Effects of School-Based Cardiovascular-Fitness Training in Children With Mental Retardation

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The aim of this study was to investigate the effects of a school-based cardiovascular-fitness-training program in children with mental retardation (MR). Thirty boys (8–15 years old) with mild to moderate mental retardation were randomly divided into 2 groups—experimental (EX) and control (CN). The EX group underwent 10 weeks of training 3 times/week for a duration of 1 hr/session at 60–80% peak heart rate. At Week 10, significant increases in 20-m shuttle-run-test (20-MST) laps were observed for the EX group. No improvements were found in percent body fat. No changes were observed for the CN. The school-based training program might prove useful in improving the cardiovascular fitness of children with MR.

Cardiovascular fitness is one of the most important parameters of health-related physical fitness (7). Low levels of cardiovascular fitness are associated with adverse health outcomes such as hypertension, obesity, some forms of cancer, Type II diabetes, osteoporosis, stroke, and coronary heart disease in adults (1). Research indicates that individuals with mental retardation (MR) exhibit lower levels of cardiovascular fitness than their peers without MR (10–13,22,23,29,31). Several authors suggest that the mechanisms responsible for this are delayed physical development, limited motivational levels, sedentary lifestyles, chronotropic incompetence, or poor leg strength (8,20,21,23).

The prevalence of atherosclerosis, cardiovascular disorders, and obesity in individuals with MR is greater than in the general population (2,5,14,17,19,24,26). Individuals with MR are at greater risk for health complications because they have a lower limit for the onset of old age (20). Furthermore, they have a higher mortality rate than the general population (20), with the most common causes of death being cardiovascular and pulmonary complications (16).

Based on the previous findings, it would appear that developing programs designed to increase the cardiovascular-fitness levels of individuals with MR would serve an important public-health interest—a reduction in the morbidity and mortality from cardiovascular disease in this population. Several researchers have reported that individuals with MR had considerable gains in cardiovascular-fitness levels.

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with exercise training (6,15,22,28,32–34). The studies that have focused on children have observed significant increases in cardiovascular-fitness levels (4,15,18,33,34). The lack of a control group and inclusion of children with disabilities other than MR (e.g., Down syndrome), however, leave questions about whether these training programs would result in improved cardiovascular-fitness levels of children solely with MR. Furthermore, a program not only needs to demonstrate positive effects on the outcome of interest (cardiovascular fitness) but also should be simple enough for non-research professionals (e.g., physical education teachers) to implement. Previous studies aimed at improving cardiovascular fitness of children with MR have proved beneficial but have taken place outside the school setting (e.g., summer) (33), were primarily focused on developing motor skills (e.g., hopping, skipping, jumping) (15) or other sport-related skills (e.g., soccer, basketball) (18), or used an activity that requires equipment not readily available in many schools (i.e., swimming pool) (34). A program designed to be used in the school setting that requires minimal equipment and can be conducted during adapted physical education is therefore necessary. This study was designed to determine whether a 10-week school-based aerobic-training program can improve the cardiovascular-fitness level of children with MR. A secondary outcome was to determine whether the program would decrease percent body fat of the experimental group.

Methods

Participants

Thirty boys between the ages of 8 and 15 years (mean age = 11.2 ± 2.0 years) with mild to moderate MR were recruited from two county schools for children with developmental disabilities in Turkey. All participants lived in home settings—none were institutionalized. The participants were classified by school professionals as having mild or moderate MR. Children were excluded from participation if they had any of the following conditions: ambulatory limitations, musculoskeletal complications, visual or auditory problems, Down syndrome, or autism. None of the children were participating in any exercise or sport activities before the study. The participants were prescreened for medical contraindications to exercise by a physician. Before the study’s preassessment measures, written informed parental consent and verbal assent were obtained from all participants.

