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Effect of a combined exercise program (aerobic and rebound therapy) with two different ratios on some physical and motor fitness indices in intellectually disabled girls

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background: Individuals with intellectual disability (ID) are mostly neglected and hardly exercised. The purpose of this study was to investigate the effect of a combined program (aerobic and rebound therapy) with two different ratios on some physical and motor fitness indices in intellectually disabled girls.

Material and methods: A total of 24 girls with ID (13–17 years old with an IQ of 50 to 70) were selected and randomly divided into two experimental and one control group. Experimental groups performed a combined aerobic-rebound therapy program with two different proportions: (group 1 performed 10 minutes of aerobic exercises and 20 minutes of rebound therapy, group 2 performed 20 minutes of aerobic exercises and 10 minutes of rebound therapy) for 8 weeks (3 sessions per week). All physical and motor fitness tests including endurance performance, lower extremities endurance, cardio-respiratory endurance, static and dynamic balance, agility and coordination were taken before and after the training period. Data were analyzed using Shapiro-Wilk's tests, covariance and variance analysis with repeated measurements ($\alpha = 0.05$).

Results: The results showed that both exercise programs in experimental groups improved endurance performance indices, lower extremities endurance, cardio-respiratory endurance, static and dynamic balance, agility and coordination in comparison to the control group. No significant differences were observed between the two experimental groups.

Conclusions: In conclusion, to improve motor and physical fitness indices in girls with ID, both combination programs (aerobic-rebound therapy) with different proportions can be used.

Key words: balance, exercise, fitness, health, intellectual disability.

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INTRODUCTION

Intellectual disability is a complex dysfunction that occurs at different stages of development, during pregnancy, childbirth and postnatal, which can be due to diseases, infection and viruses, and it cannot be contagious [1]. This disorder, in addition to cognitive functions, disrupts motor activity of people with ID [2]. The functional disability of these individuals affects all aspects of their lives, such as behavioral, self-perceptual, and interpersonal relationships, and consequently it significantly reduces the quality of their life in society [2, 3]. Educable intellectually disabled children have a lower level of muscular strength, endurance, agility, running speed, reaction time and balance in comparison with their peer normal children. This imbalance of muscular strength and endurance changes the alignment of the body and increases the pressures and/or stresses on joints and tissues [4–6]. Golubovic et al. [6] reported that intellectually disabled people exhibited low performance in strength and muscular endurance, flexibility, motor coordination and cardiovascular endurance in standardized fitness tests. Therefore, performing physical activity plays an important role in improving the health indicators as well as reducing the specific health issues of intellectually disabled people. It has been emphasized that regular physical activity is an important component of a healthy lifestyle in these people [6, 7]. Moreover, researchers have argued that increased and sustained participation in moderate to vigorous physical activity can be one of the most effective ways to improve health in this population [5, 8]. However, the way of exercising to gain the most benefits and develop physical fitness and overall health depends on the proper manipulation of the volume, intensity and type of exercises. On the other hand, international and national organizations recommend that children with ID should be involved in physical activities. But there is some evidence of daily physical activity in these individuals and few specific standards and guidelines for them. According to the guidelines of the American College of Sports Medicine (ACSM) related to aerobic exercises for healthy individuals, it is necessary to perform a continuous physical activity with moderate intensity for 20–60 minutes and 3–5 times per week in order to keep cardiovascular fitness, body composition and muscle strength [9]. However, few studies have been conducted regarding other types of exercise programs and/or designing such programs for intellectually disabled individuals.

Rebound therapy is one of the enjoyable and attractive exercises for rehabilitation of people with ID. These exercises were first used to rehabilitate children with physical disabilities and learning difficulties [10]. Furthermore, it has been shown that in a steady state of the heart rate and oxygen uptake, more work can be done on a trampoline compared to treadmill and/or other types of physical activity, which means that oxygen uptake on a trampoline is more efficient [11]. Khaliltahmasebi et al. [10] claimed that sequential trampoline jumps would reduce the risk of injury during landing. For this reason, this program could be considered as a suitable way to increase balance, muscle strength, vertical jump, and even treatment in injuries. On the other hand, aerobic exercises are defined as any kind of activity that requires the consumption of substantially more oxygen as well as a faster heart rate than at rest. Researchers have also paid special attention to the role of aerobic exercises in improving physical and cardiorespiratory fitness in people with ID [5, 13].

Considering the fact that exercises have improved physical fitness and function in intellectually disabled individuals, less attention has been paid to the subject of how different training programs can lead to the best performance. In this regard, a combination of aerobic exercise and rebound therapy can be mentioned. Combining exercises may have synergistic effects of both types of exercise programs and can improve the performance of children with ID. However, what kind of combination of these exercises can provide more benefits for them is unclear and needs to be considered. Moreover, these children's motivations are low and they are less likely to participate in social and community programs, hence the implementation of a combination of exercises that creates diversity and joy which will help them to overcome their lack of motivation. Existing research has examined the effects of training programs individually and on the limited indicators of physical fitness in this population [2, 3, 14–17]. To the best of our knowledge, there is no study that has investigated combining these two programs. Therefore, the purpose of this study was to investigate the effect of a combined exercise program (aerobic and rebound therapy) with two different ratios on some physical and motor fitness indices in intellectually disabled girls.

