CHAPTER II

REVIEW OF RELATED LITERATURE

To justify the research problem, undertaken in this piece of research various research findings relevant to this study from the field of physiology, physical education and sports were reviewed. They are presented below:

2.1 Review of literature related to Physical Education

Bale (1980)\(^1\) estimated body composition in fifty-three specialist women physical education students anthropometrically. Leg, back and grip strength dynamometers were used to measure strength indices. Arm strength was calculated from each subject's pull-ups and push-ups and lung capacity was measured using a spirometer. The somatotype ratings and percent fat measurements indicate that the P.E. students are generally more muscular and less fat for their age than non-P.E. students. There was a strong relationship between percent fat and the endomorphy rating and a moderate relationship between lean body weight and mesomorphy. The moderate relationship of the strength variables with the muscular rating, whether expressed as mesomorphy or lean body weight, suggests that the higher a subject's muscular component the greater their dynamic strength.

Hafner-Holter, Kopp and Günther (2009)\(^2\) described and compared influences from a physical activity program and a yoga program on well-being,

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mood, stress-coping, body-image and social competence in healthy people. Methods: 18 persons attending a gym and 21 taking part in a yoga program answered following questionnaires before entering the program and after taking part for 20 units: Body-Image-Questionnaire (25), Symptom-Checklist-90R (8), Complaint-List (31), Adjective Mood-Scale (32) and a Visual Analogue Scale for assessing stress-level (10). Results: Statistical analyses show significant improvement in social competence in both training groups; the gym-group report reduced sexual discomfort, whereas people taking part in yoga-group show a reduction in somatization and body-related anxiety as well as an improvement in physical and emotional well-being. Their findings support the evidence that physical activity in general improves psychological well-being, however, gym and yoga seems to have different psychological impacts.

Sallis et al., (1997) evaluated a health-related physical education program for fourth- and fifth-grade students designed to increase physical activity during physical education classes and outside of school. Seven schools were assigned to three conditions in a quasi-experimental design. Health-related physical education was taught by physical education specialists or trained classroom teachers. Students from these classes were compared with those in control classes. Analyses were conducted on 955 students with complete data. The results revealed that students spent more minutes per week being physically active in specialist-led (40 min) and teacher-led (33 min) physical education classes than in control classes (18 min; p < .001). After 2 years, girls in the specialist-led condition were superior to girls in the control condition on abdominal strength and endurance (p < .001) and cardiorespiratory endurance (p < .001). There were no effects on physical activity outside of school. From the results it was concluded that a health-related physical education curriculum can provide students with substantially more physical activity during physical

education classes. Improved physical education classes can potentially benefit 97% of elementary school students.

Another study by Stone et al., (2009)\(^4\) explored the relationship between short, frequent activity bouts and children’s health. In the method physical activity was recorded every 2 s by accelerometry (ActiGraph GT1M) for seven days in 47 boys (age 8-10 years). Summary activity measures and activity pattern characteristics (frequency, intensity and duration of > or = 4 s [short] and > or = 5 min [long] bouts of > or = light [> or = LIGHT], > or = moderate [> or = MOD], > or = vigorous [> or = VIG], and > or = hard [> or = HARD] intensity activity) were recorded. Microvascular function was assessed using laser Doppler perfusion imaging as the forearm skin blood flow response to the iontophoretic application of acetylcholine (endothelial dependent vasodilator) and sodium nitroprusside (endothelial independent vasodilator) at rest and following maximal exercise. Waist circumference, resting blood pressure and aerobic fitness (VO(2peak)) were measured. The intensity of short and long > or = LIGHT bouts and the frequency of short and long > or = MOD bouts were correlated with waist circumference (r = - 0.42 to -0.52, p < 0.01) and VO(2peak) (r = 0.42 to 0.47, p < 0.01), but not when scaled for lean body mass. The frequency of short and long > or =LIGHT bouts were associated with change in endothelial function from rest to post-exercise (r = 0.34 to 0.55, p < 0.05). No relationships were evident between blood pressure and activity. The researcher concluded that relationship between the frequency of short bouts (> or =4 s) of activity and health was as strong as relationships identified between longer bouts (> or =5 min) and health. This is encouraging as sporadic intermittent activity is characteristic of children’s activity pattern.

Fatness generally has a negative influence on the performance of a variety of motor and cardio-respiratory fitness tests. Osváth et al., (2009)\(^5\)


analyze the effects of three grades of obesity on somatic growth, physical performance and oxygen consumption during exercise by making comparison. Volunteer boys with definitely different grades of obesity were recruited for the comparison. In the group of mildly obese children (G1; n=23) BMI ranged between 24 kg.m\(^{-2}\) and 26 kg.m\(^{-2}\); and individual percent body fat was between 33% and 33.5%. In the case of moderate obesity (G2; n=23) BMI ranged between 26.5 kg.m\(^{-2}\) and 28.5 kg.m\(^{-2}\); and percent body fat was between 35% and 36%. In the extremely obese group (G3; n=20) BMI was greater than 31 kg.m\(^{-2}\); percent body fat was greater than 37.5%. Oxygen consumption during the 1,200 m run-test was measured by VIMEX-ST-type (USA) telemetric equipment. The greatest absolute aerobic power referred to the G3 boys, and the lowest oxygen consumption was characteristic of the mildly obese group. The very high differences between the body mass means resulted in a more marked inter-group variability in mean relative oxygen uptake. The predicted relative fat and high body fat content observed on the trunk, and the elevated level of resting blood pressure may indicate serious risks for the development of cardio-respiratory and metabolic disease. The very low oxygen consumption relative to body mass and poor physical performance are expected consequences of physiologic and environmental influences on the obese population.

The study done by Shin et al., (2009)\(^6\) examine the effects of exercise programs on physical fitness, depression, and self-efficacy in low-income elderly women (age > or = 75). A pretest-posttest experimental research design with a control group was used. The sample consisted of 26 women in the exercise group and 22 women in the wait-list control group in Seoul, Korea. The measures of physical fitness included body mass index, cardiopulmonary endurance (blood pressure and heart rate), muscle strength (hand grip strength), flexibility (degree of bending of the upper body), and balance (duration of time for which the subject could stand on one foot). Depression and self-efficacy were

measured by the Center for Epidemiological Studies Depression scale and a modified form of Lee’s scale, respectively. All measures were obtained twice: at baseline and at the completion of the exercise program. The exercise program consisted of 4 weeks of education along with 8 weeks of physical exercise. After the intervention, significant improvements were found in depression, self-efficacy, and all measures of physical fitness, except heart rate and flexibility, in the experimental group. Thus they concluded that the exercise program may be recommended as a method to maintain and promote the health of low-income elderly women.

Comprehensive school-based physical activity programs consist of physical education and other physical activity opportunities including recess and other physical activity breaks, intramurals, interscholastic sports, and walk and bike to school initiatives. This article by Lee et al., (2007)\(^7\) describes the characteristics of school physical education and physical activity policies and programs in the United States at the state, district, school, and classroom levels. The Centers for Disease Control and Prevention conducts the School Health Policies and Programs Study every 6 years. In 2006, computer-assisted telephone interviews or self-administered mail questionnaires were completed by state education agency personnel in all 50 states plus the District of Columbia and among a nationally representative sample of districts (n=453). Computer-assisted personal interviews were conducted with personnel in a nationally representative sample of elementary, middle, and high schools (n=988) and with a nationally representative sample of teachers of required physical education classes and courses (n=1194). Results: Most states and districts had adopted a policy stating that schools will teach physical education; however, few schools provided daily physical education. Additionally, many states, districts, and schools allowed students to be exempt from participating in physical education. Most schools provided some opportunities for students to be physically active outside physical education. Staff development for physical education was offered by states and districts, but physical education teachers generally did not receive

staff development on a variety of important topics. Conclusions: To enhance physical education and physical activity in schools, a comprehensive approach at the state, district, school, and classroom levels is necessary. Policies, practices, and comprehensive staff development at the state and district levels might enable schools to improve opportunities for students to become physically active adults.

