 %) and hip circumferences (+14 %), resting EE (+13 %) and RER (+5 %). No significant group differences were found for fat free mass, muscle mass, total EE, activity related EE, PAL, HR>FLEX HR, VO2 sub maximal, O2 pulse, Fa max and Fb max as well as the fat-free mass or muscle mass adjusted values for resting EE, aerobic fitness and muscle strength. When compared with normal children, overweight children had a lower measured VO2,
estimated resting EE (Delta resting EE) and spent more time watching television. There were positive relationships between fat-free mass(x) and resting EE(x), total EE(y), aerobic fitness(y) and muscle strength(y), but only Delta resting EE(x) and HR>FLEX HR(x) correlated with fat mass(y). In a stepwise multivariate regression analysis resting EE adjusted for fat-free mass and Delta resting EE were significant determinants of % fat mass and explained 29.7 % of its variance. Thus, in the present cross sectional study, resting EE was the most important determinant of fat mass.

Guerra et al., (2002) conducted a comparative and correlational cross sectional study to describe the associations between cardio-respiratory fitness, blood pressure and body composition in Portuguese school children. The sample comprised of 529 children (246 males and 283 females) of aged between 8 and 15 years. Height and body mass were measured along with blood pressure with children sitting after at least 5 min rest. The maximal multistage 20 m shuttle run test was carried out to predict maximal aerobic power. The results of the study shows that boys were more fit (p= or <0.05) and less fatter than girls (p= or <0.05). Multiple regression analysis revealed that weight and age explained significantly (p= or <0.01) the amounts of systolic blood pressure (SBP) and diastolic blood pressure (DBP). In girls, percentage of fat (%F) showed an influence on the variance in SBP (4.9%, p= or <0.05). In addition, weight (14.5%) and age (9.8%) account significantly (p= or <0.01) for the amount of variance to DBP in males. For girls, age
(11.4%) and BMI (2.4%) account significantly to the variance found in DBP. However, the independent variables, for both sexes, account less than 50% of the overall variance found in blood pressure values. The conclusions showed that, boys were more fit and had less fat than girls. The level of cardio-respiratory fitness does not seem to be an important correlate of blood pressure variation across age groups and gender.

Jones, Hitchen and Stratton (2000) conducted a study to investigate the effect of sexual maturity had upon performance in physical fitness tests. A cross sectional study involving 161 girls and 152 boys was carried out. Each subject was assessed for stature, mass, self-assessment of sexual maturity, vertical jump, hand grip strength and the 20 m shuttle run test, all procedures were standardized. Spearman's rank correlation coefficients were developed to assess the relationship between maturity and physical fitness measures. ANCOVA inferential statistics were performed to investigate if performance in physical fitness tests differed between children of different sexual maturity stages irrespective of mass and stature. Significance was set at p < 0.05. Stage of sexual maturity was significantly correlated with all physical fitness measures (boys: r=0.56 to 0.73; girls: r=0.24 to 0.46). ANCOVA revealed that when stature and mass were taken into account significant differences were evident between sexual maturity stages in boys but not girls. This suggests that, increases in mass and stature are primarily responsible for variation in girls' physical performance throughout maturation, whereas in boys there are
some qualitative differences in performance due to other factors. It was concluded that sexual maturity has a large influence on physical fitness measures in boys but less effect in girls. Rating of physical fitness, particularly for boys should take into account the biological maturity.

