Physiological Effects of a 13-Week Physical Fitness Program on Down Syndrome Subjects

Suzanne M. Dyer

The purpose of this study was to evaluate the effects of a 13-week health-related fitness program on 10 Down syndrome subjects aged 8 to 18. An A-B-A time-series design was used, with data collected every 6 weeks for 43 weeks: The preintervention phase included four data collection points, and the intervention and postintervention phases included two data collection points each. Data obtained included resting heart rate, blood pressure, and results of a step test designed to measure cardiovascular fitness. Analyses of results revealed significant positive changes for resting heart rate ($p < .0005$), blood pressure ($p < .01$), and step test ($p < .0001$). Motivation and the type of program implemented were identified as particular reasons for positive outcomes. It was concluded that participation in regular physical activity may be beneficial for Down syndrome subjects, particularly because poor fitness levels have been closely associated with health risks such as cardiovascular disease.

Although there has been extensive recognition of the importance of regular physical activity (particularly cardiovascular conditioning) on the general health and well-being on the nonhandicapped individual (17, 18), few studies have been conducted that investigate the effects of physical activity on individuals with mental retardation. Most studies involving subjects with mental retardation have concentrated on identifying differences between handicapped and nonhandicapped peers rather than assessing the relationship between physical activity and the individual. Furthermore, much of the research currently available (e.g., 9, 14, 23, 28, 29) has treated all individuals with mental retardation in the same manner, despite the existence of a large number of separate groups (e.g., Down syndrome, autism).

Investigations of fitness levels in subjects with mental retardation have found cardiovascular fitness to be 20–40% lower than that of nonhandicapped peers (2, 4, 6, 7, 13, 14, 25, 28, 29). Reasons suggested for the observed lower levels of cardiovascular fitness include lower maximum heart rates (14, 15, 26), sedentary lifestyles (6, 29), less opportunity for participation (20), a lack of motivation, task complexity, and poor performance on new tasks (4, 8, 16, 23, 25, 29). There is also some speculation that retardation-dependent physiological differences may be involved (16).

Suzanne M. Dyer is with the School of Early Childhood Studies at Macquarie University, 2109, Sydney, Australia.
Investigations of training-induced improvements in subjects with mental retardation have produced conflicting results. Some studies using field tests showed cardiovascular improvement (e.g., 7, 9), whereas laboratory-based testing produced no changes (e.g., 5, 26, 27). These differences may be associated with physiological efficiency (16, 36), anxiety, experience with equipment, pacing techniques, motivation, task habituation, and intensity levels, duration and frequency of activity (16).

In studies in which Down syndrome subjects have been investigated separately, several important findings have emerged. First, Down syndrome adolescents do not appear to sustain work loads for as long as their nonhandicapped peers (12). Second, the cardiovascular capacities of Down syndrome subjects have been found to be inferior to both nonhandicapped subjects and non-Down syndrome subjects with mental retardation (15, 30). Third, gains in endurance and physical work capacity may occur without concomitant increases in aerobic capacity (27). Fourth, biochemical changes after short, intensive bouts of exercise have been found to be similar to those of the nonhandicapped population, indicating that training may be beneficial for the “pathophysiological consequences of this genetic disease” (11, p. 286).

In view of these findings and the established association between health and physical activity, it would seem important to study the effects of an increase in physical activity on health-related variables. In the present study, the effects of a health related fitness program on the cardiovascular fitness, resting heart rate, and blood pressure of Down syndrome subjects were investigated. Testing procedures and program content were highly influenced by previous findings relating to Down syndrome subjects and by suggestions that motivation, access, opportunity for participation, task complexity, and test anxiety were limiting factors in relation to obtaining valid results.

**Method**

**Subjects**

All Down syndrome individuals between 8 and 18 years of age living in Townsville, Australia, participated in this study ($N = 10$). All subjects attended special education schools. IQ scores could not be released, but were estimated to be between 30 and 70 based on classification by school personnel. Permission for participation in the program was obtained from medical practitioners, parents, and subjects. Medical records indicated that 9 subjects had been diagnosed with congenital heart disease at birth: In 7 subjects, mild forms of a ventricular septal defect had closed spontaneously during early childhood; one subject was diagnosed as having partial endocardial cushion defect and was on medication; and no details were available for the remaining subject, although it is known that medication was not administered. No cases of surgical correction were reported. All subjects were classified as having some degree of muscular hypotonia. None of the subjects had previously participated in organized physical activity programs, and school physical education was limited to either 10-pin
bowling, roller skating, or swimming once a week for 1 hour. Age and physical characteristics are provided in Table 1.

