Injury Risk of Supervised Exercise for Children and Youth With Chronic Diseases: 5-Year Experience

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Little information is available on the safety of supervised exercise programs for children. This retrospective case review describes the experience over 5 years in a private, outpatient, physician-directed therapeutic exercise program. Observations were made on a total of 47 patients referred by their physicians or parents for exercise programs for diseases, including obesity (26), cystic fibrosis (10), cardiac disease (3), asthma (3), and others (5). Patients performed circuit training with an exposure that consisted of 2,646 total sessions (56.3 ± 63.3 sessions/patient), equivalent to 1,507.9 hours (32.1 ± 35.5 h/patient) of exercise time. There were three minor accidents (1.9/1,000 patient hours). Physical examination by the attending physician was negative in all three cases: No treatment was indicated, and no patient missed any training time due to these incidents. No significant injuries or cardiorespiratory complications were observed in this exercise program.

Daily physical activity is recommended for all children (21), although minimal levels are not attained by many (17, 18). Sedentary behavior is especially prevalent and problematic for children with chronic diseases (1). Partially due to lack of physical activity, poor aerobic fitness has been observed in patients with well-controlled chronic diseases (7, 12, 13, 14). To try to remedy this problem in those populations, various approaches have been reported, with programs based in schools, camps, research projects, and clinical models (1, 4, 10, 20).

One potential drawback to the prescription of exercise, as with other treatments, is side effects (2, 19). Specifically, side effects might include injuries and other adverse events, such as exacerbation of the underlying disease, or creation of new problems. As level of involvement with exercise increases, it may reach a point of diminishing returns, with increased risk of developing injuries and other problems of overtraining (6). While injuries are quite frequent in competitive sports (11), the type, frequency, intensity, and duration of exercise practiced in competitive sports is well beyond what is necessary to achieve public health objectives (17, 21).

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Little information is available on the incidence of injuries in young people in clinical exercise settings. In older adults, the experience of cardiac rehabilitation programs with adverse cardiac events is reassuring (16). However, due to the different spectrum of pathology between children and the elderly, the pertinence of this data to the younger population is questionable. Even in the adult cardiac rehabilitation research, little attention has been paid to musculoskeletal injuries or other adverse events. Only one study was found on the injury experience of presumably healthy adults exercising in fitness clubs with unspecified supervision (15). The purpose of the current study was to report the experience of our clinical exercise program for children, adolescents, and young adults with chronic diseases, in terms of injuries and other adverse events.

**Methods**

For 5 years, we conducted a private, outpatient clinical exercise program for children, adolescents, and young adults with various chronic diseases.

**Patients**

Patients were referred by their primary physicians or pediatric subspecialists, or were self-referred. The goal of treatment was to establish a safe, noncompetitive exercise program, designed to improve the patients’ physical fitness and to complement and enhance their disease management. On interview, most patients reported minimal physical activity, although a few participated intermittently in nonaerobic activities, such as baseball or soccer goaltender. A complete medical history was taken, and a physical examination was performed on each patient by the supervising physician before beginning the exercise program. Patients underwent cardiovascular stress testing, blood testing, and other diagnostic studies (9), as indicated. Physical fitness tests were completed before training began. The results of the evaluation were used in the exercise prescription and as baseline information. No patients were excluded from participation.

**Mode**

Interval circuit training was utilized in this program. The purposes of this type of exercise were multiple. It was believed that the intermittent, 3–4 min aerobic intervals would facilitate compliance and enjoyment for children who had previously been sedentary and unfit. The variety of exercises was intended to train most muscle groups, while helping to maintain interest in the activity. There were six “aerobic” stations—two lower limb cycle ergometers, an upper body cycle, a lower and upper limb cycle, a treadmill, and a rowing ergometer. A minitrampoline was added in Years 4 and 5 as an alternative station. Resistance training was provided by three separate 1-min sets on a hydraulic resistance device (Hydrafitness Total Power, Hydra-Fitness Industries, Belton, TX) that had chest press-pull, military press-pull, and leg extension-flexion exercises, each with bidirectional isokinetic-like resistance. The patient effort-controlled resistance, the lack of heavy weight components, and the absence of eccentric resistance were all considered to make this device appropriate and nearly accident-proof, even for prepubertal children.
Further low-risk upper limb resistance training was provided by 1-min sets with rubber tubing devices (Quik-fit, Fitter International, Calgary, Alberta, Canada). Stretching and other calisthenic exercise 1-min stations (abdominal crunches, lunges, modified push-ups), were performed on floor mats. A skiing simulating exercise station (Fitter, Fitter International) was also included.