Grund et al., (2000) conducted a study to assess different aspects of physical activity and fitness in order to develop a basis for sport programmes for overweight and obese children. Eighty eight prepubertal children (49 boys and 39 girls of age between 4.8 and 11.4 years of which, 61% obese, 14% overweight and 25% normal weight) were examined. Body composition was assessed by combined use of anthropometrics and bioelectrical impedance analysis. Resting energy expenditure (REE) and total energy expenditure (TEE) were measured by indirect calorimetry (IC) and individually calibrated 24h heart rate (HR) monitoring respectively. Activity related energy expenditure (AEE) and physical activity level (PAL) were calculated from TEE and REE. Fitness [assessed by O2 pulse, respiratory exchange ratio (RER) at sub maximal work intensities] was determined by ergometry. The maximal isometric muscle strength of the legs (m. quadriceps, F\text{a max}, m. ischio-cruralis, F\text{b max}) was measured by computer tensiometry. Children were grouped according to their nutritional state, AEE, O2 pulse and muscle strength. When compared with normal weight children, obese and overweight children had increased fat mass (FM), fat-free mass (FFM), waist to hip ratio and REE, but no group differences were observed for TEE, AEE, and PAL.
Obese and overweight children spent more hours per day watching TV. After correction for body weight and FFM, no group differences in REE were observed, but normal weight children had a higher O2 pulse than overweight and obese children. By contrast, RER was increased in the latter group. The fittest group had the lowest body weight, BMI, FM and FFM. Children with a low O2 pulse spent more hours per day watching TV. Grouping children according to their degree of muscle strength, younger children (4-7.5 years) did not show group differences in nutritional state, energy expenditure, physical activity and fitness. However, in the group of 7.6 to 11 year old children, those with the greatest muscle strength and FFM had reduced BMI, skinfolds, FM and FFM. FM correlated inversely with O2 pulse, but was not associated with TEE, AEE, PAL or muscle strength. By contrast TV watching was positively associated with FM. To summarize, overweight and obese children were less fit and watched more TV than their normal weight counterparts. FM did not correspond to TEE, AEE or PAL. Muscle strength was not associated with FM in young children, but was inversely associated with FM in older children. It can be concluded that the cross sectional data is consistent with the idea that increased fitness and increased physical activity may prevent children from being overweight.

Manoj and Manoj (1999) conducted a sample survey in Trichur district which indicated that the physical fitness standards of the school children to be very low and do significantly differ with their corresponding age and sex
when compared to the AAHPERD health-related physical fitness Test (HRPFT) standards. Moreover, the abdominal strength/endurance of high school girl student's have shown a decreasing trend when compared with lower classes (Manoj & Manoj, 1999). Poor performance on the tests Sit & reach and Sit-ups indicates the possibility to develop lower back inorder to be free from musculoskeletal problems among children and youth due to inadequate flexibility and/or poor abdominal strength (Ross & Pate, 1987), as Sit-ups and Sit & reach tests are clear indicators of abdominal strength and endurance respectively. The abdominal muscles anteriorly have a very significant influence on the spine, hence, good contracting of abdominal muscles gives added strength to the spine and helps to maintain posture. Lax abdominal muscles and potbelly not only create bad posture, but also lay foundation for backache. Epidemiological studies in Kerala women show that 60-70% of women aged greater than 35 have some problems related with bad back.

Rowland et al., (1999) examined the validity of this concept, assessing the influences of body fat and maximum values of oxygen consumption per unit time, stroke volume, heart rate, and arteriovenous oxygen difference on 1 mile (1.6km) run time in healthy sixth-grade boys. The subjects were 36 boys with a mean (SD) age of 12.2 (0.5) years. The relationship was examined between body fat content (estimated by skinfold measurements) and maximum oxygen consumption per kilogram and cardiac variables (during
maximum cycle testing) with 1 mile run velocity. The results obtained showed that body fat content and maximum oxygen consumption per kilogram (independent of body fat) accounted for 31% and 28% of the variance in run velocity, respectively. Stroke volume was the only component of maximum oxygen consumption that is related to 1 mile run performance. Based on the results, the conclusions suggest that cardiovascular fitness and body fat content contribute equally to 1 mile run time in healthy boys and together account for only 60% of the variance in performance on this endurance fitness test. Consequently, 1 mile run performance in children may not serve as a strong indicator of cardiovascular fitness.

Michaud et al., (1999) conducted a study on the physical fitness and physical/sports activity of children and adolescents aged 9 to 19 years. From September 1996 until March 1997, 3540 subjects (1778 girls, 1762 boys) from the canton of Vaud were enrolled in a multifaceted study which included a battery of 7 tests measuring different components of fitness, anthropometric measures and a self-administered questionnaire assessing physical activity, health and lifestyles. The results indicates that, most of the respondents practice sports on a regular basis but boys engage in physical and sports activities much more often than girls: 75% of boys versus 56% of girls spent at least one hour a day in activities inducing sweating, an index of moderate to vigorous physical activity (p < 0.001). Depending on the grade, 56 to 74% of girls and 62 to 88% of boys reported participation in sports clubs (p <
current participation ranges from 33 to 46% among girls and 64 to 69% among boys ($p < 0.001$). Participation in physical and sports activities was lower after age 15 than before and also lower among girls than among boys. As far as fitness is concerned, girls exhibit greater flexibility than boys, while the latter exhibit greater strength and endurance, especially after age 15. Calculated values for the BMI and VO2max are within the ranges published in the international literature for both sexes. Based on the results obtained, it was concluded that, programmes and strategies which aim to increase physical activities should be gender-specific and should especially target adolescents aged over 15. Physical/sports activities and fitness could and should be monitored using both a battery of tests and self-administered questionnaires.

