



# Effect of balance training and posture exercises on functional level in mental retardation

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## Research Article

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**Purpose:** The aim of this study was to determine the effect of balance training and postural exercises on the functional level in individuals with mild mental retardation. **Material and methods:** Twenty-eight mildly mentally retarded (IQ=50-70) students who were attending the Special Education Elementary School were included for this study. Participants were randomly assigned to exercise (N=14) and control (N=14) groups. The exercise group participated in a balance training and postural exercise program with a Swiss ball for 8 weeks at a frequency of three times per week, in addition to the physical education program at the school. The control group followed only the physical education program at the school. Muscle endurance (Sit-Ups Test), flexibility (Sit and Reach Test), muscle strength and coordination (Chair Rising Test), functional mobility (Timed Up and Go Test and 50 Foot Walking Test) and balance (Pediatric Balance Scale) tests were performed to assess those variables. Assessments were performed prior to commencing the exercise program and after completion of the exercise program.

**Results:** There was no statistically significant difference when the two groups were compared ( $p>0.05$ ). A statistically significant difference was found in all parameters except flexibility in the exercise group ( $p<0.05$ ). **Conclusions:** It was concluded that balance training and postural exercises were effective in improving the functional level in individuals with mental retardation.

**Key words:** Postural balance, Mental retardation, Exercise.

## Mental retardasyonda denge ve postür egzersizlerinin fonksiyonel düzey üzerine etkileri

**Amaç:** Çalışmanın amacı hafif mental retardasyonu olanlarda denge eğitimi ve postür egzersizlerinin fonksiyonel düzey üzerine olan etkilerini incelemektir. **Gereç ve yöntem:** Çalışmaya özel eğitim merkezine giden, hafif mental retardasyonu olan (IQ=50-70) 28 ilköğretim öğrencisi alındı. Olgular egzersiz (N=14) ve kontrol grubu (N=14) olmak üzere ikiye ayrıldı. Egzersiz grubuna okulda aldıkları fiziksel eğitim programının yanında, haftada üç kez 8 hafta boyunca egzersiz topu ile denge ve postür egzersizleri verildi. Kontrol grubu yalnızca okuldaki fiziksel eğitim programına katıldı. Kas endüransı (oturmaya gelme testi), fleksibilite (otur-uzan testi), kas kuvveti ve koordinasyon (sandalyeden kalkma testi), fonksiyonel mobilite testi (sürekli kalk yürü testi ve 50 adım yürüme testi) ve denge (Pediatrik denge ölçeği) değerlendirildi. Değerlendirmeler egzersiz programının başında ve egzersiz programı bittikten sonra yapıldı. **Sonuçlar:** İki grup karşılaştırıldığında istatistiksel olarak anlamlı fark saptanmadı ( $p>0.05$ ). Egzersiz grubunda fleksibilite dışındaki tüm parametrelerde istatistiksel olarak anlamlı fark bulundu ( $p<0.05$ ). **Tartışma:** Denge eğitimi ve postür egzersizleri hafif mental retardasyonu olanlarda fonksiyonel düzeyi artırıcı etkilere sahiptir.

**Anahtar kelimeler:** Postür denge, Zeka geriliği, Egzersiz.

Mental retardation (MR) is characterized by a significant deficit of intellectual functioning and adaptive behavior.<sup>1-4</sup> The ability to learn and adapt to the changing environment is limited, resulting in difficulty in activities of daily living and functioning in society. Using the Intelligence Quotient (IQ), classification systems have identified four levels of MR: mild (IQ=50-70), moderate (IQ=35-49), severe (IQ=20-34) and profound (IQ $\leq$ 20).<sup>5,6</sup>