**Supervision**

The patients in the program performed the circuit in a 500-square-foot room that was part of a sports medicine clinic. Temperature was maintained between 23 and 26 °C, with humidity between 60 and 70%. This room was adjacent and visible to the office of the supervising physician, who was on site for over 90% of sessions, and available by phone other times. Exercise physiologists (master’s level) or graduate students in exercise physiology, in a 1:4 or better ratio to patients, actually conducted the circuits. These personnel directed the patients’ activities, adjusted workloads to maintain prescribed exercise intensity, and observed the monitoring devices.

A cardiac monitor/defibrillator, pulse oxymeter, heart rate monitors, peak flow monitors, and sphygmomanometers were available, and utilized as clinically indicated. Patients with a pulmonary disease or exercise-induced bronchospasm had their peak flow measured before beginning exercise. If a significant fall from baseline peak flow was detected, treatment steps were followed in consultation with the supervising physician. Patients with exercise-induced hypoxemia had their oxygen saturation monitored by pulse oxymetry. Patients with risk for cardiac arrhythmias had their cardiac rhythm monitored, and those with elevated blood pressures had blood pressure measurements taken. Exercise performance and monitoring results were logged on flow sheets for review by the supervising physician. Any patient with an injury or other complaint was assessed immediately by the supervising physician. Patients with significant injury, acute illness, or fever were medically excused from exercise.

**Intensity**

Aerobic exercise stations were prescribed to be performed at an intensity level of 60–85% of heart rate reserve, after a 1–2 week acclimation period where intensities were prescribed in the 50–60% range. Intensities were monitored and recorded by heart rate (radial pulse and intermittent use of heart rate monitors, or cardiac monitors, if indicated) and by ratings of perceived exertion on a 6–20 scale. Resistance level and peak torque, if applicable, and repetitions completed were recorded for resistance training and calisthenic exercises.

**Duration**

As previously stated, aerobic intervals were 6 × 3–4 min in duration. Patients with obesity or otherwise in need of weight control performed the longer, 4-min aerobic intervals, with exercise intensities slightly lower than those for patients deemed not to need an increase in caloric consumption (e.g., cystic fibrosis). With six aerobic intervals and six 2 × 1-min resistance, stretching, or calisthenic intervening intervals, the total exercise time was 30 min or 36 min, depending on whether 3- or 4-min aerobic intervals were prescribed.
The amount of time between exercises varied depending on patient motivation and energy levels, with some patients taking over one hour to complete the circuit. Patients with cardiac transplantation were given prolonged warm-up and cool-down periods. The intensity of the circuit was also temporarily or permanently modified in a few cases of intellectual incapacity (Trisomy 21, children too young to comprehend) or physical incapacity (musculoskeletal injury that occurred at home or school).

**Frequency**

Patients were prescribed an exercise program of three interval training circuits per week, and daily less vigorous activities or sports. Forty of the patients began this program planning to do at least one 13-week block of three-times-a-week supervised training in the clinical exercise facility. A few patients came less frequently, due to transportation problems, but were told to do “home circuits” or other exercise workouts at home. After the first 13-week block, patients met with the program director and—depending on their progress and interest levels—continued as before, continued with less frequent in-center and more frequent at-home sessions, or were discharged from the program to exercise totally on their own.

**Data Analysis**

The number of sessions participated in by each patient was tabulated. Exercise exposure was calculated by multiplying sessions by 30 or 36 minutes, depending on whether 3- or 4-min aerobic intervals were prescribed. Results are reported as means ± standard deviations. Injuries occurring during supervised exercise training and their medical evaluation were noted in patient charts.

**Results**

A total of 47 patients between 5 and 26 years old (12.6 ± 3.9 years) participated in as few as 2 to as many as 329 sessions of supervised exercise in the program. They had the following primary medical diagnoses: obesity (25), renal disease with obesity (1), cystic fibrosis (10), cardiac transplantation (2), Trisomy 21 with congenital cardiac disease (1), asthma (3), chest pain (1), myasthenia gravis (1), short stature/unfit (1), hypercholesterolemia (1), and hip strain/unfit (1).