Marshall et al., (1998) conducted a study to examine the tracking of multiple health-related fitness components in children from fourth to sixth grade. A battery of fitness tests was used to measure 414 children (213 boys, 201 girls, mean = 9.48 yr, +/-0.41) from three elementary schools in Southern California. Children were assessed during the fall and spring of each grade. Baseline scores were correlated (Spearman) with each subsequent time point. The results indicated that for boys 3 yr correlations of Body Mass Index (BMI) (0.89), skinfold thickness (0.80), Sit & reach test (0.67) and the Pull-up test (0.66) indicated high levels of tracking. Mile run (0.56), Sit-up test (0.46), and waist to hip ratio (0.30) tracked moderately. For girls BMI (0.83), Sum of
skinfolds (0.75), Sit & reach test (0.72) and the Pull-up test (0.63) tracked highly, while mile run (0.42), Sit-up test (0.47), and waist to hip ratio (0.42) tracked moderately. The results suggest that, relative rankings of BMI, skinfold thickness, and Sit & reach test performance are more likely to track during early adolescence. Measures of cardiovascular fitness, muscular strength and endurance and fat distribution may be less likely to track into adolescence, possibly because they are more influenced by changes in physical activity or because tracking may be reduced by measurement error.

Katzmarzyk et al., (1998) conducted a study to evaluate the relationship between indicators of physical activity and health-related fitness in youth of 9 to 18 years. The subjects were 356 boys and 284 girls from phase I of the Quebec Family Study. The sample was divided into three age groups by gender, 9-12, 13-15 and 16-18 yr of age. Physical activity variables included two estimates of activity, estimated daily energy expenditure (EE) and estimated moderate to vigorous physical activity (MVPA) and one estimate of inactivity, time spent watching television per day (TVTIME). Health-related fitness variables were the sum of six skin folds (SUM), number of Sit-ups in 1 min (SITUP), physical work capacity at 150 beats x min (1) (PWC150) and static strength of the leg (LMS). Partial canonical correlation was used to quantify the relationship between standardized (z transformed) activity variables and health-related fitness items, controlling for age. The results showed that there was a weak to moderate association between
physical activity and fitness in youth. The first activity canonical variate is a function of positive loadings for EE and MVPA, with a smaller, negative loading for TVTIME. The first fitness variate generally includes positive loadings for PWC150 and SITUP, with a small negative loading for the SUM and a small positive loading for LMS. The first canonical correlations indicate that the variance shared by the fitness and activity variates ranges from 11 to 21%. From the results, it was concluded that there is a significant relationship between activity and health-related physical fitness, but a large part of the variability (80-90%) in fitness is not accounted for by physical activity as measured in this study.

Katzmarzyk *et al.*, (1998) conducted a study to evaluate the relationships among television viewing time (TVTIME), physical activity, and health-related fitness in youth 9-18 years of age from the Québec Family Study. The sample included 423 males and 361 females 9-18 years of age from the greater Québec city area. TVTIME, daily energy expenditure (EE), and moderate to vigorous physical activity (MVPA) were estimated. Four health-related fitness variables were tested namely knee extension strength, physical work capacity at 150 beats x min (1), Sit-ups, and Sum of skinfolds, apart from the Body Mass Index (BMI). Relationships were assessed using correlations and analysis of covariance. The results showed that, the correlations between TVTIME and EE and MVPA were low and not significant, with no pattern by age group and gender. Those between
TVTIME and fitness variables were also low and generally not significant, with no pattern by age and gender. Adolescents in the highest and lowest quartiles of TVTIME showed no consistent differences in EE, MVPA and the four fitness items. Similarly, adolescents in the highest and lowest quartiles of EE, MVPA and each fitness item did not consistently differ in TVTIME. The results indicate that the time watching television has only a weak association with indicators of physical activity and health-related fitness in Québec youth. Since the data are from the early 1980s, generalizations to more current samples should be tempered with care.