Balance is a condition in which all forces and torques acting on the body are in equilibrium, and as a result, the person's center of mass (COM) is within their limits of stability.<sup>7,8</sup> Postural control is the means by which balance is achieved with the purpose of controlling the relation between the COM and the individual's base of support. To maintain a position or to ensure appropriate transitions between positions, the nervous system must integrate sensory information incoming very rapidly from various sources (visual, vestibular, proprioceptive) and use this information to generate complex motor responses. Thus, individuals exert their postural control using specific, but highly adaptable, sequences of muscle activation that are described as ankle, hip and stepping strategies.<sup>7,9,10</sup>

Successful performance of a motor skill is dependent upon the individual's ability to establish and maintain stability throughout a sequence of controlled events. Subsequent movements involve the successful integration of sensory, muscular and neurological functions, while the deterioration of these functions may impede the ability to maintain equilibrium. The motor strategies used to maintain equilibrium and postural control are associated with the ability to correctly perceive the environment through peripheral sensory systems, as well as to centrally process and integrate proprioceptive, visual and vestibular inputs at the level of the central nervous system (CNS). That ability enables the CNS to form the appropriate muscle synergies needed to maintain equilibrium. In addition, motor performance is dependent on the quality of the CNS and the mood and motivation of the individuals. In children with MR, developmental retardation or deviation of the

CNS limits the motor development.<sup>11,12</sup> A considerable portion of motor development is governed by the maturation of specific neural connections and their activity in conjunction with sensory feedback, and the brain has to reach a degree of maturity before it is ready to execute a certain skill. With few systems functioning, the sensory motor afferents give the child very little input, which results in poor body image and reduced activity. Research has shown that individuals with MR have longer and more variable reaction times than those without MR.<sup>13</sup> Differences in reaction times have often been associated with central and peripheral processing components, as well as structural alterations within the CNS. Despite the longer and more variable reaction and movement times in individuals with MR, the underlying mechanisms for these differences have not been investigated.<sup>14</sup> For individuals of average intelligence and above, there are weak correlations between motor proficiency and measures of intelligence. In the range of IQ defining individuals as mentally retarded, however, motor performance deficits have been revealed in the existence of positive correlations between most performance measures and IQ.<sup>15</sup>

Individuals with MR have more functional limitations in adaptive behavior, lower vocational qualifications, and lower physical capacity and motor function compared to other groups with disabilities and their peers.<sup>14,16</sup> For children with MR, the prevailing attitude is that fitness and overall functioning is lower because they are not as active during the course of the school day and have limited opportunities to participate in the physical activities available to their peers.<sup>12</sup> The quality in motor skills performance is related to the level of certain motor abilities. Dynamic balance and coordination abilities are crucial for motor skills performance, while others are less important for this developmental stage, such as endurance and flexibility. Dynamic balance is the essential component of almost every fundamental motor skill. Therefore, balance activities are commonly included in programs designed to facilitate the acquisition of gross motor tasks in young children.<sup>17</sup> Balance can be improved

through practice and engagement in activities that involve the integration of strength related activities; as a result, improvements in balance can produce greater stability while one is participating in the activities of daily living.

Although it is known that physical therapy programs based on balance should be an integral part of mental retardation education, little research has been done to evaluate the effectiveness of such programs on the development of motor skills. The aim of our study was to determine the effect of balance training and postural exercises on the functional level in individuals with mental retardation.

## MATERIAL AND METHODS

### Participants

Thirty mildly mentally retarded (IQ=50-70) students who were attending the Special Education Elementary School 6 hours a day, 5 days per week, were included in this study, which was approved by the school administration. Additionally, the parents were included in this study. Children were excluded if they had neurological or musculoskeletal disorders limiting their mobility.

*Grouping:* Participants were randomly placed into exercise (N=15) and control (N=15) groups. Two students were excluded from the study. One of them was excluded from the exercise group due to a behavior problem, and the other was excluded from the control group because of the discontinuity. Therefore, 14 students participated in each group.

### Measurements

The subjects were assessed in the following areas: muscle endurance, flexibility, muscle strength and coordination, functional mobility and balance. Measurements were performed in both groups and were completed prior to the initiation of the exercise program. The subjects were post tested after the completion of the 8 week exercise program. Duration was measured using a manual stop watch, and the distance was measured using a standard tapeline.