Instruments

Cardiovascular Fitness. The 20-m shuttle-run test (20-MST) was used as an indirect measure of cardiovascular fitness (VO$_{2\text{peak}}$). The 20-MST has been shown to be a valid and reliable test to estimate the cardiovascular fitness (as defined by VO$_{2\text{peak}}$) of children and adolescents with MR (12) and elicits peak heart rates comparable to laboratory treadmill testing (3). All tests were performed in a gymnasium. The distance (20 m) was marked on the gym floor with tape and cones. The participants were instructed to run the distance between cones (20 m) in the allotted time. Prudential Fitnessgram audiotapes played on a portable cassette player were used for proper pacing. Proper pacing allows for each lap to be completed in 9 s during the first minute of the test. After that, the time allotted
for each lap is decreased by approximately 0.5 s each minute. During each test an assistant ran with the participants and provided continual encouragement and motivation. The participants ran in small groups of 2 or 3. The test was terminated when the participants could no longer continue (volitional fatigue) or could not maintain the required speed for two laps. The number of laps completed was recorded for analysis. Individuals were allowed several practice runs on the days before actual testing. The participants then completed two 20-MST separated by 2–5 days, with the best effort (most laps completed) used for statistical analysis. The participants who were unable to perform a proper shuttle test were not included in this study.

**Percent Body Fat.** Skinfold thickness was measured at two sites (triceps and subscapular) using baseline skinfold calipers (Professional Medical Technologies, McCallen, TX). Three measures were taken at each site and averaged to calculate the percent body fat according to the generalized regression equations for male participants developed by Slaughter et al. (30). Measures were taken on the right side of the body by one trained research-staff member.

**Procedures**

After the initial screening, the participants were randomly divided into two groups—experimental group (EX) = 16 and control group (CN) = 14. The CN group did not undergo any additional aerobic-fitness training other than what they would have normally engaged in during their habitual physical activity, which included attending a general physical education class for approximately 2 hr/week. The training intervention consisted of 10 min of warm-up that included walking, callisthenic-type and stretching exercises, 20 min of interval training (walking and running), and 25 min of recreational activities (volleyball, soccer, rope jumping, dodgeball), followed by a 5-min cool-down period (walking). This routine was performed three times/week for 10 weeks.

The interval training program was modeled after the cardiovascular-fitness program for individuals with MR outlined by Rimmer (25). For the interval training, a rectangular track (20 m × 10 m) was designated by cones in the gym. Corners of the track were named A, B, C, and D. First, the child began sprinting from corner A to corner B, then walked from corner B to corner C. The participant began sprinting again to corner D and then walked to the starting line (corner A). The second set included sprinting two sides consecutively (B and C) and then walking two sides (D and A). The third set included sprinting three sides (B, C, and D) and walking three (A, B, and C). The last set involved sprinting the entire perimeter one time and then walking it once. This series was repeated for 20 min. During training the research staff checked the participants’ pulse rates via palpation to determine whether they had reached their target heart rates. Target heart rates were calculated at 60–80% of maximum heart rate for each participant using the following formula (27):

\[
\text{target heart rate} = [(\text{maximum heart rate} - \text{resting heart rate}) \times \text{intensity level}] - \text{resting heart rate}
\]

Maximum heart rates were calculated using the formula that Fernhall et al. determined for individuals with MR (9).
For the initial 4 weeks (Weeks 1–4) the interval training was scheduled for four sets of three repetitions. This was increased during the following 4 weeks (Weeks 5–8) to four sets of four repetitions. During the final 2 weeks (Weeks 9 and 10) the training consisted of four sets of five repetitions. One set equaled a complete lap around the cones, beginning and finishing with Cone A. One repetition included four sets. Ninety-eight percent of the sessions were attended by the experimental group.