Benefice & Malina (1996) conducted a study between 1988-92 to find out the influence of body dimensions and body composition on variability in motor performance. The subjects were 348 children of 5 to 13 year of age living in Lambabye of Podor District in Senegal. Anthropometric values and motor performance values were compared with reference values from the National Center for Health Statistics (NCHS). Anthropometric dimensions included stature, weight, arm and calf circumferences, and 4 subcutaneous skinfolds. Motor performances were 50m dash, standing long jump, throw for distance and grip strength. The mean weight and height of Senegalese children were lower than the NCHS reference medians for each age group. Differences between Senegalese children and the NCHS reference age matched groups were greater in children over 8 years old and in boys. Yet, boys tended to have better motor performances than girls. Among children
younger than 10 years, height and weight accounted for about 30-50% of the variance in performances. Among children older than 10 years, weight accounted for 10-25% of the variance. Body composition (i.e., arm muscle and subcutaneous fat) contribute little to the remaining variance in motor performance. Fatness has a negative effect on motor performance among girls younger than 10 years, but had no effect on boys. The investigators could not discern whether the low performance of children raised under marginal conditions is a long term effect of stunting associated with episodes of malnutrition early in life or the effect of chronic under nutrition during childhood. They also did not know whether catch-up growth will happen during puberty.

Malina et al., (1995) conducted a two-fold survey study to investigate the association between fatness and fitness of girls between 7 and 17 years of age from a representative sample of 6700 subjects. First, age specific correlations between fatness and measures of health-related and motor fitness and the second, comparisons of fitness levels of girls classified as fat and lean. Adiposity (fatness) was estimated as the sum of five skinfolds (biceps, triceps, subscapular, suprailliac and medial calf). Physical fitness included health-related items (step test, PWC170, Sit & reach, Sit-ups and leg lifts and flexed arm hang) and motor performance items (standing long jump, vertical jump, arm pull strength, flamingo stand, shuttle run and plate tapping). Age specific partial correlations between fatness and each fitness item which
controls stature and weight were calculated. In addition, in each age group the fattest 5% (presumably the obese) and the leanest 5% were compared on each fitness test. After controlling for stature and weight, subcutaneous fatness accounts for variable percentages of the variance in each fitness item. Estimates for health-related fitness items are: cardio-respiratory endurance step test (3% to 5%) and PWC170 (0% to 16%), flexibility Sit & reach (3% to 8%), functional strength flexed arm hand (6% to 17%) and abdominal strength Sit-ups/leg lifts (1% to 8%). Corresponding estimates for motor fitness items are more variable: speed of limb movement plate tapping (0% to 3%), balance flamingo stand (0% to 5%), speed and agility shuttle run (2% to 12%), static strength arm pull (4% to 12%), explosive strength standing long jump/vertical jump (11% to 18%). At the extremes, the fattest girls have generally poorer levels of health-related and motor fitness.

Fu (1994) assessed the fitness of 20,304 primary and secondary school students in Hong Kong using the ICHPER. SD Asia health-related fitness Test in 1990-91. To have good representation, schools from all three regions (Kowloon, Hong Kong, and New Territories) of Hong Kong were selected. Feedback from participants was considered in preparing the final test manual. Norms were developed for the various age groups for future comparisons. Five subsequent research projects were conducted during 1991-92 using the new test manual. It was concluded that implementation of the new test had
met with acceptance and approval from the local community. The test results were also compared with that of results from Japan and China.

Hua et al., (1994) administered the Asian health-related fitness Test to 3,168 students 10-17 years of age attending public schools in Shanghai. Basis statistical results of measurements (i.e. height, weight and skinfold thickness and those of fitness test results) were presented in terms of means, standard deviations, maximum and minimum values for each age and gender group. The developmental tendency (in accordance with increasing age) was generally observed in tests such as endurance run, 60 seconds Sit-ups, Pull-ups and sit-and-reach. Gradual increasing effects of growth were clearly observed among girls in terms of skinfold thickness and for boys, skinfold measurements stayed roughly the same throughout all tested ages i.e., not increasing with age.