During the exercise period, tests for evaluation purposes were applied repeatedly in order to get some ideas about the effects of the exercises. However the results concerning this situation were not given.

*Muscle endurance (Sit-Ups Test):* The test was modified because the children could not perform standard sit-ups independently.<sup>18</sup> Instead, assisted sit-ups were performed with caregiver holding the child's feet. Muscle endurance was determined by the number of sit-ups that the child could complete in 30 seconds.

*Scoring:* A common method of performing a sit up fitness test is to record the maximum number of sit ups in a certain time period, such as 30 seconds, one minute or two minutes. Alternatively, the test may be performed at a set tempo, and the maximum number of total sit-ups is recorded. For this method, a metronome may be set at the desired tempo, or an audio tape or CD with a recording of the pace may be used. The test was performed three times, and the best score was recorded. Averages of less than 17 repeats in boys and 9 repeats in girls showed the weakness in muscle endurance in children.

*Flexibility (Sit and Reach Test):* The test was performed three times after stretching exercises by sitting on the floor with extended knees and ankle dorsiflexion. The best score of three trials was recorded.<sup>19</sup>

*Scoring:* The score is recorded to the nearest centimeter or half inch as the distance reached by the hand. Some test versions use the level of the feet as the zero mark, while others have the zero mark 9 inches before the feet. There is also the modified sit and reach test which moves the zero mark depending on the arm and leg length of the subject. The table below gives you a general guide for expected scores (in cm and inches) for adults using zero at the level of the feet (otherwise add 23 cm or nine inches). There are also examples of some actual athlete results. If the score was less than 4 cm, the subjects were considered to have poor flexibility.

*Muscle Strength and Coordination (Timed Chair Rising Test):* The test was performed sitting in a chair with knees 90° flexed and their hands on

their shoulders. Each participant was asked to stand up from the chair and sit again five times without stopping.<sup>20</sup>

**Scoring:** The time in seconds for the five repeats was recorded. Increased time of repetition showed weakness in muscle strength and a coordination problem.

**Functional Mobility (The Timed Up and Go (TUG) Test and 50 Foot Walking Test):** The TUG Test was used to measure the dynamic balance and gait speed.

**Scoring:** In TUG, each participant was asked to stand up from a chair, walk 3 m, and return to the chair (total walking distance of 6 m).<sup>21,22</sup> The time was recorded. The target time period to complete this test for subjects with a good level of independent mobility are less than 20 seconds.

**50-foot walk test:** For the 50 Foot Walking Test, subjects were asked to walk a distance of 25 feet and return to the start point in their maximum gait speed.<sup>23</sup>

**Scoring:** Bring subject to start on a 50 foot walk test course (25 feet out and 25 feet back) and ask the subject, on the command "go" to walk as quickly as they can to the 25-foot mark and back. Time from the command "go" until the starting line is crossed on the way back. The time was recorded. Increased time of walking showed decreased mobility and risk of falling.

**Balance (Pediatric Balance Scale, PBS):** Balance was measured by Pediatric Balance Scale. The test was assessed for each participant by performing 14 items including sitting to standing, standing to sitting, transfers, standing unsupported, standing with eyes closed, standing with feet together, standing with one foot in front, standing on one foot, turning 360 degrees, turning to look behind, retrieving an object from the floor, placing the alternate foot on a stool, and reaching forward with an outstretched arm.<sup>24</sup>

**Scoring:** Each item was scored utilizing a 0 to 4 scale. The total test score was 0 to 56. A decreased total score on this scale showed poor balance of the subjects.

All of the tests used for the study were performed three times one after another and the best scores of the children they could perform

were recorded. Low scores taken on timed tests indicated good result. But in PBS, the lessening of the total scores different from the other measurements showed that the balance was weak.

**Exercise Protocol:** The content of the exercise program: The exercise program consisted of three components.

1. Warming up phase: In this phase, ten minutes' walk and stretching exercises were applied. To Gastrocnemius, Hamstrings, hip adductor muscles, three repeated stretching of 15 sec and 5 sec relaxation were applied.

