Heart Rate Variability in Obese Children

Heart rate variability is a useful marker of autonomic activity. Gutin et al. utilized this technique to examine anthropometric and hemodynamic correlates of parasympathetic activity in obese children as well as the changes in these relationships with physical training and detraining. Subjects were 79 obese children ages 7 to 11 years old. Parasympathetic activity was estimated by the root mean square of successive R-R interval differences (RMSSD). Body composition was assessed by DXA, and physical activity was estimated by 7-day recall interview questionnaires. Cardiovascular fitness was defined by heart rate at a cycling work rate of 49 W. Subjects were randomly assigned to groups who participated in a physical training program (40 min, three times a week) during the first or second 4-month period of the study. Baseline RMSSD was related to fat mass, free fat mass, resting heart rate, resting blood pressure, and exercise heart rate. By multiple regression analysis, resting heart provided the only significant contribution to variability in RMSSD. RMSSD increased during periods of physical training and fell with detraining. The regression model indicated that only change in resting heart rate served as a significant predictor of change in RMSSD. These findings indicate that regular exercise which improved fitness and body composition in these obese children had a favorable effect on parasympathetic activity.


Tracking of Fitness and Activity From Childhood to Adolescence

Understanding the stability of physical fitness and activity over time is important in establishing strategies for exercise interventions. Janz et al. examined the tracking of aerobic fitness and strength over 5 years in 125 children, who were 10 years old at the beginning of the study. The study group included 63 boys and 62 girls. Aerobic fitness was measured directly as VO$_{2\text{max}}$ on a cycle test protocol. Strength was defined by maximal voluntary contraction for hand grip. Spearman correlations for these measures decreased over time. Coefficients for VO$_{2\text{max}}$ per kg were $r = 0.44$ and 0.39 between values for the 1st and 5th years for boys and girls, respectively. For grip strength, the correlations were $r = 0.75$ and 0.62. Boys who were classified as sedentary (by questionnaire) based on hours of watching television and video game playing were 2.2 times more likely than their peers to be classified as sedentary at the 5-year follow-up. It was concluded that preventive efforts to promote physical fitness and activity through puberty may produce favorable health outcomes in future years.

**Cardiovascular Responses to Prolonged Exercise**

Previous studies comparing cardiovascular changes with prolonged exercise (cardiovascular drift) in children and adults have provided equivocal results. Cheatham et al. examined changes in heart rate, stroke volume, blood pressure, and plasma volume during sustained steady-work exercise in 8 boys (ages, 10 to 13 years) and 10 young men (ages, 18-25 years). Subjects cycled for 40 min at an intensity equal to $VO_2$ at the previously-measured anaerobic threshold (approximately 65% $VO_{2\text{max}}$). Cardiac output was determined by the carbon dioxide rebreathing method. During the exercise period, average heart rate increased 9.5% and 13.6%, and stroke volume declined 8.8% and 11.6% in the boys and men, respectively. Cardiac output and arterial venous oxygen difference did not change significantly in either group. In the men, mean arterial pressure fell by 4.2% but did not change appreciably in the boys. The mean decline in plasma volume was significantly greater in the men (−10.2% vs. −5.7% in the boys), but the decrease was not related to changes in stroke volume in either group. This study demonstrated similar cardiovascular responses to sustained steady-state exercise in boys and men, although a tendency was demonstrated for a greater degree of drift in the men.


**Tracking of Fitness, Activity, and Coronary Risk Factors**

Cross-sectional studies have suggested a negative relationship between physical fitness/activity and coronary risk factors, but little is known regarding the association of these variables over time. Twisk et al. analyzed tracking of daily physical activity and both cardiopulmonary ($VO_{2\text{max}}$) and neuromotor fitness, and their longitudinal relationship with total serum cholesterol, HDL-cholesterol, cholesterol:HDL ratio, blood pressure, and sum of skinfolds in individuals in the Amsterdam Growth and Health Study. This investigation assessed these variables with six repeated measurements over a period from age 13 to age 27 years ($N = 181$). Statistical analysis was performed with generalized estimating equations. Good tracking was observed for neuromotor fitness (performance on testing of strength, flexibility, coordination, speed), but tracking for daily physical activity and $VO_{2\text{max}}$ was only low to moderate. Physical activity was directly associated with HDL ($p < .01$) and inversely to both the cholesterol:HDL ratio and sum of skinfolds. $VO_{2\text{max}}$ over time was inversely correlated with total cholesterol. Neuromuscular fitness was negatively related to body fat and positively to blood pressure. In this study, body fatness highly influenced activity, fitness, serum lipoproteins, and blood pressure. The longitudinal changes in physical activity and aerobic fitness were associated with a healthy coronary risk profile.