**Statistical Analysis**

Reliability of pre- and posttest 20-MST performance was determined by calculating single-measure intraclass correlation coefficients (ICCs) and the coefficient of variation (CV). Independent t tests were calculated to examine the equivalency of the descriptive characteristics (age, height, percent body fat) and 20-MST laps completed for the pretests between the EX and CN groups. The results indicated that the randomization to equate the groups on 20-MST performance failed, with the CN group having significantly better performance on the 20-MST than the EX group ($t = 2.50, p = .02$). Based on this, an analysis of covariance (ANCOVA) was conducted to examine differences between the CN and EX groups on posttest 20-MST performance, using pretest 20-MST as a covariate. Significance was set a priori at $p < .05$. All analyses were performed using SPSS (v. 12.0).

**Results**

The reliability of pre- and posttest 20-MST performance was ICC = 0.995 and ICC = 0.998, respectively. The CV of each 20-MST trial was 52.9% and 54.2% for Pretest 1 and 2, and 49.5% and 49.3% for Posttest trial 1 and 2. The equivalency tests of the two groups’ descriptive characteristics and pretest scores can be found in Table 1. For the posttest 20-MST, controlling for pretest 20-MST performance,

### Table 1  Descriptive Characteristics and Pre- (Week 1) and Post- (Week 10) Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental $(n = 16)$</th>
<th>Control $(n = 14)$</th>
<th>$t_{28df}$</th>
<th>(95%CI)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>10.9 2.0</td>
<td>11.4 2.0</td>
<td>$-0.67$</td>
<td>$(−1.99, 1.01)$</td>
<td>.51</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.4 0.1</td>
<td>1.4 0.1</td>
<td>$-1.58$</td>
<td>$(−0.15, 0.02)$</td>
<td>.13</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>37.4 11.2</td>
<td>38.1 9.8</td>
<td>$-0.18$</td>
<td>$(−8.65, 7.23)$</td>
<td>.86</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>19.5 4.7</td>
<td>18.0 2.4</td>
<td>$1.07$</td>
<td>$(−1.37, 4.37)$</td>
<td>.29</td>
</tr>
<tr>
<td>Pre- body fat %</td>
<td>24.3 5.7</td>
<td>20.5 6.2</td>
<td>$1.75$</td>
<td>$(−0.64, 8.24)$</td>
<td>.09</td>
</tr>
<tr>
<td>Post- body fat %</td>
<td>24.2 5.8</td>
<td>20.8 6.1</td>
<td>$1.56$</td>
<td>$(−1.05, 7.86)$</td>
<td>.13</td>
</tr>
<tr>
<td>Pre- 20-MST laps</td>
<td>10.6 6.9</td>
<td>16.8 6.6</td>
<td>$-2.50$</td>
<td>$(−11.21, −1.12)$</td>
<td>.02</td>
</tr>
<tr>
<td>Post- 20-MST laps</td>
<td>13.9 8.6</td>
<td>16.9 6.0</td>
<td>$-1.06$</td>
<td>$(−8.56, 2.72)$</td>
<td>.30</td>
</tr>
</tbody>
</table>

*Note.* BMI = body-mass index; 20-MST = 20-m shuttle-run test (number of laps completed).
a significant training effect was observed for the EX group in comparison to the CN group ($F = 9.95$, $p = .004$, $\eta^2 = .27$). No other changes over the training period were observed between the two groups.

**Discussion**

Cardiovascular-fitness levels of individuals with MR are considerably lower than those of their able-bodied peers (10–13,22,23,29,31). Low levels of cardiovascular fitness are associated with the early onset and high incidence of cardiovascular and other chronic diseases (1). In addition, cardiovascular fitness is important for active leisure pursuits and general quality of life (13). Therefore, the purpose of this study was to investigate whether a 10-week school-based aerobic-training program can improve the cardiovascular-fitness level of children with MR. The results of the current study indicated that a 10-week training program is efficacious in improving the cardiovascular fitness of children with MR. It is notable that not only were significant improvements observed in the number of 20-MST laps completed by the training group (an indirect assessment of cardiovascular fitness) but also the training program elicited a moderate effect ($\eta^2 = .27$). It is important that this study demonstrated that a training program designed to take place in the physical education environment has the ability to improve the cardiovascular fitness of children with MR.

