Physical Fitness and Muscle Fiber Types in Adolescents

Skeletal muscle is composed of both type I (slow twitch) and type II (fast twitch) fibers, the former considered important in endurance activities and the latter in high-burst energy activities. Jansson and Hedberg studied skeletal muscle fiber characteristics and their relationships to physical performance, physical activity, and interest in exercise in a group of 116 high school boys and girls. Vastus lateralis muscle biopsies were performed on the 69 boys and 47 girls. Activity was assessed by questionnaire, while performance measures included bench press, vertical jump, and a 9-min run/walk test. Approximately 50% of fibers were type I for both boys and girls, with a large interindividual variation. Muscle fiber area was greater in the boys than in the girls, as were the concentrations of muscle enzymes (succinate dehydrogenase, 3-hydroxyacyl-CoA-dehydrogenase, phosphofructokinase). A positive relationship was observed between performance on the 9-min run and percent type I fibers in the boys, but not the girls. Multiple correlational analysis indicated that maximal oxygen uptake and type I percent were chief determinants among the boys of performance on the 9-min run/walk. In the girls, only VO₂max related to distance performance. The correlation between amount of physical activity and percent type I fibers was higher for the boys than for the girls. There appear to be significant gender differences in the relationships between muscle fiber characteristics and physical performance, physical activity, and interest in exercise.


Exercise Testing in Evaluation of Dysrhythmias

Laboratory exercise testing has been widely used among children with congenital heart disease to induce suspected arrhythmias or suppress previously documented arrhythmias. The effectiveness of exercise testing in the evaluation of arrhythmias in this group of patients has not been critically assessed, however. Weigel et al. studied 49 patients with suspected arrhythmias (Group 1) and 92 patients with previously documented arrhythmias (Group 2) who were evaluated with cycle exercise testing at the Mayo Clinic between 1979 and 1987. In all, 27% of patients in Group 1 and 40% in Group 2 had congenital heart disease. Two-thirds of Group 1 had been referred for evaluation of complaints of palpitations or irregular heart rate. All were in sinus rhythm before exercise testing. Twenty percent of this group had abnormal findings with cycle testing (including premature ventricular contractions, second degree heart block, and supraventricular tachycardia), and treatment was subsequently modified in 4 patients. In this group
the sensitivity of exercise testing was 56%, with a negative predictive value of 79%. This suggests that exercise testing may be an alternative method for induc-
ing arrhythmia in patients who do not manifest electrocardiographic anomalies on resting tracings. Group 2 comprised 38 patients with atrial arrhythmias, 31 with ventricular arrhythmias, and 23 with atrioventricular conduction abnor-
malities prior to testing. Of these, 74% had abnormal exercise electrocardiograms, and clinical management was modified in 27% of Group 2 secondary to results of exercise testing.

Weigel, T.J., C.J. Porter, C.D. Mottram, and D.J. Driscoll. Detecting arrhyth-
mia by exercise electrocardiography in pediatric patients: Assessment of sensitiv-

Body Composition of Ballet Dancers

Young ballet dancers have lower body weight and percent body fat than non-
dancers, with an increased incidence of amenorrhea and possible risk of osteo-
penia and stress fractures. While accurate assessment of body composition in
this group is therefore important, previous techniques such as anthropometry and
hydrodensitometry may be inaccurate and could provide misleading information.
Hergenroeder et al. assessed body composition of male and female adolescent
and adult ballet dancers using total body electrical conductivity (TOBEC) to
examine the relationship between menstrual function and body composition. The
subject population included 112 female and 33 male dancers with mean ages of
15.0 (2.0) and 18.7 (3.1) years, respectively. The average percent body fat was
14.5 (4.2) in the males and 20.1 (3.6) in the females. The percent body fat was
significantly inversely related to age and pubertal status in the males but not the
females. No difference was observed in percent body fat between eumenorrheic
and amenorrheic dancers. A lower caloric intake was detected in the dancers
with menstrual abnormalities than those with normal menstrual function. The
body fat percentages observed in this study are higher than those in previous
reports of body composition of dancers using hydrodensitometry, a technique
that may underestimate body fat in this group by failing to account for the
dancers' increased leg bone density. These data suggest that earlier reports of
percent body fat in dancers may be underestimates.