**Experimental Design**

Because of constraints—including sample size, the specific characteristics of the Down syndrome population, and the age and health of subjects—an A-B-A time-series research design was adopted, with subjects acting as their own controls (Figure 1). Two strategies were employed to minimize threats to validity associated with a lack of familiarity with investigators, procedures and apparatus (29), problems associated with language deficits and a corresponding lack of comprehension (8), test anxiety, and motivation (4, 8, 16, 23, 25, 29). First, the investigator visited schools and homes on numerous occasions before data collection began in order to develop rapport with subjects, parents, and teachers. Second, before data collection began, subjects were involved in four sessions with the investigator and research staff during which they became familiar with equipment and techniques to be used. Anecdotal observations suggested that these strategies were successful because subjects became very comfortable with researchers, tests, and the situation before data collection began.

**Apparatus and Procedure**

Resting heart rate, blood pressure, and results of a 3-min step test designed to measure cardiovascular fitness were recorded every 6 weeks. The investigator

<table>
<thead>
<tr>
<th>Variables</th>
<th>Female ($n = 6$)</th>
<th>Male ($n = 4$)</th>
<th>Total ($N = 10$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>$M$ 13.6  SD 2.3</td>
<td>$M$ 13.8 SD 3.6</td>
<td>$M$ 13.7 SD 2.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>$M$ 47.4  SD 15.3</td>
<td>$M$ 40.5 SD 15.1</td>
<td>$M$ 44.7 SD 14.8</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>$M$ 141.8 SD 12.3</td>
<td>$M$ 145.4 SD 20.3</td>
<td>$M$ 143.2 SD 15.0</td>
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<table>
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<th>Intervention</th>
<th>Postintervention</th>
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</table>

**Figure 1** — A-B-A time-series design used in the present study.
administered all tests. In order to minimize investigator bias, an assistant recorded all data, and the investigator had no access to information from previous collection points until the study was completed. Tests were performed at the same hall where subjects participated in the fitness program. It should be noted that repeat testing was completed at the same time of day, on the same day of the week, and with the same investigator in every case. Subjects were encouraged to sit still on a chair for approximately 3 min, after which time carotid pulse was taken for 30 s. This was immediately followed by blood pressure readings, which were taken using a mercury sphygmomanometer. The 3-min rest period preceding measurement was chosen after observations made during practice sessions indicated that most subjects had difficulty remaining still for longer periods of time.

Following blood pressure readings, subjects walked around the hall for 1-min and then completed a step test. The step apparatus included two 8-in steps on which two people could comfortably work (35). Based on the work of Seidl et al. (35), cadence was set at 102 beats per minute (bpm). However, it became obvious during practice sessions that this was too fast for 5 of the subjects, despite the use of several verbal and physical teaching strategies. The cadence was consequently set at 96 bpm, a rate that appeared to elicit an efficient performance from all subjects.

Recovery heart rate using the carotid pulse was taken manually by the investigator within the first 20 s after termination of the test (3, 31), and was counted for 15 s. Comparisons of the investigator’s manual readings with those obtained using a sports pulse meter revealed a correlation of .96, and thus, pulse rates for this study were considered valid.

Choice of a step test as the mechanism for measuring cardiovascular fitness in the present study was based on a number of factors. First, more rigorous measures of VO2 max were not considered appropriate because the emphasis was on school-based programs and field applicability. Second, investigations of the validity of field tests in populations with Down syndrome or other forms of mental retardation are limited (16, 36), and furthermore, studies attempting to establish validity have had varying results (8, 34). Third, use of the step test minimized problems associated with poor motivational levels because it is considered to have no motivation component due to set workload and cadence parameters (37). Fourth, anxiety, which is often attributed to lack of familiarity of surroundings, was minimized by having testing carried out in the same place as all other measures and the intervention program. This would not have been possible if a maximal test of cardiovascular fitness had been used. Fifth, problems associated with motor skill and localized fatigue (37) were minimized due to the length of the test and the fact that all subjects were familiar with walking up stairs. Finally, because of the low level of intensity expected during administration, the step test was considered safe in terms of risks associated with heart disease, obesity, and a lack of regular activity.