Pongprapai, Mosuwan and Leelasamran (1994) studied 259 primary school children (average age 9.2 years) who were randomly selected from three groups of children whose weights for height were 90-110% (normal 111), > 110-120% (over weight 25), and > 120% (obesity 123) of reference values for Bangkok children. They underwent physical fitness tests which included measurement of speed (50 meters run), flexibility (Sit & reach), abdominal strength and endurance (30 seconds Sit-ups), vital capacity (spirometer) and indirect maximum oxygen uptake (VO2 max sub maximal
bicycle ergometer). The results showed that all physical fitness tests were statistically significantly different ($p < 0.05$) between groups, except for flexibility in boys. But for the girls, only 50 meters run, Sit-ups and VO2 max showed statistically significant differences ($p < 0.05$). In the comparison of physical fitness tests between sexes, normal weight boys did better than girls ($p < 0.05$) for all tests except flexibility. There were no statistically significant differences between sexes in overweight and obese children. This study demonstrated that physical fitness of obese children was worse than that of normal children in both sexes, especially as measured by 50 meters run, Sit-ups and VO2 max tests. Thus, promotion of exercise in obese children should be stimulated to develop better physical fitness and weight reduction. In comparison of physical fitness between the sexes, boys had better physical fitness than girls, significant in the normal weight group only. There is no definite explanation as to why increase in weight results in no difference of physical fitness between sexes. Lifestyle, physical skills and genetic determinants should be considered for interpretation of physical fitness.

Sallis, McKenzie and Alcaraz (1993) conducted a study to examine the relationship between habitual physical activity and components of health-related physical fitness in children of seven public elementary schools in a suburban area of Southern California City. Five hundred twenty eight healthy fourth grade children (274 boys and 254 girls), 85% of whom were non Hispanic whites i.e., Ninety eight percent of eligible students. Results of six
measures of physical activity in children (monitoring by accelerometer, parent report and child self-reports of weekday activity weekend activity and summer involvement in activity classes and youth sports) were combined in a physical activity index. This index of habitual physical activity was examined in relation to measures of five components of health-related fitness such as the mile run, skinfold tests, Pull-ups, Sit-ups and the Sit & reach test. The physical activity index was significantly associated with all the five fitness components and the canonical correlation was 0.29. From the results, it was concluded that active children appear to engage in a sufficient variety of activities to enhance multiple components of health-related fitness.

Lehnhard et al., (1992) conducted a study to assess current fitness levels in the state of Maine, more than 8,000 public school students of age between five and nine were assessed using a nationally known (American Alliance for Health Physical Education Recreation and Dance) health-related physical fitness test. Maine students were then compared with a national norm group on (1) the one mile walk/run (minutes and seconds), (2) skinfold thickness (centimeters) (3) one minute timed Sit-ups (number performed correctly) and (4) the Sit & reach test for flexibility (centimeters). Generally, Maine boys and girls scored higher than the norms on the Sit-ups, Sit & reach and one mile walk/run. However, they had significantly larger skinfold thicknesses. Implications for assessment of health-related fitness in this age group were discussed.
Jonas (1990) studied the influence of parental physical activity levels, attitudes towards physical activity, socio-economic status, educational levels and past sports involvement on school age children's health-related physical fitness test items performance levels. The health-related physical fitness test and the children's parents' psychosocial factors were assessed by means of mailed parental questionnaire. Separate one-way analysis of variance were done to determine the children with high health-related physical fitness levels whose parents had more positive attitude towards physical activity, higher physical activity levels and higher socio-economic status than the parents of children with low health-related physical fitness level. Separate two-way ANOVA and chi-square analysis were done to determine, if children with high health-related physical fitness levels had parents with higher educational levels and higher levels of past sports involvement than the parents of children with low health-related physical fitness level. In addition, a step wise multiple regression analysis was employed to assess the extent to which each of the parental psycho-social factor was associated with school age children's health-related physical fitness test item-wise percentile rank scores.