Hergenroeder, A.C., M.L. Fiorotto, and W.J. Klish. Body composition in ballet

Step Test for Estimation of Aerobic Fitness

The single stage step test has been used to estimate aerobic fitness as an alterna-
tive to direct measurement of maximal oxygen uptake. Recently an anatomic
model has been described for adults that addresses problems associated with
erlier step tests. This model standardizes platform height using an individual’s
stature and specific hip angle to be used with a 3-min step test to predict VO2,max
from recovery heart rate. Francis and Feinstein measured hip angles and exam-
ined test results in children to determine whether this new height-adjustable step
test model was applicable to 6- to 18-year-old subjects. No statistical difference was seen at any age between measured hip angle and that calculated from prediction equations. To assess the ability of the step test to estimate VO$_2$max, three step tests were performed by 93 subjects at one platform height using stepping frequencies of 22, 26, or 30 ascents per minute. Directly measured maximal aerobic power was determined during a treadmill test using the Bruce protocol. Correlation coefficients between heart rate at 15 seconds of recovery and treadmill-measured VO$_2$max were .80, .79, and .81 when using 30, 26, and 22 ascents per minute, respectively (all significant at the $p<.01$ level). These findings indicate that the model is valid for standardizing the platform height for children in performing a single-stage step test for estimating aerobic fitness.


Physical Activity Patterns in British Schoolchildren

The recognized importance of physical activity to good health has prompted a need to better understand the normal activity patterns of children. The optimal means of recording such activity is not clear, however. Certain methods such as self-report questionnaires and daily exercise diaries have proven largely unreliable. Armstrong and Bray estimated daily activity in a group of 132 British schoolchildren (mean age 10.7 yrs) by continuous heart rate monitoring over 3 normal school days. A self-contained computerized telemetry system was used to record heart rate, with a lightweight transmitter attached to the chest and a receiver worn as a watch on the wrist. There was no significant difference between the 67 boys and 65 girls in the percentage of weekday time spent with heart rate above 139 bpm (9.4 and 8.2%, respectively), but the boys demonstrated a higher percentage of time with heart rate over 159 bpm (4.5 vs. 3.5%, respectively, $p<.05$). During 1 day of weekday monitoring, 22% of boys and girls achieved at least one 20-min period when the heart rate was sustained over 20 minutes. However, shorter periods (i.e., 5 minutes) of sustained heart rate to this level were common. These findings suggest that more information is needed regarding the effects of short periods of intense physical activity on cardiovascular fitness in children.


Factors Limiting Exercise Capacity Following Tetralogy of Fallot Repair

Although surgical repair of tetralogy of Fallot has been highly successful in restoring normal hemodynamics, many of these patients demonstrate abnormal exercise capacity during laboratory testing. Rowe et al. studied 55 patients after tetralogy repair by exercise testing, pulmonary function testing, and resting echocardiography to examine those variables that might be responsible for diminished exercise capacity. Subjects ranged in age from 15 to 37 years. Mean age at surgical repair was 8.1 years, with an average follow-up time of 18 years. Tread-
mill exercise duration, using the Bruce protocol, averaged 92% of predicted, and maximal heart rate was 94% of predicted. Mean VO₂max (measured in 30 patients) was 31 ml kg⁻¹ min⁻¹ (86% of predicted). Forty-five percent of the subjects demonstrated a low vital capacity at rest (<80% of predicted). Of the 42 patients with pulmonary regurgitation (75%), valvular insufficiency was considered moderate in 10. Fifteen percent had a Doppler estimated right ventricular outflow gradient exceeding 15 mm Hg. No correlation was observed between age of repair, duration of follow-up, and type of repair with any of the echocardiographic, ventilatory, or exercise performance variables. Moderate pulmonary regurgitation was associated with right ventricular dilatation, and both were inversely related to exercise duration and vital capacity. Right ventricular volume overload and ventilatory dysfunction may therefore be linked to decreased exercise performance in patients following tetralogy of Fallot repair.