The aim of this randomized study done by Walther et al., (2009) was to examine whether additional school exercise lessons would result in improved peak oxygen uptake (primary end point) and body mass index-standard deviation score, motor and coordinative abilities, circulating progenitor cells, and high-density lipoprotein cholesterol (major secondary end points). For this seven sixth-grade classes (182 children, aged 11.1+/-0.7 years) were randomized to an intervention group (4 classes with 109 students) with daily school exercise lessons for 1 year and a control group (3 classes with 73 students) with regular school sports twice weekly. The significant effects of intervention estimated from ANCOVA adjusted for intraclass correlation were the following: increase of peak \( \text{VO}_2 \) (3.7 mL/kg per minute; 95% confidence interval, 0.3 to 7.2) and increase of circulating progenitor cells evaluated by flow cytometry (97 cells per 1x10(6) leukocytes; 95% confidence interval, 13 to 181). No significant difference was seen for body mass index-standard deviation score (-0.08; 95% confidence interval, -0.28 to 0.13); however, there was a trend to reduction of the prevalence of overweight and obese children in the intervention group (from 12.8% to 7.3%). No treatment effect was seen for motor and coordinative abilities (4; 95% confidence interval, -1 to 8) and high-density lipoprotein cholesterol (0.03 mmol/L; 95% confidence interval, -0.08 to 0.14). It was concluded that regular physical activity by means of daily school exercise lessons has a significant positive effect on physical fitness (\( \text{VO}_2 \)max). Furthermore, the number of circulating progenitor cells can be increased, and there is a positive trend in body

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mass index-standard deviation score reduction and motor ability improvement. Therefore, they concluded that primary prevention by means of increasing physical activity should start in childhood.

Self-reported physical activity (PA) is well associated with cardiorespiratory fitness and exercise capacity. The short International Physical Activity Questionnaire (IPAQ-short) is a frequently used instrument for cross-national assessments of PA in adults. Papathanasiou et al., (2009)\(^9\) study was to validate IPAQ-short against exercise capacity in Greek young adults. One hundred and thirteen men and 105 women, aged 20-29 years, were randomly selected from a larger population of young health-science students. A Greek version of IPAQ-short (IPAQ-Gr) was administered to all participants before their exercise capacity evaluation with a maximal Bruce treadmill test. Multiple regression and correlation analyses were used to examine the associations between all IPAQ-Gr outcomes with exercise capacity based on maximal treadmill time. Spearman's correlations for total and vigorous PA against maximal treadmill time were significant in all groups examined, ranging from 0.35 to 0.43. Moderate and walking PA correlations were poor and non-significant, ranging from near-zero values to 0.19. In multiple linear regression analysis, only sex, smoking, and vigorous PA from all personal and log-transformed IPAQ-Gr data were significantly associated with maximal treadmill time. Partial correlation analysis for the overall population, adjusted for sex and smoking, showed that total PA (r=0.37) and vigorous PA (r=0.47) were significantly associated with exercise capacity. IPAQ-Gr was tested against exercise capacity and showed acceptable validity properties in Greek young adults. Total and vigorous weekly PA expenditure were well associated with exercise capacity, presenting significant validity correlations against maximal treadmill time.

Verstraete et al., (2007) evaluated the effects of a comprehensive physical activity (PA) promotion programme in elementary schools on children's total PA levels, leisure-time PA, physical fitness and psychosocial correlates of PA. Design: A pre-test-post-test design over two school years. Setting and Subjects: Sixteen elementary schools (764 children, mean age: 11.2 +/- 0.7 years) were randomly assigned to the intervention condition (n = 8) and the control condition (n = 8). The intervention included a health-related physical education programme, an extracurricular PA promotion programme and classroom-based PA education lessons. In the total sample, leisure-time PA, psychosocial correlates of PA and physical fitness were measured using a PA questionnaire and the Eurofit test battery. In a sub-sample, total PA levels were measured using an accelerometer. Results: According to accelerometer data, children's moderate PA and moderate-to-vigorous PA (MVPA) levels decreased less in the intervention schools than in the control schools (p < 0.01). The average time spent on MVPA decreased by 9 min per day in the intervention schools compared with 33 min per day in the control schools. Children in the intervention schools reported significantly more moderate PA in leisure time than the controls (p < 0.05). No overall improvement of physical fitness and no effects on the psychosocial correlates of PA were found. Conclusions: The comprehensive PA promotion programme was successful in preventing a decline in children's total activity levels. Furthermore, the intervention increased children's PA engagement in leisure time. Therefore, implementation needs to be encouraged.

2.2 Review of health related physical fitness

In a study done by Beckham et al., (1993) anterior compartment pressure was measured in 10 competitive runners and in 10


competitive cyclists who were asymptomatic for compartment syndrome. Pressures were measured at rest, after exercise at 80% VO\(_2\)max, after maximal exercise, and 15 minutes after both exercise bouts. No difference in compartment pressure was found after exercise at 80% VO\(_2\)max in runners and cyclists. Total creatine phosphokinase enzyme levels measured before and after exercise at 80% VO\(_2\)max showed a 10-fold increase in runners as compared to cyclists. Anterior compartment pressure measured after maximal exercise was significantly greater in runners as compared to cyclists. Compartment pressure showed no increase from resting values during cycling at 80% VO\(_2\)max or maximal exercise. These findings suggest that patients with chronic anterior compartment syndrome may be able to cycle without elevation of compartment pressure and concomitant pain as an alternative exercise to maintain a continued degree of fitness and training. Compartment pressures should be measured during cycling in patients with chronic compartment syndrome to determine its efficacy as a method for maintenance of cardiorespiratory fitness. (A comparison of anterior compartment pressures in competitive runners and cyclists.

Zahner et al., (2006) conducted a study to outline the design of a school-based randomized, controlled trial (RCT) aiming to increase overall PA and to improve fitness and health in 6- to 13-year-old children. 15 schools were randomized to the intervention (n=9) or the control (n=6) group, stratified by geographic region (urban vs. rural) and by age (1st and 5th grade). Participation was given for all children in the intervention group since in this group the intervention was part of the normal school curriculum. The intervention during one academic year consisted of: 1. two additional physical education classes per week given by trained physical education teachers adding up to a total of five PA classes per week, 2. Short PA breaks (2-5 min each) during academic lessons, and 3. PA homework and 4. Adaptation of recreational areas around the school. All children underwent anthropometric measurements, blood pressure

assessment, fitness testing, measurement of PA and they filled out questionnaires. At least 70% of all children agreed to blood sampling and measurement of body composition and bone mineral measurements by dual energy x-ray absorptiometry. The primary endpoints of the study after one year were an increase in total PA by accelerometry, an increase in aerobic fitness measured by the 20m shuttle run, a decrease in percent body fat derived from skinfold measurements and an increase in quality of life as assessed by the child health questionnaire in the intervention group as compared to the control group. Secondary outcomes were overall fitness, differences in body composition including body fat distribution, cardiovascular risk factors, psychosocial health, bone mineral content and density of femur, lumbar spine and total body and food intake.

Physical activity, physical fitness and motor competence are important health-related constructs. However, the relationship among them, particularly for children and adolescents, is still unclear. In this study, conducted by Hands et al., (2009) 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.

Fogelholm *et al.*, (2007)\(^{14}\) studied the associations of overweight (OW, BMI $\geq$ 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 and reach, five-jump, back and forth jumping, balls 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 test was significant ($P \leq 0.005$). The main effect OW was significant ($P < 0.002$) for all tests, except for sit and 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 and reach test (coefficient 0.04) and only weekly with the ball skill test (coefficient-0.10 to -0.12). In conclusion, OW had the most negative association with cardio respiratory and muscle endurance and explosive power tests.

Marshall, Sarkin, Sallis and McKenzie (1998)\(^{15}\) conducted this study with a view to examine the tracking of multiple health-related fitness components in children from fourth to sixth grade. Methods: 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. For boys 3-yr correlations of body mass index (BMI) (0.89), skinfold thickness (0.80), sit-and-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-and-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. Results suggest that relative rankings of BMI, skinfold thickness, and sit-and-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.

Baquet et al., (2006) analyzed health-related fitness values during childhood (from age 11 to 16 years) in relation to changes in physical activity level. One hundred and fifty eight children were monitored over a 4-year period. Twice a year, they performed six physical fitness tests: standing broad jump, 10 x 5 meter shuttle run, sit and reach, handgrip, number of sit ups in 30 s, and 20 m shuttle run. Height was measured four times a year to access age at peak height velocity. Physical activity was assessed with a self administered questionnaire at baseline and at the end of the follow up. The physical activity level was defined by the frequency and the time spent in moderate to vigorous physical activities. Two groups were constituted: regularly active and sedentary. A multiple linear multilevel regression analysis was used to analyze the longitudinal relationship between changes in physical activity and physical fitness levels. Correlations were made for both time dependent (time) and time independent (sex) variables. Except for flexibility, boys’ fitness performances increased more than that for the girls. Positive and significant (p<0.05) regression coefficients were found with the regularly active for standing broad jump, 20-m shuttle run, number of sit-ups 10 X 5-m shuttle run in both sexes, and for the girls’ sit and reach performance. Increasing or decreasing physical activity level was not associated with changes in fitness performances over time, except for flexibility for the girls and the 20 m shuttle run for the boys. From childhood to adolescence, increasing physical activity is associated with improvement in fitness performances.

activity is not sufficient to be more fit. The children who are stayed the most active were the fittest, particularly the girls.