**Development of Short-Term Power Output**

Children's daily activities are typified by short-burst exercise, but the development of anaerobic performance during the childhood years is poorly understood. In a longitudinal study, Armstrong et al. examined the influences of age, body size, skinfold thickness, gender, and maturation on the anaerobic fitness of young people using multilevel modeling. Ninety-seven boys and 100 girls had a mean age of 12.2 ± 0.4 years at the onset of the study. Sexual maturation was assessed by Tanner staging. Anaerobic fitness (peak and mean power) was measured using the Wingate Anaerobic Test. Body mass and stature were identified by initial models as significant explanatory variables, and an additional positive effect was observed for age. Girls demonstrated significantly lower values for both peak and mean power compared to the boys. An incremental effect of later maturity (stages 4 and 5 for pubic hair development) was seen for mean power only. When the sum of two skinfolds thicknesses was incorporated into the analysis, the model disclosed significant negative estimates for both indices of power and negated the effects of stature and maturation. These results indicate that gender differences exist in the longitudinal development of anaerobic fitness as measured by the Wingate Test. In both genders, body mass and skinfold thicknesses serve as the best anthropometric predictors of peak and mean anaerobic power.


**Decreasing Inactivity in Obesity Management**

While most treatment interventions for obesity involve increasing caloric expenditure, little attention has been paid to the potential effectiveness of reducing factors responsible for physical inactivity. Epstein et al. enrolled 90 obese children, ages 8 to 12 years, to participate in one of four treatment groups in a 6-month program that varied in targeted behaviors. The children were between 20% and 100% overweight. Two groups were targeted to increase physical activity (high dose = energy equivalent to 20 miles per week, low dose = 10 miles), and the other two groups were provided guidance on decreasing sedentary behaviors such as watching television, video games, and talking on the telephone (high dose = 20 hours per week, low dose = 10 hours). All groups received intensive and comprehensive dietary counseling and close follow-up measurements of body weight, composition, fitness, and assessment of physical activity by questionnaire. During the treatment period, all four groups demonstrated significant and similar decreases in percent overweight and body fat, as well as increases in aerobic fitness. There was an increase in minutes of physical activity in all groups, and participation in the targeted sedentary activities declined. However, in some cases children substituted nontargeted sedentary behaviors for those that were targeted. These findings indicate that efforts to reduce sedentary behaviors may serve as a useful adjunct to traditional treatment of obese children.
Determinants of Physical Activity in Adolescents

Recognition of the importance of improving exercise habits of teenagers has prompted a need to understand the determinants of regular activity in this age group. Gordon-Larson et al. examined environmental and sociodemographic determinants of physical activity and inactivity among 17,766 U.S. adolescents enrolled in the 1996 National Longitudinal Study of Adolescent Health. Time spent in inactivity (television watching, video games) and moderate-to-vigorous activity were assessed by questionnaire. Moderate to vigorous levels of physical activity were lower for non-Hispanic black and Hispanic adolescents. High family income correlated with greater activity and less inactivity. Maternal education level was inversely related with inactivity. Use of a community recreation center and daily physical education class were associated with greater levels of vigorous activity. High crime level was significantly related to a lower level of physical activity. This study demonstrated a number of modifiable determinants that influence physical activity levels in adolescents. An important finding was that physical activity and physical inactivity were associated with different determinants. Physical activity was most often related to environmental factors, while inactivity was more likely to be associated with sociodemographic variables.


Effects of Home Exercise on Patients With Cystic Fibrosis

Whether aerobic exercise training is useful in improving pulmonary function in patients with cystic fibrosis is unclear. Schneiderman-Walker et al. performed a 3-year randomized study to determine the effects of a prolonged home exercise program on clinical status of these patients. The study group was 72 mild-moderately impaired patients with cystic fibrosis ranging from 7 to 19 years. The home exercise program consisted of a minimum of 20 min of aerobic exercise at a heart rate of approximately 150 beats per minute, performed three times a week. Clinical status (pulmonary function, exercise tolerance, clinical status, hospitalizations, treatment compliance) was monitored with visits to the hospital cystic fibrosis clinic. Findings were compared to those of a control group of patients who maintained their usual pattern of physical activity. During the study period, greater declines in percent forced vital capacity as well as forced expiratory volume in 1 s were observed in the control group compared to the exercise patients. These findings demonstrated a retardation of decline in pulmonary function over time in patients with cystic fibrosis who participated in regular aerobic exercise. This suggests that such a program may be beneficial in the management of these patients.