From participation in 2,646 sessions (56.3 ± 63.3 sessions/patient), an exercise exposure of 1,507.9 hours (32.1 ± 35.5 hr/patient) was calculated. Three events occurred during this time:

1. A 13-year-old girl had her foot and ankle caught momentarily between the pedal crank and plastic covering while pedaling a cycle ergometer (CatEye EC-1000, Tsuyama Mfg. Co., LTD, Osaka, Japan). She had mild pain of her distal ankle and foot. On examination, there was no swelling or discoloration, full range of motion, no instability, and minimal diffuse tenderness. A mild limp resolved within a few minutes, and the patient resumed exercising. She was completely asymptomatic within 48 hours.
2. A 7-year-old boy hit himself in the face with his hand while backcranking the upper limb cycle (Uppercycle, Engineering Dynamics Corp., Lowell, MA). He did not immediately report this accident. When examined, he was asymptomatic, and there was no ecchymosis or tenderness.

3. On another occasion, this same 7-year-old misstepped while treadmill walking, and fell down and off the device (Challenger 2.0, Challenger Fitness Equipment, Dallas, TX), which was going less than 4 mph at the time. He had no physical complaint or physical findings observed, and continued to exercise without incident. This particular patient had a history of surgically treated club feet and documented gait abnormalities.

These three events, involving no treatment or time lost from exercise, occurred at a rate of 1.9 events/1,000 patient hours of exercise. There were several other instances of patients reporting injuries sustained at home, school, or other settings, related or unrelated to physical activities, who were evaluated. None of these injuries were serious, and only a few caused patients to miss even one or two exercise sessions. As these injuries occurred outside of our supervised program, they were not tabulated for this report. Similarly, there were several untabulated episodes of patients suffering exacerbations of their underlying disorders (e.g., asthma, cystic fibrosis, congenital heart disease, renal disease), some of which affected their ability, or their parents’ or physician’s willingness to permit them to exercise. None of these events occurred during or immediately after a supervised exercise session, and none were considered related to supervised or unsupervised exercise participation.

**Discussion**

Our experience demonstrates a very low frequency of events, none of which were clinically significant in terms of causing observable injury or disability, and none of which required medical treatment. This safety record is more impressive in light of the sedentary, inexperienced, and unfit population exposed to exercise in this study.

This experience contrasts sharply with the experience of competitive team sports, which, especially at the high school level and higher, have appreciable injury risks (11). There is less information available from competitive sports more analogous to the exercise modalities used in our program, such as running, walking, rowing, and cycling (19). Research studies on strength training in prepubescent children, each involving small numbers of subjects, report good safety records, particularly with hydraulic resistance equipment (23). More problems have been seen in adolescents and chiefly involve accidents during unsupervised lifting of free weights and overuse injuries (16). Studies of adults doing cardiac rehabilitation fairly similar to our program in type, supervision, intensity, duration, and frequency of exercise, report few cardiac events (1.2/100,000 patient hours) (22), but do not consider musculoskeletal injuries. The elderly age range of most patients in those studies limits the generalizability of that data to children.

Requa and colleagues (15) reported an injury risk for 986 recreational fitness activity participants, ranging in age from 17 to 76, of 7.83/1,000 hours of participation. The majority had experienced a previous injury, but coexisting
medical conditions were not determined. They found no significant difference in injury risk between 17- to 29-year-olds and older participants. Of the injuries in their study 64.9% resulted in an interruption of sport and fitness activities, as opposed to none in the present study. Exercise intensity and duration/session were not reported.

Some data has been reported on injuries in children from indoor exercise equipment in the home (5). The usefulness of this data in assessing injury risk is, again, limited. The exposure is not defined, the age range includes very young children who were not the actual users of the equipment, supervision of the victims is not known, and the safety design of the equipment is quite variable, due to its nonprofessional use.

Due to small numbers of patients and varying compliance regarding attendance, the efficacy of our program was not readily assessable, except for the obese population. The patients with obesity who completed one 13-week block of treatment had good compliance and showed improvements in body composition and fitness, as reported elsewhere (3, 8).

As various approaches are attempted to increase the physical activity of children, especially those with chronic disease, the clinical approach may suffer due to its expense and its inability to handle large numbers of children. Further data should be gathered to substantiate the excellent safety record demonstrated here. With this information, the clinical model should be considered, as it may be especially beneficial in children who have been previously sedentary or otherwise have special needs.

References


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