Our findings coincide with those reported from previous studies on children with MR. Yilmaz et al. (34) reported that increases in VO$_{2\text{peak}}$ of 16 children with MR can be realized from a 40-min swimming and water-exercise program twice weekly for 10 weeks. No control group was included, however, thereby bringing into question whether the changes observed were in fact elicited from the program. Un et al. (33) found increases in VO$_{2\text{peak}}$ in 25 children with MR after a 12-week program consisting of sessions lasting 30–60 min three times/week. Their program consisted of circuit training to improve speed and agility (four stations), exercises to improve muscle strength and endurance, and interval sprint training to improve cardiovascular fitness. Halle et al. (15) trained 17 children with MR three times/week for 10–13 weeks at 70–85% of maximum heart rates. Their training program included a 5-min warm-up, a 20-min aerobic segment, and a 5-min cool-down period. Consequently, Halle et al. (15) found notable changes in aerobic-fitness levels of their participants. Kasch and Zasueta (18) showed a substantial increase in VO$_{2\text{peak}}$ of 6 children with MR after a daily 30 min training program over 6 months, but they included no control group. Bundschuh and Cureton (4) showed similar increases in cardiovascular fitness of both their control and experimental groups after 7 weeks of training.

Apart from the beneficial results from these studies, several of them employed exercise modalities that many practitioners (i.e., adapted physical education teachers) are unlikely to have access to (34) or included children with developmental disabilities other than MR (e.g., Down syndrome) (15). The former comment is important when considering the dissemination of a training program for widespread implementation. Practitioners (i.e., adapted physical education teachers) are more likely to have access to a gymnasium where jogging and running activities can be performed. Programs that use available resources might, therefore, be more appealing and easier to adopt solely on the basis of reducing a major barrier to
implementation—facility access. The latter comment concerning the inclusion of children with other disabilities in a study suggests that studies of children with multiple developmental disabilities might not be directly applicable to children with only MR (22). Specifically, children with down syndrome might confound the results of a study because they appear to be physiologically different from their peers with MR (8). Pitetti and Fernhall showed that children with Down syndrome had lower run performance and higher BMI than children with MR without Down syndrome (31). Thus, studies that do not separate these pathologies might have resulted in greater or lesser improvements in cardiovascular fitness if conducted with children with only MR.

Our study found no change in the percent body fat of children with MR participating in the training program. The result of several studies support our findings. Both 10- and 12-week programs also failed to reduce percent body fat (33,34). It is likely that our training program (10 weeks) and others were not of sufficient duration (number of weeks) or intensity to realize a reduction in body fat. Therefore, we recommend that if a reduction in percent body fat is of interest, a longer training program or one eliciting a higher energy cost would be needed. Also, one would not expect to see any changes in body composition with exercise training without other lifestyle interventions.

In light of the current findings, several limitations need to be noted. First, cardiovascular fitness was measured with a field-based test, the 20-MST. This test might not fully reflect the participants’ cardiovascular-fitness level, compared with a more precise measure obtained from laboratory treadmill testing. Studies have shown, however, that the 20-MST is an acceptable indicator of cardiovascular fitness (10,11) and elicits peak heart rates comparable to treadmill stress testing (3). Second, although randomized assignment was conducted before the study’s beginning, it failed to make the groups equivalent, specifically on the 20-MST pretest performance. The EX group might, therefore, have had more room for improvement in cardiovascular fitness (they exhibited lower initial 20-MST laps), thereby accounting for the increase. Nevertheless, positively affecting the cardiovascular fitness of children exhibiting the lowest levels, at minimum, suggests the efficacy of the current study.

In conclusion, we found increase in our participants’ cardiovascular-fitness levels with a 10-week exercise training program. We recommend that children with MR be exposed to similar training programs with hopes of improving their involvement in active leisure pursuits and quality of life, while reducing their risk for cardiovascular diseases later in life. Future studies need to investigate the implementation of this program for longer durations (number of weeks) and in other populations (Down syndrome).

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