Hay (2000)\textsuperscript{17} evaluated 1. One Mile Walk/Run Cardiovascular/ Aerobic Endurance 2. Sum of Skin Folds Body Fat Percentage 3. Sit and Reach Flexibility (Lower Back and Hamstrings) 4. Sit Up Abdominal Strength and Endurance 5. Pull Up Upper Body Strength and Endurance of a fourteen year old female. After evaluating this student’s test, it is apparent that the student is not exactly physically fit, but definitely not overweight. The one-mile walk/run, proves that the student has had little or no exposure to cardiovascular/aerobic workouts. The sum of her skin fold test however, proves she is quite lean for her age. Her flexibility was good according to her sit and reach test scores, and the pull up test showed that she meets the standard for her age. Similarly, the evaluation was done on a second student of fourteen year old male. His one-mile walk/run shows that he is not in great physical condition. His skin fold test further explains his cardiovascular disappointment, as he is definitely overweight with a skin fold of 30. His flexibility is probably another factor of his weight. His sit and reach test was 20 cm, which definitely under the national standard. His sit up test was right on the nose with the standards, which proves this is probably an abdominal strong young man, but just the opposite in arm strength, not even reaching one pull up. Also, this may be a factor of his weight. After an experiment, this study suggests the suitability of AAHPERD’s Health Related Physical Fitness.

Mikkelsson et al., (2006)\textsuperscript{18} investigated relationships 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 (2,000m boys or 1,500m 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 and reach test. The adult heath related physical fitness index (APFI), stratified by sex, was formed by

\textsuperscript{17} Hay and Melissa, J. (2000). Health fitness project health components. Motor Behavior, 35, 2, pp.16-22.

summing the z-scores of a bicycle ergometer test, sit-up test, handgrip test, and sit and reach test. Height and weight adjusted correlation 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 and reach tests, 0.41 (95% CI, -0.04 to 0.72) and 0.55 (95% CI, 0.20-0.78) in sit and reach 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 sit and reach test for men and sit up test, flexed arm hang, and BMI in 2001 for women.

In the Amsterdam Growth and Health Longitudinal Study (AGAHLs) conducted by Kemper et al., (2001) a cohort of about 400 boys and girls (mean age 13 years) were followed over a period of 20 years. Over that period repeated measurements were done of body dimensions (height, weight, skinfolds), physical fitness (eight motor performance field tests: plate tapping, bent arm hang, 10 x 5 m sprint, arm pull, sit and reach, standing high jump, 10 leg lifts, 12-min endurance run, and one laboratory test to measure maximal aerobic power), and physical activity (by a cross-check interview). Three research questions were studied: (1) Is there a positive relationship between adolescent fitness (age 13-17 years) and adult physical activity (age 33 years)? (2) Do physical fitness and physical activity track from adolescence into adulthood? (3) What is the longitudinal relationship between physical fitness and physical activity? Multiple linear regression analysis showed that of the 9 physical fitness tests, only the 12-min endurance run and the maximal aerobic power during adolescence are significant (p < 0.05) predictors of adult physical activity. The effects are not influenced by biological age but by sex: only in females are the predictions significant (p < 0.05). Tracking over the period of 20 years estimated from stability coefficients showed values for physical fitness varying between 0.83 (plate tapping) to 0.38 (standing high jump and maximal aerobic power). Physical

activity shows lower stability coefficients (0.35-0.29). A longitudinal linear regression technique was used to analyse the relationship between physical activity and physical fitness over the 20-year period; in this analysis corrections were made for both time-dependent (time, biological age, and cardiovascular factors) and time-independent variables (sex). All physical fitness tests show positive and significant (p < 0.05) standardized regression coefficients with physical activity, but the explained variance is less than 1%. Only maximal aerobic power has a higher explained variance of 1.8%. It can be concluded that: (1) Physical fitness in adolescence is only weakly related to adult physical activity; (2) between age 13 and 33 years, physical activity has low stability and physical fitness was higher stability; and (3) the longitudinal relationships between physical fitness and physical activity are only meaningful with maximal aerobic power.

Knopfli et al., (2008) evaluated the gender differences of an 8-week multidisciplinary inpatient program on body weight, body composition, aerobic fitness, and quality of life of severely obese children and adolescents. Methods: Body weight was measured daily, and body composition, aerobic fitness, and quality of life were measured at the beginning and the end of an 8-week multidisciplinary inpatient program in 130 severely obese patients (52 girls, 78 boys), median (25th, 75th percentile) age of 13.8 (12.1, 15.0) years, median body weight of 89.4 kg (77.1, 100.1), and a body mass index of 33.4 (30.1, 36.6) kg/m(2), which is well above the 98th percentile. The inpatient program was based on a multidisciplinary treatment and education program that focused on daily physical activity, a 1200-1600 kcal/day balanced nutrition regimen, and a behavior modification therapy. Results: All results are expressed as medians (25th, 75th percentiles). At the end of the program all patients had lost a significant amount of body weight: 12.7 kg (10.8, 16.6), p < .001, girls 11.6 kg (9.7, 13.2), boys 13.7 kg (11.7, 17.3), p < .001, absolute body fat 8.0 kg (6.8, 20 Knöpfli, B. H., Radtke, T., Lehmann, M., Schätzle, B., Eisenblätter, J., Gachnang, A., Wiederkehr, P., Hammer, J., and Brooks-Wildhaber, J. (2008). Effects of a multidisciplinary inpatient intervention on body composition, aerobic fitness, and quality of life in severely obese girls and boys. J Adolesc Health, 42, 2, pp.119-1127.
10.0) p < .001, girls 7.0 kg (5.7, 8.1), boys 9.4 kg (7.6, 11.0) p < .001, % body fat per kg body weight: 4.9% (3.2, 6.6) p < .001, girls 3.7% (2.7, 4.9), boys 5.7% (4.0, 7.5) p < .001, and absolute fat free (or lean body) mass: 1.8 kg (0.64, 3.0) p < .001, girls 1.8 kg (0.87, 3.2), boys 1.7 kg (0.50, 2.9) p = .43. In addition, all measurements of aerobic fitness: VO(2)peak (mL/min.kg) and peak mechanical power (watts and watt/kg) and of quality of life increased significantly (p < .001, p < .001, p < .004 to p < .001). Conclusion: A multidisciplinary inpatient treatment program including moderate calorie restriction, daily physical activity, and behavior modification induced a major weight loss, a decrease in body fat, and an increase in aerobic fitness as well as the quality of life of severely obese children and adolescents. Weight loss and the decrease in body fat (absolute and percent) were significantly more pronounced in boys than girls.

Gao (2008)\(^\text{21}\) investigated the predictive strength of perceived competence and enjoyment on students’ physical activity and cardiorespiratory fitness in physical education classes. Participants (n = 307; 101 in Grade 6, 96 in Grade 7, 110 in Grade 8; 149 boys, 158 girls) responded to questionnaires assessing perceived competence and enjoyment of physical education, then their cardiorespiratory fitness was assessed on the Progressive Aerobic Cardiovascular Endurance Run (PACER) test. Physical activity in one class was estimated via pedometers. Regression analyses showed enjoyment (R\(^2\) = 16.5) and perceived competence (R\(^2\) = 4.2) accounted for significant variance of only 20.7% of physical activity and, perceived competence was the only significant contributor to cardiorespiratory fitness performance (R\(^2\) = 19.3%). Only a small amount of variance here leaves 80% unaccounted for. Some educational implications and areas for research are mentioned.

Foglholm et al., (2006)\(^\text{22}\) conducted a study with the hypothesis: (1) cardio-respiratory (CRF) and neuromuscular (NMF) fitness is associated with

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body mass index (BMI) and waist circumference (WC), independent of each other and of leisure time physical activity; (2) individuals with high CRF and NMF have lower (WC), for a given BMI, compared with those with low CRF and NMF.

Design: cross-sectional study. Setting: Men participating in refresher training organized by the Finnish Defence Forces. Participants: A total of 951 men (mean age 29.1, s.d. 4.2 years; BMI 25.3 kg/m², s.d. 3.8; WC 91, s.d. 11 cm). Main Outcome Measures: Body mass index, WC, maximal oxygen uptake (VO(2)max), height of vertical jump, number of push-ups and sit-ups during a 1 min test, static back extension endurance, isometric grip strength, self-reported leisure-time vigorous physical activity. Multiple linear regressions were used to explain the variation in fitness. Result: Waist circumference had significant (p<0.001) negative association with all test results (standardized beta coefficients from -0.23 to -0.77), except for grip strength. Body mass index had significant negative association with VO2max (-0.12; p<0.05), but positive association (p<0.01) with grip strength (0.28), vertical jump (0.21) and push-ups (0.55). For a given BMI, the estimated WC was highest among those with the poorest results for VO2max, vertical jumps, sit-ups and push-ups. Conclusion: Despite stronger isometric grip strength, the functional muscle fitness of the upper body, trunk and lower extremities is impaired in individuals with abdominal obesity. Although the known loss of CRF is a serious consequence of obesity, the deterioration of NMF deserves increased attention.