2. Exercises phase: In this phase balance and posture exercises with Swissball were repeatedly performed 8-10 times.

3. Cooling Phase: In this phase, the same stretching exercises in the warming up period, were applied.

### **Grouping**

1. **Exercise Group:** The exercise group participated in a balance training and postural exercise program with a Swiss ball for 8 weeks at a frequency of three times per week, in addition to participating physical education courses twice per week at school.<sup>25</sup>

**Intensity:** This was improved by compulsive exercises with the Swiss ball, which requires better balance.

**Frequency:** Training was performed three times per week for 8 weeks.

**Duration:** Training was performed 30 minutes daily.

**Activities:** Ten minutes of walking and active stretching exercises were undertaken prior to each exercise session. Participants walked at a speed below their threshold of breathlessness, but as fast as they could comfortably tolerate, and stretching exercises included prolonged stretching of the Gastrocnemius, Hamstrings, Quadriceps femoris and hip flexor muscles for warming up. Subsequently, balance training included posture exercises on a Swissball with different postures and bending movements for 15 minutes. Finally, 5 minutes of stretching exercises for cooling down were performed.

The exercises were made difficult with the addition of extremities and body movements. As

the training period advanced, the difficulty degrees of them were increased progressively.

2. *Control Group*: The control group followed only physical education program at school two times per week for 8 weeks. Physical education program consists of general body exercises and running, which were realized by physical education instructors.

Procedure: Parents assisted with pacing and provided ongoing verbal encouragement to motivate the participants while doing activity. We suggested specific strategies for the participants: parents and teachers setting an example and acting as role models; considering adolescents preferences and making activities enjoyable; using peers and friends in activity opportunities; combining efforts of families, health professionals; and community organizations to promote active living; and using a balanced program involving endurance, flexibility, and strength training.

#### Statistical analysis:

All data were analyzed using the SPSS 11.0 statistical package. Wilcoxon Signed Rank Test was performed to compare the pre- and post-training measures of both groups separately. The Mann Whitney U Test was used to identify possible differences between the exercise and control groups. Differences with a significance level ( $p$ ) less than 0.05 were considered significant.

## RESULTS

The descriptive statistics for both groups of demographics are presented in Table 1. It was noticed that among our subjects, there appeared no statistically significant difference in age, BMI, gender and the number of falls ( $p > 0.05$ ). Our groups were homogeneous. The mean and standard deviations for the pre-training and post-training measurements and descriptive statistics of both groups are presented in Table 2.

Muscle endurance, flexibility, muscle strength and coordination, functional mobility and balance measures were compared within the groups. In the exercise group, a statistically significant difference was found in muscle endurance, muscle strength and coordination, functional mobility and balance

( $p < 0.05$ ) (Figure 1-6). The difference in flexibility was not statistically significant ( $p > 0.05$ ) (Figure 2). In the control group, the increase in the balance score was significantly different ( $p < 0.05$ ) (Figure 6), but the differences in the pre-training and post-training measures of muscle endurance, flexibility, muscle strength and coordination, functional mobility were not significant ( $p > 0.05$ ). Based on the data analysis, there was no statistically significant differences in the pre and post-exercise values for each group ( $p > 0.05$ ).

## DISCUSSION

Individuals with MR are sedentary and inactive during the course of their life, so their fitness level and overall functioning are lower.<sup>14,26-33</sup> Regardless of the reasons for predominant sedentary lifestyle, additional training programs need to investigate how to improve their physical capacities. Previous studies have indicated that individuals with MR have problems maintaining the balance, which is necessary for performing functional tasks.<sup>34,35</sup> In agreement with these studies, our results also indicated that children with MR performed poorly in most areas of motor functioning. The main purpose of our study was to determine the effects of balance training and postural exercises on the functional level in individuals with MR. The results of this study revealed significant increases in functional levels for participants with MR after participation in a training program that included balance training and postural exercises. In our study, the distribution of the assessment scores for both groups was similar, and there were no significant differences between the groups. The subjects were able to demonstrate functional level improvements by performing a combined balance and posture exercises training program. Poor muscle endurance may affect the trunk stability during many gross motor skills and may lead to deterioration in functional activities. In the exercise group, the mean sit-ups score was  $8.00 \pm 3.48$ , and after the balance training program, this score increased to  $8.85 \pm 3.82$ . The flexibility scores of the exercise group ranged from