Diaries showing a 24-hr/day activity profile were also completed for 7 days every 6 weeks. The forms were filled out by parents and teachers, and included a record of all activities that the subjects engaged in, the length of time spent on each activity, and with whom subjects interacted. Diaries were designed to indicate any changes in behavior that might influence results.
Treatment

The intervention program was conducted four times per week for a period of 13 weeks. Monday and Friday sessions were held during school time, and Tuesday and Thursday sessions were held immediately after school ended in the afternoon. During implementation of the intervention program, subjects did not attend the 1 hr/week physical education sessions that formed part of their normal school routines.

Although age varied, the program format remained the same for all subjects. Individual differences in age, motor skill, and fitness were accounted for by using activities that all subjects could successfully execute, choosing activities that could be varied according to individual need, and using heart rate as the basis for workload level. The program consisted of four sections—warm up, cardiovascular endurance, circuit weight training, and cool down—which are outlined below (detailed information can be obtained from the author on request).

The warm-up section of the program continued for approximately 8 min and included low intensity, range of motion movements as well as static stretching exercises for the major muscle groups. Subjects then participated in 22 min of cardiovascular endurance activities. Initially, the program consisted of low impact moves incorporating simple arm and leg movements, together with fast walking or slow jogging. Gradually, a stationary bike, mini trampoline, various obstacles and balls were introduced as extra motivational devices. In order to increase variety and sustain movement, a variety of group formats was also used. Subjects were encouraged to choose preferred activities and vary them appropriately.

Although it is generally recommended that target heart rates (HR) for training be calculated as either HRrest + 60–90% (HRmax – HRrest), or 70% HRmax, it was decided to use the aerobic threshold range (130–150 bpm) as a guide to intensity levels for the cardiovascular endurance section of the program (24). Reasons for this were as follows:

1. Results from a pilot study and from prestudy familiarization sessions indicated that elevating the pulse above approximately 144 bpm was extremely difficult due to complaints of breathlessness and fatigue. When heart rate remained at approximately 132 bpm, these problems did not occur. Had the target heart rate formulae been used, minimum working heart rate for subjects would have been 155 bpm.
2. The reported differences in HRmax, cardiac output, and metabolism indicate that although HR is lower, Down syndrome individuals may be working at intensities similar to those of nonhandicapped peers (27, 30).
3. Use of the formula 220 – age to establish HRmax may not be appropriate, particularly in light of suggestions that peak heart rate may be lower in this population (15, 27, 30).
4. Vigorous exercise can involve musculoskeletal injury, which is of particular concern to Down syndrome individuals because of the prevalence of hypotonia and the associated possibility of joint injury.
5. Retaining high motivational attitudes is easier if intensity levels fall within a range deemed comfortable by the participant.

The lack of motor ability and high incidence of hypotonia, together with a lack of knowledge in the literature concerning the effects of lifting heavy weights
under these conditions, called for a conservative approach to the development of the muscular-endurance component of the intervention program. Use of a circuit weight training routine ensured high levels of safety and motivation and did not overtax the joint structures of participants.

The circuit weight training section of the program continued for 25 minutes and included two sets (15 repetitions/set) of 10 exercises: leg extension, leg curl, crunch, back extension, leg adduction, leg abduction, bench press, lateral fly, tricep extension, and bicep curl. Initially, intensity was determined by calculating 40% of one repetition maximum for each exercise (19, 21, 40). However, it was immediately obvious that, due to a lack of motor control, the participants could not safely lift 40% of one repetition maximum under program conditions. Consequently, the amount of weight to be lifted was determined by trial and error and depended to a large extent on the ability of the individual to safely execute the exercise. As subjects’ strength increased, heavier weights were lifted. It should be noted that, due to problems with safety and controversy surrounding the use of weights by young children, the two prepubescent subjects in the study did not use weights when participating in the circuit weight training routine. The final program component consisted of a 5-minute cool-down period that included static stretching.

**Statistical Analyses**

For the purpose of most analyses, data were divided into three phases (Figure 1). The preintervention Phase 1 included data collected during Weeks 1, 7, 13, and 19; the intervention Phase 2 included data collected during Weeks 25 and 31; and the postintervention Phase 3 included data collected during Weeks 37 and 43. Data within each phase were averaged together and considered as one. Means and standard deviations for each phase were calculated for all variables, and two-tailed Student’s t tests were used to determine if significant differences existed between phases.