As the body mass index (BMI) norms for children and adolescents are developed from a reference population that includes obese and slim subjects, the validity of these norms is influenced by the observed secular increase in body weight and BMI. Hence, Chen et al., (2002)23 hypothesized that the performance of children in health-related physical fitness tests would be negatively related to increase BMIs, and therefore fitness tests might be used as a criteria for developing a more appropriate set of BMI norms. The investigators evaluated the existing data from a nation-wide fitness survey for students in

Taiwan (444 boys and 433 girls) to examine the relationship between BMI and fitness tests. The fitness tests included: an 800/1600-m run/walk; a standing long jump; bent leg curl ups; and a sit and 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 BMIs 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 BMI percentile curves of this fitter subgroup were lower than those of the total population. The 85th and 95th BMI percentile values of the fitter 18-year old students (23.7 and 25.5 kg m\(^{-2}\) for boys; 22.6 and 24.6 kg m\(^{-2}\) for girls) linked well with the adult cut off points of 23 and 25 kg m\(^{-2}\), 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 sub groups that have better physical fitness. From this experiment the researchers of this study expect 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.

Dulaney (1991)\(^{24}\) conducted a study to determine if a flexibility training programme would improve performance on flexibility tests for first, third and fifth grade M and F (n=228) The children were tested for the sit and reach test and the V-test 3 times during a 6wk treatment period and once after a 6wk latency period. The children, per grade level, were randomly assigned to 3gps, a control group and 2treatment groups (stretching exercises twice a wk or 5times a wk). A 3*3*4 ANOVA with repeated mean revealed that M and F, regardless of what grade or gp, sig (p<05) improved on the sit and reach test over the 6wk treatment period, however, their scores decreased on the v-sit test scores continued to worsen. The results suggest that the PE programme during the treatment period contributed to the improvement in Sit and reach test performance but improved V=set test performance.

The protective effects of physical activity and fitness on cardiovascular health have clearly been shown among adults and, to a lesser extent, among children and adolescents. However, data are currently lacking pertaining to children and adolescents living in Switzerland. Hence, Michaud, Narring Cauderay and Cavadini (1999)25 conducted a study with the objectives to gather data on the physical fitness and physical/sports activity of children and adolescents aged 9 to 19 years. Method: 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. Result: Most of the respondents practise 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 < 0.01); 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. Conclusion: 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.

Monyeki et al., (2005) conducted a study with the purpose to determine the relationship between the body composition characteristics, body mass index (BMI), sum of skin-folds (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 consisted of 462 boys and 393 girls who were aged 7-14 years. Five body composition measures were assessed: BMI, SSF, %BF, FFM and WHR. Nine physical fitness items were assessed: standing long jump, bent arm hang, sit ups, 10x5 m shuttle run, 50 m sprint, 1600 m run, flamingo balance, sit and reach, plate tapping. The results revealed 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 worst in arm hang (girls, B=-0.84, p<0.001, and B=-0.06, p=0.02, respectively) and in 1600 m 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 and 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 and 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 and 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 and reach (boys, B=0.59, p=0.03). In this study in 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.

Impact of promoting lifestyle activity for youth (play) on children’s physical activity this study was conducted by Pangrazi, Beighle, Vehige and Vack

This study examined effects of a school-based intervention called PLAY (Promoting Lifestyle Activity for Youth) on physical activity levels and body mass index (BMI) of students. Participants included 606 fourth-grade students selected from a stratified sample of 35 schools in Arizona and placed into four groups: PLAY & PE, PLAY Only, PE Only, and No Treatment. A treatment-control, post-measurement design assessed physical activity using the YAMAX pedometer, and height and weight data were collected following the intervention. One-way ANOVAs were used to analyze the data. Results indicated the treatment was effective at increasing the physical activity level of children, especially girls. No significant differences between groups were found for BMI. Programs such as PLAY, which can increase the activity level of children, may have significant health implications for youth.

Suzuki and Tatsumi (1993) determined characteristics of physical fitness in obese children, and to examine the effect of a diet exercise program, developed in our laboratory, on the physical fitness of these children. To accomplish the first objective, a physical fitness test consisting of 11 items was administered on 126 obese and normal weight children (Boys 83, Girls 43) matched for age, sex and stature. The children 9-10 years of age were pupils from 11 public elementary schools in Morioka, Iwate, Japan. To accomplish the second objective, 92 obese children participated in a study. The children were divided into experimental and control groups. Children in the experimental group (n=50) participated in a diet exercise program for three months, while children in the control group (n=42) were left alone without taking part in the program. The results of this study are summarized as follows; 1. The obese children were found to be significantly inferior to the normal weight children in fitness items such as standing long jump, pull ups, sit-ups, step test, and total fitness scores. While no difference in lying trunk extension and standing trunk flexion for body


flexibility were observed, the obese children were found to be superior to the normal weight children in static strength such as grip and back strengths. 2. The poor physical fitness of the obese children was found to be negatively affected by their excess body fat, rather than body weight, and that this trend was more pronounced for boys than for girls. 3. The intervention study clearly demonstrated that children in the experimental group improved in physical fitness for most items, especially in abdominal muscle endurance, aerobic capacity and total physical fitness. 4. It was shown that the diet exercise program, which comprised guidance on physical exercise and individual nutritional counseling, was very useful, because the participants should decrease a considerable in percent overweight and body fat, but without limiting their linear growth velocity or reducing their LBM.

Wallace (1975) took thirty-one college women (age 17 to 42) and divided them into four age groups to observe the effects of four months of cardiovascular training on the composition of body fat. Training was 3 days/week for an average of 15 minutes which session, at 80% of physical work capacity. Measurement of percent body fat, weight and girth were taken before and after four months of training. Daily caloric needs and daily caloric intake were measured along with the caloric expenditure of each workout. Each group decreased in percent body fat, and one group decreased significantly. This significant decrease was found in the group that was extremely the optional fat ranges. The remaining groups were within the optional fat ranges. Weight changes did not reflect fat loss due to lean body mass development. Daily caloric needs were equal to daily caloric intake, which would indicate fat maintenance. All fat lost was therefore due to the caloric expenditure of the training. Over fat individuals can reduce body fat significantly with simple cardiovascular training of walking and running. Individuals within the optional ranges can maintain body composition with simple cardiovascular training of walking and running. Increasing the intensity, duration and frequency of exercise can reduce further fat.

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Sallis, Mckenzie and Alcaraz (1993) examined the relationship between habitual physical activity and components of health related physical fitness in children. Design: cross sectional survey with correlational analysis. Setting: Seven public elementary schools in a suburban southern California city. Participants: Five hundred twenty eight healthy fourth grade children (274 boys and 254 girls), 85% of whom were non-Hispanic whites. Ninety eight percent of eligible students participate. Interventions: None. Measurements/Main results: Results of six measures of physical activity in children (monitoring by acceleroscope, 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: the mile run, skin fold tests, pull- ups, sit-ups and the sit and reach test. The physical activity index was significantly associated with all five fitness components. The canonical correlation was 0.29. Conclusion: Active children appear to engage in a sufficient variety of activities to enhance multiple components of health related fitness.

34 subjects (13-18 years) participated in the study of Baldwin (1991) to evaluate the physical fitness effect experienced by engaging in the North East PA. The experimental (aerobic) group met 5 days a week, 50 mins. per session for 16 weeks. 24 experimental subjects were dropped because they exceeded 3 absences, which the study defined as a limit. The control group was not permitted to take physical education course during research period. Control subjects were selected randomly across 5 grade levels (B-12), out of study period. Pre- and post-data were collected on 5 fitness parameters: cardiovascular endurance, flexibility, muscular endurance, muscular strength, and body composition. The following tests were utilized: a 5 minutes Astrand Rhyming Step Test, a Sit and Reach Test, a One-min. modified Sit Up Test, a


Hand Grip Dynamometer Test, and Skinfold means with Lange Skinfold Calipers. Results indicated only significant improvement in muscular strength from aerobic programme participation. No significant improvements were demonstrated in cardiovascular endurance, flexibility, and muscular endurance or body composition.