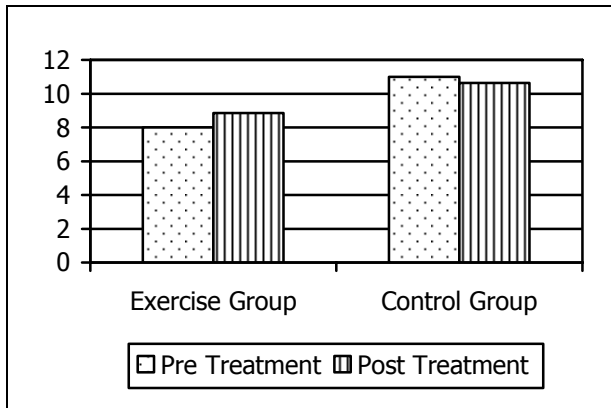
Table 1. Demographic characteristics of the subjects.

	Exercise Group (N=14)	Control Group (N=14)	p
	X±SD	X±SD	
<b>Age</b> (years)	14.28±5.13	16.71±5.91	0.24
<b>Body mass index</b> (kg/m <sup>2</sup> )	20.21±2.12	20.58±2.63	1.00
	N (%)	N (%)	
<b>Gender</b> (boys / girls)	5 / 9 (36 / 64)	7 / 7 (50 / 50)	0.70
<b>Number of falls</b> (0 / 1 / 2+)	7 / 2 / 5 (50 / 14 / 36)	8 / 5 / 1 (57 / 36 / 7)	0.13

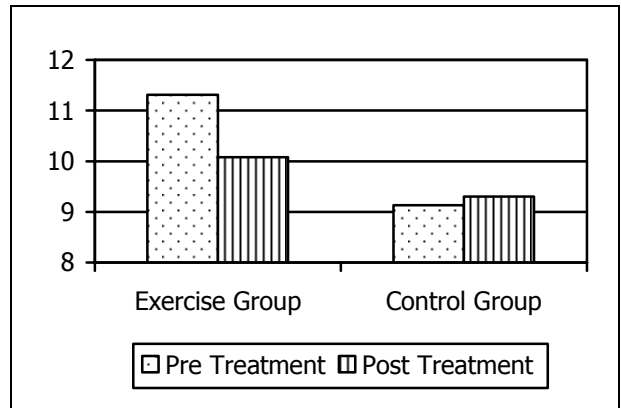
Table 2. Comparison of the subjects' measurements.

		Exercise Group (N=14)	Control Group (N=14)	p
		X±SD	X±SD	
<b>Muscle endurance</b>				
<i>Sit-Ups (repetition)</i>	Pre	8.00±3.48	11.00±5.76	0.07
	Post	8.85±3.82	10.64±5.84	0.33
		p=0.015*	p=0.374	
<b>Flexibility</b>				
<i>Sit and Reach (cm)</i>	Pre	10.42±3.36	10.21±4.17	0.94
	Post	10.85±3.39	10.28±4.32	0.64
		p=0.058	p=0.739	
<b>Muscle strength-Coordination</b>				
<i>Chair Rising (sec)</i>	Pre	11.61±2.51	11.59±2.59	0.81
	Post	10.51±1.90	11.48±2.26	0.29
		p=0.009*	p=0.470	
<b>Functional mobility</b>				
<i>The Time up and Go Test (sec)</i>	Pre	11.31±5.26	9.13±1.61	0.49
	Post	10.08±3.84	9.30±1.29	0.81
		p=0.019*	p=0.363	
<i>50 Foot Walking (sec)</i>	Pre	30.71±12.97	26.98±4.36	0.96
	Post	27.60±9.82	26.04±2.87	0.49
		p=0.001*	p=0.140	
<b>Balance</b>				
<i>Pediatric Balance Scale (0-56)</i>	Pre	46.14±8.84	50.07±4.53	0.36
	Post	48.92±7.26	51.35±3.83	0.70
		p=0.002*	p=0.011*	