Relationship of Fitness, Fatness, and Activity

The research literature examining the relationship of physical fitness and physical activity habits in children has produced conflicting results. Failure to consistently demonstrate a strong fitness/activity association may be partially explained by variations in body composition. Taylor and Baranowski investigated the relationship of physical activity, age, gender, and cardiovascular fitness in 93 high body fat and 93 low body fat children ages 8 to 13 years. Physical working capacity (PWC₁₇₀) was used as the measure of fitness, activity was assessed by a 2-day observation period, and body fat was estimated by the sum of tricep, suprailiac, and subscapular skinfold measurements. In the combined sample, a low to moderate positive correlation was observed between PWC₁₇₀ and physical activity score (r = .25, p < .001). Physical activity was a significant predictor of fitness in the high adiposity group (beta regression coefficient .26, p < .01) but not in the low adiposity group (beta regression coefficient .11, p > .05). The authors suggested that this might be explained by the fact that the more obese children required more work for any given level of physical activity. Alternatively, the level of physical activity in the low adiposity group, which was more fit, may not have been sufficiently intense to further enhance fitness (a ceiling effect). These results indicate that the effects of body fatness need to be considered in investigations of the association of physical activity and fitness in children.


Physiologic and Anthropometric Differences Between Peripubertal Swimmers and Nonswimmers

The effects of physical training on prepubertal children may be less than in older age groups. Benefice et al. compared physiologic and anthropometric character-
istics of 45 swim-trained boys (>3 hrs weekly training) with those of 94 non-athletes. The subjects were divided into three maturity groups (prepubertal, pubertal, and end of puberty) according to pubic hair status. A ramp protocol on a cycle ergometer was used for determining maximal oxygen uptake. Four skinfold measurements were used to estimate body fat and calculate lean body mass. The swimmers had greater limb circumferences, chest circumference, lean body mass, and arm muscle area compared to the nonswimmers, but these differences were significantly greater only in the postpubertal subjects. The swimmers demonstrated greater VO\textsubscript{2}max relative to body weight in all maturational groups, but these differences disappeared when maximal oxygen uptake was related to arm muscle area. The authors concluded that the differences in aerobic capacity between the swimmers and nonswimmers appeared to be related only to the difference in muscle mass (while acknowledging that the cycle exercise used in this study involved predominantly the leg muscles). Although the physiologic and anthropometric differences between the trained and untrained children in this study might reflect the result of training, the influence of preselection is possible and can only be ruled out by a longitudinal investigation.


Determinants of 1-Mile Run/Walk Time in Children

Performance in the 1-mile run/walk test has been considered the best field test for evaluating maximal aerobic power (VO\textsubscript{2}max) in children. Correlations of VO\textsubscript{2}max on laboratory testing with distance run time have varied widely, however, with coefficients ranging from 0.26 to 0.90, and in some studies less than 50% of the variance in distance run performance has been accounted for by VO\textsubscript{2}max. Studies in adults have indicated that running economy (VO\textsubscript{2} at a given speed) and average percent of VO\textsubscript{2}max utilized during the activity are also strong determinants of endurance performance. This study investigated the relative importance of VO\textsubscript{2}max, movement economy, and %VO\textsubscript{2}max utilized in mile run/walk performance (MRWT) in 59 children divided into age groups 6-8, 9-11, and 12-14 years. When the effects of age and sex were held constant, partial correlations between MRWT and VO\textsubscript{2}max were -0.26, -0.43, and -0.60 for the three groups, respectively. Partial correlations between MRWT and economy were 0.03, 0.09, and 0.45, and between MRWT and %VO\textsubscript{2}max they were -0.82, -0.88, and -0.80, respectively. Standardized regression coefficients for VO\textsubscript{2}max, economy, and %VO\textsubscript{2}max in the younger group (-0.66, 0.19, and -0.83), middle group (-0.45, 0.33, and -0.92), and older group (-0.76, 0.27, and -0.50) revealed that %VO\textsubscript{2}max was the most important determinant of MRWT variance in children 6-11 years old, while VO\textsubscript{2}max was the principal determinant in children 12-14 years old.