Effect of Gender on Energy Expenditure

Adult males demonstrate higher metabolic rates than females, a difference explained by variations in fat-free mass. However, little is known regarding gender influences on energy expenditure in children. Grund et al. studied the effect of gender on resting energy expenditure (REE), activity-related energy expenditure (AEE), total energy expenditure (TEE), and physical activity level (PAL) in 24 boys and 16 girls, 4 to 11 years old. Energy expenditure was estimated by both indirect calorimetry and individually calibrated 24-hour heart rate monitoring. Body composition was measured using anthropometric indices as well as bioimpedance. No significant differences in mean fat mass or fat-free mass were found between the boys and girls. Similarly, no significant effects of gender were observed on REE, TEE, AEE, and PAL. Stepwise regression indicated that fat-free mass explained most of the variation in resting energy expenditure. This study indicated that gender has no effect on the different components of energy expenditure in prepubertal children. The authors hypothesized that gender differences would become apparent once puberty was achieved.


Aerobic Fitness and VO₂ Kinetics

In adults, a slow component rise in VO₂ is typically observed at exercise intensities above the anaerobic threshold (AT), which is superimposed on a monoeponential increase in VO₂ to steady state below AT. These kinetics may be influenced by level of aerobic fitness. To determine if such observations hold true in young subjects, Obert et al. investigated oxygen uptake kinetics in prepubertal children of varying fitness levels. Twelve highly trained swimmers and 11 untrained subjects, 10–13 years old, initially performed a maximal cycle test to determine VO₂max and AT. Subjects then returned for two constant power tests performed at intensities equal to 80% AT and 90% VO₂max. VO₂values for the swimmers and untrained children were 51.1 ± 3.8 and 38.3 ± 5.6 ml/kg/min, respectively. A slow component for VO₂ was observed only during the 90% VO₂max test. No difference was observed in the contribution of the slow component to the total VO₂ response between the two fitness groups. This study confirmed the presence of a slow component of VO₂ during high intensity exercise in prepubertal children, and this phenomenon was similar in aerobically trained and nontrained children.


VO₂ Versus Exercise Intensity As a Fitness Marker

Conventional means of assessing aerobic fitness involve maximal testing, which can be influenced by subject motivation. Reybrouck et al. examined the relationship of oxygen uptake versus submaximal exercise intensity as an alternative marker of cardiovascular function in a group of patients with previous surgery for transpo-
sition of the great arteries \((N = 29; \text{mean age, } 10.3 \pm 2.5 \text{ years})\) and tetralogy of Fallot \((N = 30; \text{mean age, } 12.1 \pm 3.3 \text{ years})\). Findings were compared to a control group of 24 normals. Submaximal exercise was performed on a treadmill (4.8–5.6 km/hr) to a heart rate of 170 bpm. The slope of oxygen uptake versus exercise intensity was \(1.50 \pm 0.64, 1.68 \pm 0.75, \text{ and } 2.42 \pm 0.68 \text{ ml } \text{O}/\text{min}^2/\text{kg}\) for the transposition, tetralogy, and normal subjects, respectively. This slope was associated with a subnormal value for ventilatory threshold in the two groups of cardiac patients \((78 \pm 13\% \text{ and } 85 \pm 11\% \text{ of normal, respectively})\). Similarly, the lower slope was also related to a steeper slope of carbon dioxide output versus oxygen uptake above the ventilatory threshold in both cardiac groups compared to normals. These findings indicate that the slope of oxygen uptake versus exercise intensity is a valid measure of oxygen flow to exercising muscle and may serve as useful marker of aerobic fitness.


**Plasma Fibrinogen Level and Physical Fitness in Children**

Plasma fibrinogen level has been identified as a risk factor of cardiovascular disease in adults. Studies in adult populations have indicated an inverse relationship between physical activity and/or physical fitness and plasma fibrinogen level, but little is known regarding this association in children. Isasi et al. performed a cross-sectional study on 193 subjects, ages 4 to 25 years, to examine the relationship between plasma fibrinogen level and physical fitness in this age group. Most of the subjects (68%) were Hispanic. Physical fitness was defined by the physical work capacity (PWC) at a heart rate of 170 beats per minute. The level of physical fitness was found to be inversely related to plasma fibrinogen level \((r = 0.24, p < .001)\). This significant relationship persisted after multivariate adjustment for age, sex, race/ethnicity, and body mass index. The heart rate at rest also correlated with plasma fibrinogen level \((r = 0.18, p < .05)\). There was no association between family history of early onset coronary heart disease and fibrinogen level in the children. This study indicated that plasma fibrinogen level is inversely associated with physical fitness in children independent of body mass index.