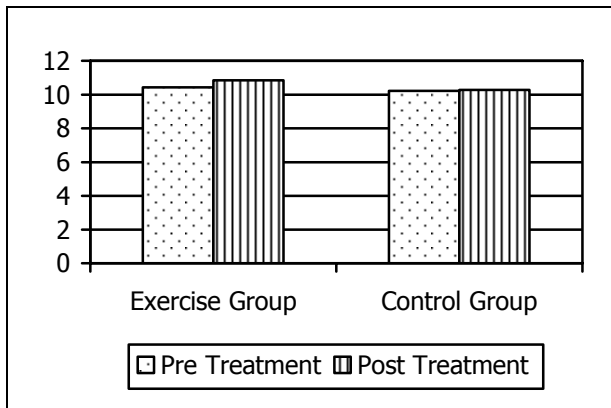
\* p<0.05. Pre: Before exercise treatment. Post: After exercise treatment.



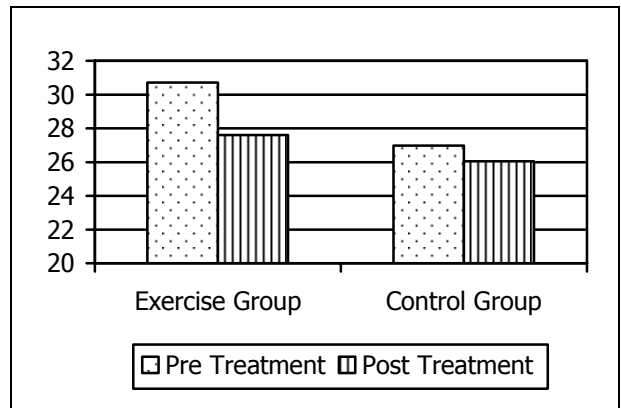
**Figure 1. Measurement of muscle endurance** (Sit-Ups, repetition).



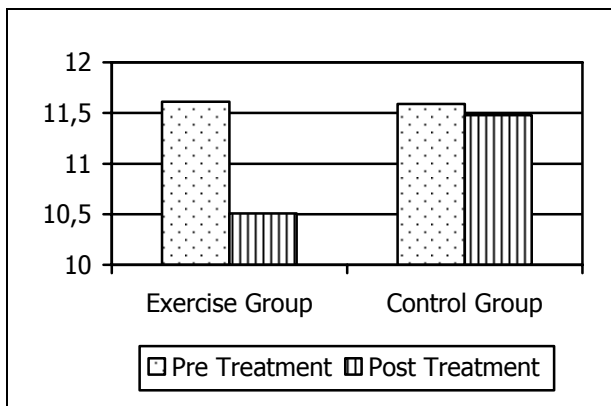
**Figure 4. Measurement of functional mobility** (The Time up and Go Test, sec).



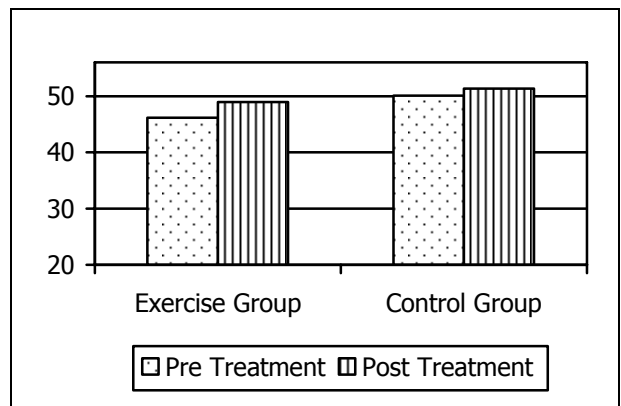
**Figure 2. Measurement of flexibility** (Sit and Reach, cm).