Pollock et al., (1971)\textsuperscript{32} studied the effects of walking on body composition and cardiovascular function of middle-aged men. Sixteen sedentary men 48.9 years of age volunteered to train 40 min, 4 times/week, for 20 weeks. Eight controls of similar qualification were also evaluated. Training progressed from 2.5 miles during week 1 to 3.25 miles during weeks 16-20. The experimental group increased significantly in oxygen intake capacity from 2.30 to 2.941/min (± 28%). Pulmonary ventilation from 86.9 to 102.61/min (STPD: + 15%) and oxygen pulse form, resting heart rate and systolic blood pressure did not change. Resting diastolic blood pressure reduced significantly from 77.7. to 74.9 mm Hg. Heart rate reductions from a standard treadmill walk ranged from 4 to 17 beats/min during exercise and from 16 to 20 beats/min during recovery. Body composition showed reductions in total body weight (-1.3 kg) and percent fat (-1.1%). The control group remained constant in most cardiovascular functions and body composition measures. Vigorous walking training had significant effects on cardiovascular function and body composition of adult men.

Yoshizawa, Ishizaki and Honda (1977)\textsuperscript{33} determined maximal oxygen uptake (VO2 max) of 85 healthy kindergarten children, 46 boys and 39 girls, aged 5 and 6 years, by means of track running. Their physique, skin-fold thickness, grip and back muscle strength, and performances of 25m run, 50m run, standing broad jump, and 5 minutes endurance run were also measured. Skin-fold thickness of girls was significantly larger than that of boys. Boys were significantly superior to girls in all the motor performances. The VO2 max per unit


of body weight was 49.46 ml/kg/min for boys and 46.30 ml/kg/min for girls, the sex difference being significant at the 0.001 level. The correlation coefficient between VO2 max per kg body weight and 5 min endurance run performance was 0.417 for boys and 0.049 for girls, while that between absolute VO2 max and body weight was 0.899 for boys and 0.563 for girls. The regression equation of the absolute value of VO2 max (liter/min) of body weight (kg) was: Y=0.051X-0.025 for boys and Y=0.024+0.408 for girls, regression coefficient of boys being twice as large as that of girls. It appears that at ages 5-6 sex differences are exhibited not only in muscle strength and agility but also in endurance run and aerobic work capacity.

Stewart and Gutin (1976)\textsuperscript{34} studied the changes in sub maximal and maximal HR and VO\textsubscript{2} as a result of 8 weeks interval training in boys aged 10-12 years. 13 boys trained while 11 acted as controls. Training HR.S averaged approximately 9% of the mean maximal HR. VO\textsubscript{2} max did not change significantly with training, the apparently high thresholds for a training effect on VO\textsubscript{2} max in children is probably related to their naturally active levels. The stresses induced by short term training are probably small as compared to the overall activities of children. On the other hand sub maximal heart rate during bicycle and treadmill exercise decreased significantly with training. The O\textsubscript{2} cost of these submaximal tasks remained unchanged. The findings suggest that the use of VO\textsubscript{2} max as the only training criterion for cardiorespiratory fitness may be misleading. Since most work tasks proceed at a submaximal rate, and training induced improvement in submaximal response was demonstrated without improvement at maximal effort. Perhaps submaximal physiological and performance measures are more important than maximal ones in the assessment of cardiorespiratory fitness.

Marshall et al., (1998)\textsuperscript{35} conducted a study with a view to examine the tracking of multiple health related fitness components in children from fourth to sixth grade. A battery of fitness test was used to measure 414 children (213 boys, 201 girls, mean=9.48 yr, +/- 0.41) from three elementary schools in South California. Children were assessed during the fall and spring of each grade. Baseline scores were correlated (Spearman) with each subsequent time point. Results: For boys 3-yr correlations of body mass index (BMI) (0.89), skin-fold thickness (0.80), sit and 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 skin-folds (0.75), sit and reach test (0.72), and 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. Results suggest that relative rankings of BMI, skin-fold thickness, and sit and 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.

Christine et al., (1950)\textsuperscript{36} conducted a study on body composition and aerobic requirement of male and female marathon runners (seven male and four female marathon runners). It was determined that experienced female runners as well as male runners were able to work at a high fraction of their aerobic capacity during actual marathon competition. And both the male and female marathon runners had more than lean body mass. Further no significant differences in these parameters were observed between the male ad female runners studied.


Shire et al., (1977)\textsuperscript{37} studied the effect of high resistance slow rate (HR-SR) and low resistance fast rate (dr-fr) training on cardiorespiratory function and body composition. 34 college women (age 17 to 22 years) were randomly assigned to one of the three groups: HR-SR (n=13); LR-FR (n=11); or c (control, n=10). Assessment of cardiorespiratory function (using a progressive load bicycle ergometer test to maximal exertion) and body composition (anthropometric and underwater weight) were made before and after ten weeks physical training programme. The experimental subjects trained on a bicycle ergometer three days per week, with the time per training session progressively increased from 20 to 25 min over the ten week period. The work load for each subject was set to elicit approximately 70% of that subjects pretraining VO$_2$ max to equate the total mechanical work of the two training groups. Both training groups HR-SR and LR-FR significantly increased relative to the control group in VO$_2$ max (12%, 12%) O$_2$ pulse max (12%, 12%) work output (79% to 60%) and total rides times (57% to 51%), but difference between the training groups was not significant. No significant alteration in body weight or body composition was found. These results suggest that the cardiorespiratory adaptations measured are independent of those modes of training.

Gutin et al. (1978)\textsuperscript{38} examined the extent to which variance in endurance performance could be explained by various physiological and morphological factors in 11 to 12 years old girls (n=33). VO$_2$ max (ml/kg/minute), determine in a multistage treadmill test was significantly related to run time ($r=-.70$). However when percentage of fat as estimated from skinfolds and girths was held constant. The partial correlation was 90. The correlation between the sum of five skinfolds and run time was 92, the greater amount of subcutaneous fat was associated with poorer performance. the second independent variable to be selected onto a forward selection regression equation was the score on all out 1-minute step test.


an indirect measure of anaerobic capacity. The third variable selected was an index of maturity—whether or not the girls had achieved menarche: the more nature girls tended to do worse on the run. these three variables accounted for 90% of the variance in run time (R=95). The Dominance of fat as predictor of endurance performance was attributed to the extraordinary variability that exists in this parameter in girls of this age.

2.3 Review of Sports Physiological Parameters

Body weight is a very good and easily done parameter through which the effect of training can be judged grocely. It has been seen in a number of experiments that body weight is affected the most to the exercise related stress. Body mass index, or BMI, is the ratio of the square of one’s height to his/her weight. BMI is a very simple tool. Knowing how to calculate your body mass and fat percentage is an excellent way to measure the success and effectiveness of one’s exercise. As a person's BMI increases so do the risk of ill health. The BMI is the ratio of your weight to the square of your height. The number is proportional to your body shape. Generally, the number is small for thin people and large for fat people. People with a BMI 25 or greater are considered overweight, unless they have a very muscular body. (Duncan et al., 2009) examined the effect of 6-week circuit-based training on body esteem and body mass index (BMI) in 68 British children (34 boys and 34 girls, aged 10–11 years, 16% overweight, 7% obese). The Body Esteem Scale for Children (BES-C) was administered to both the intervention group and control group, pre, post and 6 weeks post the intervention. BMI was directly assessed from height and body mass pre- and post-intervention. The results of the study revealed that, as compared to the control group, participation in 6-week circuit training significantly improved body esteem scores post-intervention. However, these scores were not sustained 6 weeks post-intervention. The improvement in body esteem scores from pre- to post- intervention was greater for girls as compared to boys.

Additionally, BMI decreased significantly in the intervention group compared to the control group.

Glenn (1980) determined if the physiological responses due to training are the same for walkers and joggers when the distance is kept equal. Experiments were designed to determine the effect of 20-week training program on the following body composition variables: body density, percent fat weight, lean body weight and total weight. Experiments were also designed to determine the effect of the training on the following cardiorespiratory variable during submaximum exercise and recovery: oxygen consumption, respiratory exchange ratio, oxygen pulse, heart rate and blood pressure. Under water weighing maximum inspiration was used to determine body composition changes. A modified Balke treadmill test to a heart rate of 150 and a standard treadmill walk at three miles per hour on a five percent grade for five minutes and a ten minute recovery were used to determine cardiorespiratory changes. Expired gas samples were taken for one minute at a heart rate of 150 during the modified Balke and during the last minutes of the standard treadmill walk, blood pressure was taken at rest immediately after exercise in both treadmill test and during the last minute of recovery in the standard treadmill walk. Heart rate was recorded at the end of each minute of exercise and recovery in the standard treadmill walk.

Twenty five untrained subjects age 25-52, participated in the training and testing. A two way analysis of variance with subjects repeated across time was used to determine if any significant difference existed between the means due to time, type of training or an interaction of time and type. If significant F-ratio were found for time Duncan’s multiple range test was utilized to determine where the differences occurred.