**Results**

**Program Adherence**

Absenteism occurred on 14 occasions; one subject was absent twice for 2 consecutive days, one was absent on four nonconsecutive occasions, and another was away for one 4-day period and one 2-day period. All subjects participated in the activities and appeared to enjoy themselves. No instances of refusal to participate were observed.

Subjects’ working heart rates, taken by the investigator or research assistant using a 15-s carotid pulse count, were recorded at least three times during every session. On a few occasions, intensity levels during the cardiovascular session were difficult for some subjects to maintain (Table 2). Use of specific motivational strategies helped minimize these problems (10).

Adherence to the circuit weight training program was also high. The only problems encountered concerned three of the circuit weight training exercises: Leg abduction and adduction using a pulley system proved difficult for most subjects as they could not isolate the leg muscles and constantly used hip and
Table 2 Working Heart Rate Mean, Standard Deviation, and Estimated Exercise Intensity Levels of Each Subject During Participation of the Intervention Program

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean working HR (bpm)</th>
<th>SD</th>
<th>Mean working HR calculated as % of HRmax</th>
<th>Level of intensity (%) if HRmax is calculated as (220 – age) × 0.92</th>
<th>Level of intensity (%) if HRmax is calculated as (220 – age) × 0.82</th>
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<tr>
<td>1b</td>
<td>126</td>
<td>6.0</td>
<td>61.77</td>
<td>67.13</td>
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<td>2</td>
<td>136</td>
<td>8.2</td>
<td>64.76</td>
<td>70.39</td>
<td>78.98</td>
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<tr>
<td>3</td>
<td>135</td>
<td>4.9</td>
<td>65.83</td>
<td>71.58</td>
<td>80.31</td>
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<tr>
<td>4</td>
<td>139</td>
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<td>81.91</td>
</tr>
<tr>
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<td>72.20</td>
<td>78.47</td>
<td>88.04</td>
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<tr>
<td>6</td>
<td>131</td>
<td>6.2</td>
<td>64.22</td>
<td>69.98</td>
<td>78.30</td>
</tr>
<tr>
<td>7</td>
<td>130</td>
<td>8.3</td>
<td>64.04</td>
<td>69.59</td>
<td>78.08</td>
</tr>
<tr>
<td>8</td>
<td>138</td>
<td>8.1</td>
<td>67.75</td>
<td>73.52</td>
<td>82.49</td>
</tr>
<tr>
<td>9</td>
<td>133</td>
<td>5.8</td>
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<tr>
<td>10</td>
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<td>9.1</td>
<td>68.30</td>
<td>74.23</td>
<td>83.28</td>
</tr>
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</table>

*Studies by Fernhall et al. (15) and Millar et al. (27) showed that HRmax in Down syndrome subjects was between 8% and 18% lower than would be expected using the 220 – age formula. Mean working HRs of subjects in the present study were converted into estimated intensity level percentages using the following formulae: 0.92 × HRmax; 0.82 × HRmax. The calculated percentages provide some indication of the level of exercise intensity of Down syndrome subjects in the present study. The recommended working HR for Subject 1 was set between 120 and 140 due to medication that lowered HR.

back muscles to simulate the required movement; and several subjects used a back-and-hip swinging motion to aid lifting of the arms during the lateral fly.

Diaries

Daily activity patterns were broken into four categories regarding the time spent sleeping, watching television, engaging in light activities, and engaging in moderate activities (excluding intervention). These categories were adapted from a study by Shephard et al. (39) that identified the types of daily activities in which children participate. The amount of time not accounted for was also noted.

The only significant change in daily behavior patterns noted throughout the 43 weeks of the study was an increase in the time spent engaged in light activity between Phases 2 and 3 ($t = -3.691; p < .01$). This may have been a response to termination of the intervention program. Overall, analysis of data collected using diaries indicated that influences from historical events, maturational trends, and intervention reactions were minimal, suggesting that changes in results corresponding to intervention were likely to be program related.
Table 3  Mean Results at Each Phase for Blood Pressure, Resting Heart Rate, and Step Test Measurements

<table>
<thead>
<tr>
<th>Phase</th>
<th>Blood pressure (mmHg) M</th>
<th>SD</th>
<th>Resting heart rate (bpm) M</th>
<th>SD</th>
<th>Heart rate response to step test (bpm) M</th>
<th>SD</th>
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</thead>
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<tr>
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<td>112.1/70.1</td>
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<td>84.5</td>
<td>5.6</td>
<td>141.1</td>
<td>11.7</td>
</tr>
<tr>
<td>2</td>
<td>103.8/63.8</td>
<td>9.7</td>
<td>72.0</td>
<td>4.9</td>
<td>130.2</td>
<td>10.7</td>
</tr>
<tr>
<td>3</td>
<td>108.4/65.0</td>
<td>10.8</td>
<td>79.3</td>
<td>7.6</td>
<td>137.8</td>
<td>11.8</td>
</tr>
</tbody>
</table>