The results of the study revealed that parent's physical activity levels, attitudes toward physical activity, socio-economic status, educational level, and past sports involvement can significantly influence school age children's
Miller (1990) conducted study to determine whether or not participation in selected Physical Education activities affects the health-related physical fitness of college students. In addition, it was to determine whether significant differences existed among activities relative to the components of health-related physical fitness and to determine whether a significant interaction existed between gender and types of activity. The subjects were 228 university students enrolled in either aerobic dance, archery, bowling, swimming, tennis, badminton or weight training. The FYT programme manual served as a guide in defining the test components and procedure. Skinfold thickness were measured to evaluate body composition. The 20 minute steady state jog evaluated cardio-respiratory endurance. The Sit & reach test evaluated flexibility through the use of a flexibility measuring apparatus. Muscular strength and endurance was evaluated by means of the bent knee curl up. A correlated t-test was performed to determine whether there were significant differences in pre-test and post-test scores of each item in the test battery for each group. Analysis of covariance was used to determine whether a significant difference existed among groups on the post-test scores for the 4 performance variables. Tests of simple effects were performed to clarify the meaning of significant interactions. The results indicate that Aerobic dance and weight training elicit significant
improvements in flexibility and muscular strength. Based on the results of the study, it was concluded that 10 week programme of activity will have improvements in the components of health-related physical fitness and will occur depending on the activity selected.

Sykes (1989) studied the role of exercise in community health and fitness promotion. A selected battery of tests was conducted on a small group of middle aged businessmen (n=13) inorder to establish a baseline of fitness from which individually graded exercise programmes could be prescribed. A strategy for personal wise developed exercise programmes were administered and evaluated over a six month period. A twelve month voluntary fitness promotion project with officers of the Cheshire Fire Service (n=291) was then inaugurated. The battery of fitness tests was conducted at the onset, mid-term and end of the project. The test result indicated that the strategy developed was successful in effecting community fitness promotion.

Nahas (1986) conducted a study on a short term Health Fitness Education Programme which was having two purposes, first to promote an assessment of health-related fitness and develop norms for college women in Santa Catarina, Brazil; the second and more important objective was to investigate experimentally the effects of a short term health fitness education programme on the knowledge and attitudes of low fit students.
Hatano et al., (1984) assessed the fitness of 2,149 Japanese boys and girls, aged between 10-17 years, attending elementary, junior and senior high schools in urban areas using the Asia health-related fitness test. The test battery consisted of an endurance run, Sit-ups, Pull-ups (modified Pull-ups for girls), Sit & reach in a sitting position to test flexibility and skin folds. Upon examining the results of the subjects of different grades and genders for each test item in terms of skewness and kurtosis, the following outcomes were noted:

- Endurance run times and Sit-ups results showed normal distributions except in the case of 10 years old girls where significant skewness was observed.

- Noticeable degrees of skewness were observed in Pull-ups scores of all groups, except in the case of 11 year old boys where skewness was less.

- Sit-and-reach results showed normal distributions except in the case of 11 year old boys.

- Skewed distributions in all groups and extreme skewness in 11 year old girls were observed in sum of skinfold thickness.

Upon examining various distributions of test results for each subject group, the following findings were noted:
- Endurance running times of 13 and 14 year old boys and 16 and 17 year old girls showed normal distributions and that of other age groups significant skewness.

- Sit-ups scores of 12 year old boys showed significant negative skewness, 12+ and upto 16 year old girls showed significant negative skewness, 12+ and upto 16 year old girls showed significant strong skewness and normal distribution when compared with all other age groups.

- Pull-ups scores of all age groups showed significant skewness except in 17 year old boys and 14 year old girls which showed strong kurtosis.

- Sit-and-reach performances of 16 year old boys and 14, 15, and 17 year old girls showed strong skewness.

- Sum of skinfold thickness of the 13 year old male group showed strong skewness.

Giving considerations to these results, five graded evaluation tables were developed. Ten graded evaluation percentile tables were specially developed for Sum of skinfolds.

Robson, Uppal and Bose (1981) conducted a study to determine the selected Physical Fitness components of boys and girls at different stages of elementary school level. 20 boys and 20 girls were selected at random from
each grade from one through five. Their age ranged from five to eleven years. The components tested were speed, shoulder strength, explosive power and agility. It was found from the analysis of the data that boys had more shoulder strength than girls in all grades and in Standing broad jump, there was no significant difference in the performance between boys and girls of grade one and two. Besides, boys of grade three and four were significantly superior to their girl counterparts in Standing broad jump. It was also found that boys of grade five were significantly superior to the girls of the same grade in 50 meter run and shuttle run.