In a study by Slinger et al., (2006) body build was defined more specifically using fat free mass index (FFMI = fat free mass normalized to the

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stature) and fat mass index (FMI = fat mass normalized to stature). The body build of an individual is ‘solid’ in individuals with a high FFMI for their FMI and is ‘slender’ in individuals with a low FFMI relative to their FMI. The aim of the present study was to investigate the association between aerobic test, performance and body build defined as solid, average or slender in 10 to 15 year old children. Five hundred- and-two children (53% boys) aged 10 to 15 years of age were included in the study. Aerobic test performance was estimated with an incremental cycle ergometer protocol and a shuttle run test. BMI and percentage fat (by skin folds) were determined to calculate FMI and FFMI. After adjustment for differences in age, gender and body mass the solid group achieved a significantly higher maximal power output (W) and power output relative to body mass (W/kg) during the cycle test (p<0.05) and a higher shuttle-run score (p<0.05) compared to the slender group. The power output relative to FFM (W/kg FFM) was comparable (p>0.05) between different body build groups. This study showed that body build is an important determinant of the aerobic test performance. In contrast, there were no differences in aerobic test performance per kilogramme FFM over the body build groups. This suggests that the body build may be determined by genetic predisposition.

Belle (1983) investigated the effects of aerobic dance on physical work capacity, cardiovascular function and body composition of middle aged women. Maximal oxygen uptake, heart rate during submaximal treadmill walking, resting heart rate, blood pressure and body composition assessed using hydrostatic weighing and skinfold. Circumference measures were determined before and after a ten week aerobic dance conditioning program in 28 women (18 experimental and 10 control), aged 25 to 44 years. During the 10 week treatment period, the experiment's subjects participated in 45 minute of aerobic dance that utilizes 70-85% of the heart rate reserve, 3 days/week whereas the control group continued their normal physical activity pattern VO$_2$ max increased significantly (p. 05) in the experimental group by 0.142 (1/min 16%) or 1.8ml/kg min (5%) where as the control group decreased significantly (p .05) by 0. 1171/min (6.0%)

and 2.5 ml/kg min (7.7%). The on the modified Balke treadmill test increased significantly by 2.1 minutes in the experimental group and did not change in the control group. Heart rate of submaximal workloads on the treadmill test decreased 14-18 beats /min in the experimental group and increased 1-4 beats/min in the control group. Resting heart rate and systolic blood pressure decreased significantly in the experimental groups by 5 beats/min and 6 mm Hg, respectively, but did not change in the control group. Body weight, % fat weight, fat free weight estimated using hydrostatic weighing: sum of 7 skinfolds and sum of 7 circumferences did not change significantly in either groups. It was concluded that a 10 week aerobic dance program produces small but significant improvement in physical work capacity and cardiovascular functions, but without dietary control, does not alter body composition in sedentary middle-aged women.

Lung function tests (also called pulmonary function tests or PFTs) evaluate how well lungs work. Various studies have suggested that body size and in-hospital mortality are related. However, only a few analysed the effects of obesity on pulmonary complications following coronary artery bypass graft surgery (CABG). In a study by Akdur et al., (2006)43 the purpose was to assess early changes in lung volumes, respiratory complications and arterial blood gas tension following CABG in obese women. Pulmonary function tests (PFTs), treadmill exercise capacity tests (TM), arterial blood gases and pulmonary complications were studied in 124 obese (mean age 57.2+-5.8 years) and 108 non-obese (mean age 58.6+-5.9 years) female patients undergoing elective CABG. PFT, TM tests, arterial blood gas analyses and CXR were performed in the preoperative and postoperative periods and pulmonary complications were recorded. Breathing and coughing exercises, early ambulation and pulmonary clearing techniques were used by physical therapists to prevent pulmonary complications after CABG surgery. Postoperative PFT and TM tests deteriorated significantly in both groups (P<0.0001). The deterioration in the obese group was

highly significant. The postoperative deterioration of blood gas measurements in obese patients was also statistically significant compared to non-obese patients. Early pulmonary complications developed in 21 (16.94%) of the obese patients and in 10 (9.25%) of non-obese patients. Duration of mechanical ventilation, intensive care unit and hospital stays were longer compared to the non-obese patients (P=0.008, P<0.0001, P=0.0386, respectively). And their conclusion was that, obesity has a detrimental effect on pulmonary function, exercise capacity, blood gas measurements and complications rates in postoperative period following CABG surgery.

Stein (1991)\(^{44}\) examined the difference in vagal tone between non-trained (n=6) and endurance trained (n=6) collaged male at the initiation and termination of aerobic exercise. Subjects completed an activity history form and a test of aerobic capacity for classification as endurance trained (ET) and nontrained (NT). At the initiation of exercise vagal tone was analysed during the last 2 minutes of walking (3.5 mph; 6% grade) through the first 2 minutes of running (6 mph; 6% grade), and at the termination of exercise vagaltone was analysed during the last 2 minutes of the final run (a speed which elicited 95% of the individual’s \(\text{VO}_2\text{ max}\); 6% grade) through the first 2 minutes of recovery walking (3.5 mph; 0% grade). ECG was monitored continuously and recorded for subsequent off-line analysis of the heart period. The data were subjected to a 2 x 2 x 4 (Group x Workload x Interval) ANOVA with repeated measures on the last 2 factors. This design was used for phase I, the initiation of exercise, and again, separately, for phase II, the termination of exercise. Intervals referred to the 2 minutes work periods, which were divided into four 30 sec periods. Alpha was set at 0.05. At the initiation of exercise ANOVA for V showed significant main effects for group and workload. ET subjects exhibited a greater degree of vagal tone, and vagal tone was observed to be greater during walking. So significant interactions were revealed. Results indicate that endurance trained and nontrained individuals exhibit similar phasic alterations in vagal tone at the

initiation and termination of aerobic exercise. Although nonsignificant, endurance trained individuals demonstrated an initial rapid return in V during the first 30 second of recovery relative to the nontrained.

In another study done by Pakkala et al., (2005)\(^4^5\) aimed to determine during exercise the maximum related oxygen transport viz, maximum heart rate (max HR), dyspnoeic index (DI), oxygen pulse (O2 pulse), recovery heart rate in an athletic and a non-athletic group. Both study groups were subjected to graded treadmill exercise testing and pulmonary function test (PFT) was done using an electronic spiroyser. Results were compared and analysed. Significantly higher values in athletes were observed as compared to non-athletes regarding the following parameters: VO2 max, V(E) max, delta heart rate and max O2 pulse where resting heart rate, DI at VO2 max and recovery heart rate were lower in athletes while there was no significant change in both the groups in observed value of: MW, BR at VO2 max HR. The observations suggest an overall higher adaptability of the cardiovascular system and the relative refractoriness of the respiratory system to the effects of training and the maximum oxygen consumption in both the groups show similar values as that from other parts of the country while MW, V(E) max, BR at VO2 and DI at VO2 max differ. A higher delta heart rate in athletes suggests a lesser risk for cardiovascular mortality in this group.

Pherwanj et al., (1989)\(^4^6\) studied the pulmonary function of competitive swimmers. Pulmonary Function Tests (PFT) of 45 swimmers who swam a distance of 2 to 5 kms per day regularly were compared with age, sex, height and weight matched controls. VC, IRV, FVC, FEV1 and V25 were higher in swimmers (S) than controls (NS) by 20%, 25%, 37.4%, 30.1% and 15.1% respectively. The effect of the period of training on PFT’s was also analysed. Inspiratory capacity


was significantly higher in Gr IS than NS probably due to a reduction in FRC, FVC and FEV\textsubscript{1} were higher in Gr. II than NS. Greater differences were seen between Gr. IV S and NS, where FVC, FEV\textsubscript{1}, V75 and PEFR were higher by 50.2\%, 38.2\%, 69.4\% and 25\% respectively in the S than NS. They suggested that probably the first parameter to increase is IC. The greater differences in PFT values of Gr. IV S and NS may be due to hypertrophy of the diaphragm which requires hard work for prolong period.