Physiologic Responses to Treadmill and Deep Water Running

Buoyancy devices designed to allow simulation of running motion in deep water have been used to rehabilitate injured runners as well as serving as a supplemental training technique. Little information is available, however, on high intensity exercise during "running" in water. Butts et al. compared maximal physiologic responses to deep water running with those during treadmill exercise in a group of 12 competitive high school female cross-country runners. The maximal treadmill protocol involved running at 6 mph with a 2.5% increase in treadmill slope every 2 minutes. Maximal testing in the water with a buoyancy vest was conducted with the subjects performing leg strides (simulating running) at a rate of 100 per minute. No significant differences were observed in peak ventilation or respiratory exchange ratio between the two tests. The mean peak heart rate was 198 bpm on the treadmill run and 180 bpm in deep water (p<.001). Likewise, significant differences in maximal oxygen uptake were seen (54.7 and 46.8 ml kg⁻¹ min⁻¹ for the treadmill and water exercise, respectively). Among the factors potentially responsible for these differences, the decreased active muscle mass in the water (because of less work to maintain body posture) may be most significant. Prescribing water training exercise intensity by heart rate requires a substantial reduction in target rate compared to land exercise (approximately 20 bpm).


Immunologic Responses to Ballet Dancing

An increased interest in ballet dancing has prompted investigations into the physiologic responses to dance training. Xusheng et al. studied immunologic responses to ballet dancing in 32 Chinese adolescents (mean age 17.5 yrs). Subjects had been dancing an average of 3.5 years daily over a 5.5-year period; responses were compared to nontraining control subjects who participated only in routine school activities. Microdeterminations of lymphocyte blast transformation and mixture rosette forming cells were made at rest in the sitting position and immediately after a daily ballet class lasting approximately 90 minutes. No significant differences were detected between the exercise and control group in lymphocyte blastogenesis at rest, but the percent of erythrocyte rosette forming cells was significantly lower in the ballet training group. The changes in these two variables did not differ significantly before and after the dancing class. At rest the percent zymosan-complement rosette forming cells was similar in the trained and untrained subjects, but this percentage increased markedly postexercise (mean of 22.5 to 39.0%). The authors interpreted these findings as indicating a saving effect on expenditure of cellular immunofunction in ballet students at rest. The clinical implications of the humoral immune response identified in this study to intensive ballet exercise need to be clarified.

Reliability of Field Tests in Young Children

It is important that field exercise tests have a high test-retest reliability if they are to be used as markers of physical fitness in children. Previous reports describe reliability correlation coefficients of .68 to .94 in health related tests of distance run, sit-ups, sit and reach, and skinfolds, but few of these comparisons have included primary-grade children. Erbaugh evaluated test-retest reliability of physical fitness tests administered to first-, second-, and third-grade children (mean age 8.3 yrs). Ninety percent of the children were black and 10% were white. In all, 26 children (13 boys, 13 girls) performed repeated components of the AAHPERD Health Related Physical Fitness Test and a modified pull-up test. Test results indicated a mean score at the 20th percentile of 1980 AAHPERD normative data on three of the four items (9-min run, sit-ups, and skinfold measurements), and at the 60th percentile on the sit-and-reach test. The test-retest reliability coefficient was .93 for sit-and-reach performance, .83 for 9-min run, and .99 for skinfolds. These values are slightly higher than those previously reported for these test items. Reliability coefficient was .83 for sit-ups and .52 for modified pull-ups. These findings indicate that these health related test items reliably assess physical fitness among primary school children.


Psychologic Factors in Soccer Participation

A positive emotional experience and a tendency to persist in soccer participation appears linked to soccer related self-evaluation in adolescents. This evaluation may in turn be influenced by the attributional style, the tendency to causally explain success and failure in a consistent manner across situations. If so, attempts to alter attributional style when faced with soccer failure outcomes might serve to enhance soccer enjoyment and persistence. Ommundsen and Vaglum investigated the relationship between attributional style for failure outcome and self-esteem in soccer in a group of 223 Norwegian boys, ages 12 to 16 years, who were playing organized league soccer. A 40- to 70-min interview consisted of structured precategorized as well as open questions. Dependent variables were soccer related self-esteem index and dropout from soccer; independent variables were attributional style index and perceived importance of soccer competence. Internal and stable attributions for failure in soccer were related to low soccer related self-esteem. An association was also observed between effects of both internal and stable attributions for failure in soccer and high perceived importance of soccer competence with low soccer related self-esteem and increased rates of dropout. These findings suggest that young soccer players who have low soccer related self-esteem may be helped by attributional retraining.