The AAHPERD health-related fitness Test (1980) served as the criterion to select the low fit group for the second part. In the post-test only control group design was used, with one control (CD = 31) and two experimental (AD = 30; BD = 28) groups. Group A attended six 50 minute lecture discussion classes; group B read a series of six hand outs and answered the review questions. Students in all three groups (low fit, ages 17-26 years) were regularly attending physical activity classes during the experimental period. All groups were post tested for knowledge about health-related fitness and attitudes toward physical activity for health and fitness. Differences between experimental groups (A & B) and control (C) were analyzed by the Dunnett's significance test. The findings indicates that Trunk flexibility and Cardiovascular endurance (AAHPER) Test, 1980 of College
women in this study were below the values reported by previous studies in Brazil and in the United States for this age group.

The study concluded that Physical activity classes at Federal University of Santa Catarina should emphasize more flexibility and aerobic-type activities. Both experimental groups displayed better knowledge than the control group, which suggested that the short term course made a difference. Additionally the lecture-discussion approach appears to be effective in changing attitudes. The findings suggest that the implementation of regular, short term lecture-discussion course for low-fit college women in Santa Catarina would have a positive influence over atleast two of the pre-disposing factors to behaviour modification knowledge and attitude.

Ingersoll (1977) conducted a study to compare the motor performance of elementary boys and girls classified as per first grade with those classified as regular first grade. One hundred and seventy five subjects were selected and examined on each of seven variables of motor performance with exception of one variable. In the 300 yards each subjects classified as regular first were superior in their performance than to subjects classified as pre first male subject and were also significantly superior to female students.

Ponthieux and Barker (1973) investigated the relationship of several factors of physical fitness to the variables of socio-economic status. They found that lower socio-economic status girls were faster, better co-ordinated
and had better endurance but the upper status girls were stronger in arms and shoulder girdle strength and in abdominal strength and hip flexor muscles.

Loyd (1971) conducted a study to determine the difference between Negro and white boy's measures on Physical Fitness. Physical Fitness was measured by administering the three sub tests of AAHPER Youth Fitness Tests (Sit-ups, standing broad jump and soft ball throw). The findings indicates that Negro boys obtained a higher mean score than white boys on gross body co-ordination (soft ball throw) at both ninth and sixth grade level and at the ninth and tenth grade levels. The difference was significant at 0.05 level. Besides, negro boys were also significantly higher than white boys on standing broad jump at both fifth, sixth, ninth and tenth level at 0.01 level of significance.

Young (1970) while comparing the motor performance with socio-economic status tested fifty-six middle class and fifty-six lower class, five and six year old children for height, weight and performance in motor skill. The result indicated that the middle class students were significantly taller than the lower class. Besides, significant differences favouring lower class girls and boys were indicated in both throwing accuracy and distance. While, middle class boys recorded better on the distance throwing than the girls of either class. Lastly, middle class girls and lower class boys were faster than middle class boys and girls in running 30 yard dash.

Riddle (1969) investigated on the relationship between Physical Education activity performance, socio-economic status and personality need
of freshman and sophomore college women. A total of 3422 subjects were placed in groups on the basis of activity preference and skill level i.e. (i) lowly skilled, (ii) moderately skilled, and (iii) highly skilled. Stern's Activity Index was administered to determine personality need differences. The family background questionnaire was used to determine socio-economic status. Analysis of variance showed that fathers of highly skilled students enjoyed a significant higher occupational prestige rating than the fathers of lowly skilled students. It was also concluded that the socio-economic status for the university sample studied was not a significant factor in physical activity preference.

Ritcherson (1968) studied the relationship of several physical fitness variables in elementary school (100 fourth grade) boys and girls. Data on the following variables such as age, height, weight, IQ, leg strength, body movement time, 50 yard dash, shuttle run and standing broad jump were collected and correlated. The mean scores on AAHPER Test items were compared on National norms. Second significant correlations found that the highest being height with leg strength (0.48), leg strength with shuttle run (0.35) and leg strength with 50 yard dash (0.86).