**Figure 5. Measurement of functional mobility** (50 Foot Walking Test, sec).



**Figure 3. Measurement of Muscle Strength and Coordination** (Chair rising, sec).



**Figure 6. Measurement of Balance** (Pediatric Balance Scale, 0-56).

3 cm to 16 cm on the sit and reach task, with a mean of  $10.42 \pm 3.36$ , in the pre-training assessment. These scores ranged from hypoflexible to hyperflexible, with hypoflexibility potentially affecting the child's ability to perform the skills effectively. After the training program, the mean score was  $10.85 \pm 3.39$ . The mean duration of activity to assess the muscle strength and coordination was  $11.61 \pm 2.51$  during the pre-training session, which was decreased to  $10.51 \pm 1.90$  post-training. This decrease in duration showed increased muscle strength and coordination. The changes in the pre- and post-training scores in the exercise group were significantly different, with the exception of flexibility. The balance scores of the exercise group increased after the training program. The mean score was  $46.14 \pm 8.84$  in the pre-training assessment, and after the training program, the mean was  $48.92 \pm 7.26$ . On the other hand, the balance score was also increased in the control group from  $50.07 \pm 4.53$  to  $51.35 \pm 3.83$ . It was thought that this increase in the score was due to changing mood and motivation, which affects the motor behavior of children with MR. The strategies used to motivate the subjects were participating in group activities, giving them photos of the exercises to carry out at home, and performing exercises with a Swiss ball. The exercises were shown individually before the training program to assist with the courage and self-confidence, which contributed to the success of the training program. Earlier studies of individuals with MR focused on different topics. Michael et al. compared the physical activity levels of 23 elementary school aged children with mild MR, across three environmental conditions, and demonstrated that both types of recess encourage physical activity that may promote improvements in physical fitness for children with MR.<sup>14</sup> Seagraves et al. investigated the effectiveness of a school-based physical education progressive resistance-training program on physical functioning and work productivity with 14 high-school participants with MR. They demonstrated significant increases in physical function and vocational tasks. A progressive program can

benefit individuals with MR by increasing physical functioning.<sup>26</sup> Yılmaz et al, studied 16 children with trainable, and educable MR and demonstrated the efficacy of a 10 week water exercise and swimming program as an effective therapeutic tool in the management of mentally retarded children. A highly significant improvement was found in developing physical fitness of children with MR.<sup>36</sup>

Beckung et al, assessed the motor and sensory functions in a population-based series of 88 mentally retarded children with epilepsy. Children with MR and epilepsy often have immature, slow and poorly developed motor and sensory functions. Their study demonstrated that physical activity does not increase seizures, and the children should be encouraged to be more active. If impairments in gross and fine motor function, coordination, balance and perception are present, the child could be helped by physiotherapy, individually or in a group, with activities such as horseback riding or supervised swimming.<sup>5</sup> Our study has demonstrated the importance of the balance training program for mentally retarded individuals. The current program differed from previous studies in that it was based on balance and posture exercises with a Swiss ball, which may be more acceptable to students with MR than other exercises programs such as resistance training. All participants in the study reported that they enjoyed the exercise program. These findings support the claim that the adoption of active physical exercise program in relatively inactive people may be beneficial. The improvements in muscle endurance, muscle strength, coordination, functional mobility and balance may have additional positive benefits. In this study, we were able to demonstrate the strong need for more effective physical therapy programs for those with mental retardation.

Our study supports the conclusion that regular balance training and postural exercises can provide crucial benefits for individuals with MR and can lead to improvements in functional level. The importance of this improvement in mentally retarded individuals is to increase their daily activities.



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