**Step Test**

Results from step tests are provided in Table 3. Paired t-test results showed significant decreases in recovery heart rate between Phases 1 and 2 ($t = 7.564; p = .0001$), and significant increases between Phases 2 and 3 ($t = -4.924; p = .0008$). The nonsignificant difference in recovery heart rate between Phases 1 and 3 ($t = 1.766; p = .111$) indicated that cardiovascular fitness during these times were similar.

**Resting Heart Rate**

Resting heart rate data are presented in Table 3. Paired t-test results showed a significant decrease in resting heart rate between Phases 1 and 2 ($t = 5.238; p = .0005$) and a significant increase between Phases 2 and 3 ($t = -4.302; p = .002$). No significant differences were found between Phases 1 and 3, which indicated that resting heart rate returned to a point similar to Phase 1 levels 12 weeks after intervention withdrawal.

**Blood Pressure**

Blood pressure results are detailed in Table 3. Paired t-test results identified a significant decrease in systolic blood pressure between Phases 1 and 2 ($t = 4.572; p < .01$) and a significant increase between Phases 2 and 3 ($t = -3.613; p < .01$). No significant changes were found between Phases 1 and 3 ($t = 1.684$). Results from statistical analysis of diastolic blood pressure also showed a significant decrease between Phases 1 and 2 ($t = 3.323; p < .01$). There was no significant response to intervention withdrawal ($t = -1.01$); however, a small nonsignificant increase was noted. A significant difference was found between Phases 1 and 3 ($t = 2.403; p < .05$), which indicated that diastolic blood pressure decreased throughout the study.

**Discussion**

A major finding of this study was that participation in a health-related fitness program significantly improved the cardiovascular fitness of a group of Down
syndrome subjects as measured using a 3-min step test. Although it can be argued that failure to establish validity of the step-test protocol calls into question the findings of this study, it should be noted that the test was stable with regard to the subsample used. Ex post facto repeated measures ANOVAs of the first 4 collection points (preintervention phase) showed no significant differences in step-test results, $F(3) = 1.983, p = .1403$. Furthermore, test–retest reliability estimates were high ($r = .94$). Thus, it is argued that results were dependable, at least with regard to the population being studied.

Several points can be made that provide further support for suggestions that results from the present study may be accurate despite shortcomings associated with a lack of validity for the measure of cardiovascular fitness. First, comparative analysis of results from Phases 1 and 3 showed no significant differences in recovery heart rate, indicating that preintervention and postintervention performances on the step test were similar. Second, the significant increase in recovery heart rate between Phases 2 and 3 indicated a decrease in cardiovascular fitness following intervention withdrawal. Third, diary records identified few changes in activity patterns throughout the study, indicating that changes in recovery heart rate may be related to participation in the intervention program rather than changes in other behavioral patterns. Fourth, significant improvements in the present study were in agreement with results from other studies using field tests to investigate training effects on the cardiovascular fitness of subjects with mental retardation (7, 9, 23, 29). It is argued that when taken together, these points provide some support for the contention that cardiovascular fitness improved following intervention.

The observed changes in recovery heart rate may have been a result of improved exercise economy, test familiarity, or reduced anxiety. However, it is suggested that prestudy familiarization sessions served to minimize the effects of these variables on performance. Anecdotal observations indicated that by the end of familiarization sessions, subjects felt at ease with both the investigator and test procedures. Also, performances on the step test appeared to have stabilized, at least in terms of stepping ability and adherence to cadence. Results of ex post facto analysis of Phase 1 data, which showed no significant changes in performance during the preintervention phase, provided further support for suggestions that step-test performances were stable.

It is more likely that the large changes in recovery heart rate were due to poor initial cardiovascular fitness levels. Direct evidence of subjects’ fitness levels in the present study was not available because the step test used for measuring cardiovascular fitness was modified, thereby preventing comparisons with standardized norms. However, the low level of activity required to elevate pulse rates during cardiovascular workout sessions suggested that initial fitness levels were poor.