Cardiopulmonary fitness is primarily a function of the oxygen transport system and, therefore, is monitored by determining maximal aerobic capacity (VO\textsubscript{2max}). The VO\textsubscript{2max} is a highly reproducible parameter related to cardiac output and the arterio-venous oxygen difference. Exercise conditioning can improve the VO\textsubscript{2max} by augmenting both the cardiac output and the oxygen extraction within the capillaries. Resting stroke volume is increased by a conditioning effect and resting bradycardia is common. Changes in total peripheral resistance (TPR) and blood pressure are not as readily demonstrable. To produce a conditioning effect and maintain fitness it is recommended that dynamic exercise at intensities of 60 to 90\% of the maximum heart rate reserve for at least 15 minutes should be performed at least 3 days/week. The total work load (as a function of intensity and duration) appears to be the most important criterion for producing a conditioning effect. Proper testing and evaluation is necessary for a clinician in prescribing an exercise program that is safe and effective. With the middle-aged individual precautions must be taken to discern any risks for a cardiovascular event or structural injury. (Peter B. Raven and Michael L. Smith, 1984)\textsuperscript{47}

The relationship between absolute body weight, relative body weight (in percent of normal weight predicted from age and height) percent body fat (determined by densitometry), and pulse rate at rest, and during and after walking on the treadmill was investigated in 45 sedentary young men (Group A), 26 more active young men (Group B), and 82 sedentary middle-aged men

Their observations are as follows: A significant correlation between resting pulse rate and relative obesity occurred in the sedentary groups A and C, but not in the active group B. During walking, all groups exhibited a highly significant correlation between fat content and absolute and excess pulse rate. Relative and absolute body weight showed a similar relationship to a lesser degree. The correlation declined during recovery. The correlation between fat content and excess work or recovery pulse rate was lowest in group C; this was confirmed in another group of 88 sedentary middle-aged men (Group D). There was no correlation between the pulse rate and relative or absolute body weight during recovery after a step test in group D. (Relationships between obesity and the pulse rate at rest and during work in young and older men. A significant correlation between resting pulse rate occurred in the sedentary groups, but not in the active group.

In this study Meyers et al., (1992)49 examined the physical, hematologic, and exercise response of 20 male and 10 female athletes of the National Intercollegiate Rodeo Association, Central Rocky Mountain Region. Male subjects were grouped by rough stock, steer wrestling, and roping events. Female athletes were grouped separately. Maximal aerobic capacity, pulmonary ventilation, respiratory exchange ratio, energy expenditure, maximal heart rate, blood pressure, treadmill time, pre- and post exercise lactate, percent body fat, lean body mass, blood chemistry, serum lipids, and reaction/movement time were analyzed by event. No significant differences (P > 0.05) were found in any of these categories between male events. Mean resting blood chemistry parameters of rodeo athletes were within normal ranges. Steer wrestling athletes possessed greater body size and lean body mass than other groups. When analyzing body composition, blood pressure, and total cholesterol: high-density lipoprotein (HDL) cholesterol ratios, results indicate average to low risk for


coronary heart disease. When compared to other intermittent-activity sport athletes, college rodeo athletes appear to have similar aerobic capacities, but possess lower lean body mass and greater percent body fat.

In medicine, a person's pulse is the arterial palpation of a heartbeat. It can be palpated in any place that allows for an artery to be compressed against a bone, such as at the neck (carotid artery), at the wrist (radial artery), behind the knee (popliteal artery), on the inside of the elbow (brachial artery), and near the ankle joint (posterior tibial artery). The pulse rate can also be measured by measuring the heart beats directly (the apical pulse). Pulse rate can be measured at any point on the body where an artery's pulsation is transmitted to the surface - often as it is compressed against an underlying structure like bone - by pressuring it with the index and middle finger. Pulse of the body can also be measured by finding the heart rate. A more precise method of determining pulse involves the use of an electrocardiograph, or ECG.

Electrocardiography (ECG or EKG) is a trans-thoracic interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes. It has been seen that exercise training significantly affect the relation between QT and RR intervals by reducing the QT/RR slope in both genders.

In a study done by Genovesi et al., (2007) assessed the effects of exercise training on heart rate, QT interval, and on the relation between ventricular repolarization and heart rate in men and women. A 24 h Holter recording was obtained in 80 healthy subjects (40 males) who differed for the degree of physical activity. Trained individuals showed a lower heart rate and higher heart rate variability than sedentary subjects, independent of the gender difference in basal heart rate. Mean 24 h QTc was similar in trained and non-

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50 Genovesi, Simonetta, Zaccaria, Daniele, Rossi, Emanuela, Valsecchi, Maria, Grazia, Stella, Andrea, and Marco, Stramba-Badiale, “Effects of exercise training on heart rate and QT interval in healthy young individuals: are there gender differences?” The European Society of Cardiology, 9, 1, 2007, pp.55-60.
trained men, while a significant difference was observed between trained and non-trained women. Exercise training reduced the QT/RR slope in both genders. This effect on the QT/RR relation was more marked in women; in fact, the gender difference in the ventricular repolarization duration at low heart rate observed in sedentary subjects was no longer present among trained individuals. The results of the study suggested that the cardiovascular response to exercise training may be different in men and women. Women may benefit more from interventions aimed to increase physical activity as a tool for prevention of cardiovascular morbidity and mortality. The mean QT interval corrected for heart rate (QTc) was longer in females than in males in both trained and non-trained subjects. The effects of exercise training on QT interval in men and women were different. While mean 24 h QTc was similar in trained and non-trained men, a difference was observed between trained and non-trained women. In fact, trained women showed a shorter QTc than sedentary women during the 24 h period. Nevertheless, the test for interaction between training and gender was not significant, \( P = 0.563 \). Twenty-four hour QTc variability did not differ between men and women, both trained and non-trained, while the circadian variation of QTc was greater in men than in women both in non-trained subjects and in trained subjects. Exercise training did not affect the variability of QT interval or the circadian variation of QT interval. Gender differences in the relationship between QT and RR interval were observed in both trained and non-trained subjects. Exercise training significantly affected the relation between QT and RR interval by reducing the QT/RR slope in both genders. In fact, both male and female trained subjects showed a lower QT/RR slope compared with non-trained subjects. There was a significant interaction between training and gender: When the absolute values of QT interval at fixed RR intervals were compared in trained and non-trained men and women, no gender differences in QT interval were found at short RR intervals (600 ms). By contrast, at long cardiac cycles (1000 ms) QT intervals were significantly greater in women than in men in the sedentary group, but the gender difference was not present in the group of trained subjects.
A previous study performed by Perhonen et al., (2006)\textsuperscript{51} in healthy subjects demonstrated that not only QTc on standard ECG but also the long term relation between ventricular repolarization and heart rate is affected by gender.

A randomized, controlled intervention study of the effect of a 6-month intensive training programme on QTc was performed in an elderly population of 229 healthy men and women, aged 60–80 years by Schuit et al., (1998)\textsuperscript{52} The subjects of the intervention group trained three–four times a week at a work load of about 70% of their maximum capacity for 6 months, while the control subjects maintained their habitual activities. For women, the mean QTc interval of the intervention group was significantly reduced, while it did not change in the control group. In contrast, men of both the intervention and the control groups did not show any change in QTc.

Physical activity to reduce one’s risk for cardiovascular disease is strongly recommended in the consensus statement from the Centers for Disease Control and Prevention and the American College of Sports Medicine. (Westcott, 2001)\textsuperscript{53}.

Nineteen long distance runners and 19 age- and sex-matched sedentary controls were evaluated by echocardiography and electrocardiography (ECG) at rest and after 12 minutes of treadmill exercise by Mumford and Prakash (1981)\textsuperscript{54}. Seven of ten male athletes exhibited ECG abnormalities of prominent precordial voltage, early repolarization, and one had right ventricle hypertrophy; only three of nine females had ECG abnormalities. The resting and postexercise heart rates


and blood pressures were lower in athletes than controls ($P < 0.001$). The athletes increased their left ventricular end-diastolic volume and stroke volume and had a moderate increase in heart rate. Controls markedly increased only their heart rate to the same level of exercise. One female athlete and one female control had 1 mm of ST segment depression with exercise. The right ventricular wall thickness was equal to or greater than 6 mm in athletes versus equal to or less than 5 mm in controls. The left ventricular wall was thicker in athletes than controls, the resultant left ventricular mass was 60% more in athletes due to left ventricular hypertrophy ($P < 0.001$). We concluded left ventricular hypertrophy is present in athletes as a result of endurance running.

Increased sympathetic tone with exercise enhances ventricular conduction and would be predicted to shorten QRS duration. Previous studies, however, have not consistently documented such changes. Using a digital electrocardiograph (ECG) cart sampling at 500 Hz, a bipolar precordial lead (V5-V2) was recorded (supine, at end expiration) in 25 healthy men (mean age 29 yr, range 19-37) at rest and immediately after submaximal treadmill exercise by Goldberger and Bhargava (1983)\textsuperscript{55} QRS duration was measured on complexes recorded at high gain and expanded time scale. A significant ($P < 0.0005$) decrease [4.9 +/- 2.3 (SD) ms] in QRS duration was noted, and decreased QRS duration was observed in all 25 subjects (range 1-10 ms). Furthermore there was significant ($P < 0.01$) shortening of the intervals between QRS onset and Q-wave nadir (1.2 +/- 2.0 ms) and between QRS onset and R-wave peak (2.4 +/- 2.5 ms), as well as of the Q-R interval (1.3 +/- 2.7 ms). However, there were no significant differences in percent shortening of early vs. later phases of the QRS. To exclude digital sampling errors the same protocol was also applied in 11 healthy men by using an analog ECG cart. QRS duration immediately postexercise shortened by 7.1 +/- 4.3 ms (range 2-11.5 ms), which was not significantly different from the results obtained with the digital ECG. We conclude that decreased QRS duration is a physiological response to

moderate treadmill exercise in healthy men, reflecting enhancement of conduction in early, middle, and later phases of ventricular activation.

A person's total body fat percentage is the total weight of the person's fat divided by the person's weight. The resulting number reflects both essential fat and storage fat.

Storage fat consists of fat accumulation in adipose tissue, part of which protects internal organs in the chest and abdomen. Arguably, body fat percentage is the superior gauge of an individual's fitness level, as it is the only body measurement which directly calculates the particular individual's body composition without regard to the individual's height or weight.

The average man has 15 to 17% body fat, while the average woman is between 18 and 22%. Typical values for elite athletes are 6% to 12% for men and 12% to 20% for women.

Trichopoulou et al., (2001) examined the relative role of energy intake and physical activity as determinants of WHRs in men and women, after adjustment for body mass index (BMI) and other likely confounding factors. 16433 women and 11520 men aged 30–82 y, apparently healthy and from all over Greece, were examined between 1994 and 1999. Anthropometric measurements were taken, a validated semi quantitative food-frequency questionnaire was administered, and time-weighted occupational and leisure activities were assessed. The WHR was regressed, separately for men and women, on energy intake and energy expenditure after age and BMI were controlled for. Results for women and men differed. In women, neither energy intake, nor energy expenditure was associated with the WHR in any way other than that mediated through BMI. In contrast, in men, higher energy intakes and

higher energy expenditures were associated significantly, and largely independently of BMI, with higher and lower WHRs, respectively. Because the WHR is an important predictor of several cardiovascular and other chronic diseases, documentation of a strong effect of physical activity on the WHR selectively in men may provide a partial explanation of how the effect of physical activity is mediated and why physical activity is more effective in men than in women in reducing disease risk.

Laws et al., (1990)\textsuperscript{57} examined lifestyle and dietary habits in 685 men and 943 women (mean age 67 years) who completed an interview, examination, and food frequency questionnaire in 1984-87. Waist-to-hip ratio increased with age and body mass index in both men and women. In multiple regression, waist-to-hip ratio was independently associated with smoking, alcohol consumption, and exercise in men, and with smoking and alcohol consumption in women. The data suggest that waist-to-hip ratio is affected, at least in part, by behavioral, and potentially modifiable, factors.

Tuomey (1990)\textsuperscript{58} investigated the energy expenditure of 3 aerobic exercise videotapes on 10 females. The exercise programmes were divided into the following sections: warm up; aerobics; aerobic cooldown; and muscle tone/stretch. VO\textsubscript{2}, means in ml.kg\textsuperscript{-1}.min\textsuperscript{-1}, calories means in kcal.min\textsuperscript{-1}, and HR measures in bpm were taken during each of the sections, and then combined for a total programme value. The exercise videotapes used were: Joanie Greggains – vital, vigorous and visual, Jane Fonda’s New Workout (Advanced) and Jazzercise – The Best Yet! Live! An edited version of Joanie Greggains – Vital, Vigorous & Visual was created by the investigator, and was also monitored. This was necessary in order to eliminate format as a factor in the results. Jane Fonda’s, Jazzercise’s, and Joanie 2’s formats were: warm-up; aerobics; aerobic cooldown; and muscle tone/stretch. Joanie 1’s format was: warm-up; muscle


tone/stretch; aerobics; and aerobic cooldown. Each subject was also tested on a
treadmill for VO\textsubscript{2} max and was shown to be of similar levels of fitness. 2-way
factorial ANOVAs were computed for VO\textsubscript{2} max, calories, and HR between Joanie
1 and Joanie 2. There was no significant (p>0.05) difference found between the 2
tapes. Joanie 1 was used in the remaining part of the investigation. Joanie 1 was
found to be significantly (p<0.05) higher than Jane Fonda and Jazzercise, in total
energy expenditure, with respect to VO\textsubscript{2}. However, there were no significant
(p>0.05) difference found between the tapes with respect to calories and HR.
There was significant (p<0.05) difference in the individual segments between the
3 tapes. There was significant (p<0.05) difference in work periods for VO\textsubscript{2} values,
but no significant (p>0.05) difference for caloric and HR values.

Some studies have been done earlier on various physiological parameters
and fitness. In this study Maddali et al., (1998)\textsuperscript{59} considering a training program.
The effects of this exercise program were monitored properly by taking accurate
biometric data, such as Body Mass Index (BMI), Waist-to-Hip ratio and fat
percentage. The study group consisted of 77 professional football players in
preseason training. All players’ concentrations of serum nitrite and of other serum
chemicals were determined during their preseason evaluations and compared
with the concentrations in 40 serum samples taken from 25 of those same
players who required intravenous rehydration for severe generalized muscle
cramps after a training session. Player weight and percentage of body fat were
significantly higher in players who received intravenous fluids than in players who
did not.

Duncan (1989)\textsuperscript{60} investigated whether beta-blockers with intrinsic
sympathomimetic activity (ISA) improve VO\textsubscript{2} more than a beta-blocker without

\textsuperscript{59} S. Maddali, A. Rodeo Scott, Barnes Ronnie, F. Warren Russell, and A. C. Murrell George, “Post exercise
Increase in Nitric Oxide in Football Players with Muscle Cramps.” Am J Sports Med, 26, 6, 1998, pp.820-
824.

\textsuperscript{60} J. J. Duncan, “The effects of a 12 week exercise program on aerobic capacity in hypertensive subjects
receiving inderal or visken”. Completed Research in Health, Physical Education, Recreation and Dance, 31,
1989, p.159.
ISA after a 12-week training programme. Accordingly, 50 sedentary subjects, aged 18 to 70 years, with resting unmedicated DBP between 95-110 mmHg participated in this study. Subjects were randomly assigned to the Inderal (n=23) or Visken (n=27). Subjects were given Visken (5 to 20 mg daily) or Inderal (40 to 160 mg daily) in doses sufficient to lower resting DBP. All subjects participated in a training programme consisting of walking and jogging at an intensity between 70% to 85% of maximum HR; 20 to 30 minutes in duration, 3 days per week, for a total of 12 weeks. MANCOVA with age and pretests serving as covariates revealed significant group difference with respect to resting HR, maximum HR, and maximum expiratory exchange ratio. Post-training resting HR was higher in the Visken group compared to subjects in the Inderal group (p=0.0004). In contrast, maximum HR was significantly higher in the Inderal group compared to the Visken group (p=0.014). Maximum respiratory exchange ratio was significantly higher in the Inderal group following training (p=0.0003). There was no between-group difference for VO$_2$ max.

Thomsen and Ballor (1991)\textsuperscript{61} examined the effect of aerobic capacity (peak oxygen uptake) and aerobic dance exercise on the physiological responses to an aerobic dance routine. The heart rate and peak oxygen uptake responses to three level (intensities) of aerobic dance were measured in 27 women. Experienced aerobic dancers VO$_2$ were compared to subjects with limited aerobic dance experience of high and low aerobic capacities. The result indicated that the low group exercised at a higher percentage of peak heart rate and peak VO$_2$ at all three dance levels than did either the high or experienced aerobic dancer group. The study recommends that the design of aerobic dance routines must consider the exercise tolerance of the intended audience. In mixed groups, individuals with low aerobic capacities should be encouraged.

In general, athletes involved in a sport where their body weight is supported, such as canoe and kayak (males, 13.0 ± 2.5%; females, 22.2 ± 4.6%)

and swimming (males, 12.4 ± 3.7%; females 19.5 ± 2.8%), tended to have higher % fat values. Athletes involved in sports where a weight class has to be made to compete, such as boxing (males, 6.9 ± 1.6%) and wrestling (male, Junior World Freestyle 7.9 ± 2.7%), events such as the 100, 200, and 400 meters in athletes (male 100 and 200 meters, 6.5 ± 1.2%; female 100, 200 and 400 meters, 13.7 ± 3.6%) that are very anaerobic in nature and extremely aerobic events such as the marathon (males, 6.4 ± 1.3%) demonstrated lower % fat values. Athletes involved in sports where body size is a definite advantage, such as basketball (males, 84.1 ± 6.2 kg; females, 55.3 ± 4.9 kg) and volleyball (males, 75.0 ± 6.6 kg; females, 58.4 ± 4.5 kg) tended to have a larger LBM, Steven J. Fleck (1983)\textsuperscript{62}.

After reviewing the above literature, it was seen that there is no research which gives a picture of overall developmental status of a physical education teacher trainee on morphological, physiological and physical fitness. So the researcher, in her work, has tried to present the same.