For reasons mentioned previously, aerobic threshold range rather than individual intensity level was used to establish workloads during the cardiovascular section of the program. A particular problem with using this mechanism is that actual exercise intensity level is not immediately known. Furthermore, attempts to estimate exercise intensity level as a percentage of HRmax, where HRmax is established using the formula $220 - \text{age}$, may be erroneous for Down syndrome subjects (15, 27). Fernhall et al. (15) and Millar et al. (27) found that HRmax in Down syndrome subjects was between 8 and 18% lower than would be expected.
using the 220 – age formula. In order to ascertain approximate intensity levels at which subjects in the present study were exercising, ex post facto calculations using subjects’ working heart rates and HRmax data from the studies by Fernhall et al. (15) and Millar et al. (27) were completed (Table 2). Resulting estimates of exercise intensity levels adhered to by subjects in the present study fell within the range recommended by the American College of Sports Medicine (1) (Table 2). Thus, it is argued that for this group of subjects, use of a heart rate range to determine workload level was appropriate.

It is interesting to note that if approximate intensity levels calculated in Table 2 are accurate, subjects in the present study exercised at higher intensity levels than those in similar studies (e.g., 27, 29). One reason for this may be that subjects with Down syndrome are more inclined to maintain prescribed workload levels under conditions whereby they have some sense of control over program content. Specific motivational strategies adopted in the present program included using music, providing a wide range of activities, and encouraging subjects to choose preferred music and activities and to take responsibility for cardiovascular endurance sessions. Anecdotal observations indicated that subjects responded positively to these strategies; by the sixth week of the program, subjects were essentially conducting their own cardiovascular sessions, with the investigator only occasionally needing to provide individual encouragement to elevate workload levels.

Blood pressure results reported in the present study showed significant decreases in response to intervention. While investigator bias is unlikely due to methods used in data collection, a random zero sphygmomanometer was not used, and thus, results may not be indicative of actual changes. However, similar decreases were noted in a study by Lavay et al. (23) which investigated the effects of a cardiovascular-fitness program on adults with mental retardation (systolic, \( p < .02 \); diastolic, \( p < .001 \)). It was interesting to note that blood pressure readings from this and other studies (12, 23) were lower than average, and decreased significantly following participation in a fitness program. Although no conclusions can be drawn from the present study, further investigation of this seems warranted, particularly because similar changes do not appear to occur in nonhandicapped subjects who have normal blood pressure.

**Conclusion**

Conclusions based on data presented in this paper must be seen in light of the fact that the test of cardiovascular fitness was not validated. Also, similar studies using larger numbers of subjects, together with valid and reliable means of testing cardiovascular fitness in the field, would need to be conducted before findings from the present study could become generalizable.

Despite these shortcomings, several preliminary conclusions are proposed. First, results from step data indicated that Down syndrome subjects in the present study had a large capacity for improving cardiovascular fitness. Previous investigations using nonhandicapped subjects have concluded that higher levels of physical fitness result in increased work capacity and performance and decreased resting heart rate and blood pressure (e.g., 18), all of which provides some protection against health risks such as coronary heart disease, orthopedic problems, and hypertension (18, 22). Because a high incidence of cardiovascular and
respiratory diseases has been reported within the Down syndrome population, participation in a program such as the one detailed in this study has the potential to improve health and well-being.

Second, withdrawal of training resulted in regression of resting heart rate, cardiovascular fitness and blood pressure. As these measures have also been associated with health and well-being, it would seem essential that training be continued, if possible. Furthermore, previous studies found that individuals with higher fitness levels were more productive and less often absent from work (6, 33, 38). Thus, improved fitness levels such as those evidenced in the present study could also have a positive impact on job performance and employment opportunities for Down syndrome individuals.

Third, Down syndrome subjects in the present study maintained predetermined workload levels that were estimated to correspond to intensity levels of approximately 68–89% of HRmax. If, as suggested, a major reason for adherence to these exercise intensity levels was that subjects were highly motivated due to a sense of control over program content, then future studies should consider implementing similar procedures.

Finally, the program presented in this paper is socioculturally valid (32). That is, similar activities are available within the community, are regularly attended by nonhandicapped persons, and have the capacity to cater to handicapped individuals (32). Participation at the school level may help handicapped individuals develop the skills, familiarity, and motivation necessary for confident participation in similar activities within the wider community—an important long-term consideration in view of findings that individuals with mental retardation rarely participate in physical activity outside school (20) and thus fail to develop general fitness and its associated benefits.

References


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