MATERIAL AND METHODS

PARTICIPANTS

This research was a semi-experimental study. The statistical sample included 24 girls, from the Khamseh Gorjestani school in Quchan city, aged between 13–17 years old and with the IQ of 50 to 70. These individuals are targeted based on entry criteria including the absence of medical problems, the lack of multiple disabilities and specific diseases such as epilepsy, the absence of injury in lower extremities, and the ability to perform sports activities. Then subjects were randomly divided into three equal groups: 1) experimental group 1 (10 minutes aerobic and 20 minutes rebound therapy), 2) experimental group 2 (20 minutes aerobic and 10 minutes rebound therapy) and 3) control group. After completing the administrative requirements, obtaining permission and in coordination with the management of a special school in the Quchan city, with the help of the school counselor and according to the criteria of entry and exit, students were selected. After explaining the method and purpose of the research, the subjects’ parents completed the medical history questionnaire and filled in the consent form. Before performing the exercise protocol, the variables of functional endurance, endurance of lower extremities, cardiorespiratory endurance, static and dynamic balance, agility, and neuromuscular coordination were taken by the researcher from all subjects. Then subjects of the experimental groups followed an 8-week course (3 sessions per week) of a combined exercise program. All measurements were repeated 48 hours after the last training session.

EXERCISE PROTOCOL

The training program was designed to motivate students to perform, and to form leisure activities and sports hours at school. The program included 15–10 minute warm-up including jogging and stretching exercises, then 30 minutes of training which for experimental group 1 included 20 minutes exercises on a trampoline and 10 minutes play, and vice versa for experimental group 2. Notably, training on the trampoline was done periodically in the form of one minute activity and one minute rest. Furthermore, 5 minutes were allowed for cooling down. One minute was added to the time of training to keep the principle of overload.

Measuring the research indicators

Endurance performance: To measure this index, 6 minute walk test was used [18].

Lower extremities endurance: Leg lift test was used to measure lower extremity endurance [4].

Cardiorespiratory endurance: The Rockport Fitness Walking Test was used to measure this variable [19].

Static balance: To measure this index, the subjects stood on a balance board with one leg (dominant leg) with closed eyes while holding their hands on the hip for 10 seconds, then the duration of their balance was recorded [10].

Dynamic balance: To measure this index, the subject walked on a balance board six steps heel to toe while their hands were on their hips, then the correct steps were calculated and recorded [10].

Agility: To measure agility, we used a test shown in Figure 1. In this test, a cone was located in the center and four were placed around it at three-meter distance. The subject moves from the center in the clockwise direction, after touching cone number 2, returns to the center, then goes to cone number 3. This process continues until the subjects goes to number 5 and passes the final line. Then the time is calculated [20].

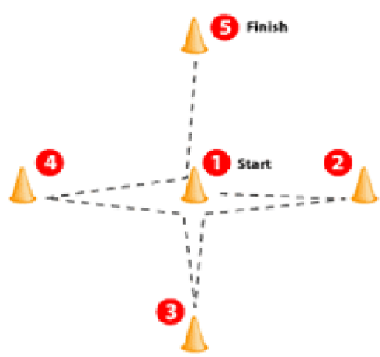

Fig. 1. The test of agility [www.topendsports.com]

Coordination: Nelson's motion test was used. In this test, the two lines on each side were spaced 12 meters and 80 centimeters with a line in the middle. While standing the subject is prepared on the middle line facing the trainer. The examiner standing in front of the athlete and holding a timer in one hand shows one of the two directions with his other hand and immediately uses the stopwatch. The subject begins to run quickly to cross the finish line. At the same time, the examiner stops the time and records the athlete’s result. This movement is repeated 6 times, 3 times randomly to the right and left. The interval between each repetition is 20 seconds. The average of 6 repetitions is considered as the final result of the subject [21].

Statistical analysis

The Shapiro-Wilk test was used to determine the normal distribution of data, and descriptive statistics were used to display the central tendency and

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dispersion. The ANOVA was used to examine the intragroup changes, and one-way ANCOVA and Bonferrony's post-hoc test was used to examine the changes between groups. All statistical operations were performed by SPSS software version 20, and the level of significance was set at $p \leq 0.05$.

RESULTS

Using the Shapiro-Wilk test showed that the distribution of all the variables is natural ($p < 0.05$). Therefore, parametric tests were used for statistical calculations. The characteristics of the subjects are presented in Table 1. This table shows that there is no meaningful difference between the groups in these indices. The results of statistical tests for the research variables are presented in Table 2.

Table 1. Characteristics of the subjects in the three groups

Exercise groups	P value	Control	Experimental 2	Experimental 1	P value
Height (m)	0.78	1.5 ±0.07	1.595 ±0.03	1.57 ±0.04	0.78
Weight (kg)	0.07	51.87±13.76	56.62±13.07	51.5 ±10.6	0.07
Body mass index (kg/m^2)	0.65	22.91 ±5.32	22.23 ±4.684	20.78 ±4.75	0.65

*Significance level: p ≤ 0.05**

Table 2. Results of statistical tests on research variables

Variables	Groups	Pre-test	Post-test	Intragroup changes		Intergroup changes	
				F	P	F	P-value
Endurance performance (m)	Experimental 1	620±40.58	747.87±100.02	19.49	0.003*	16.06	0.001*
	Experimental 2	534.75±119.20	634.25±46.12	5.62	0.05*		
	Control	542.5±75.93	515.25±64.08	4.8	0.6		
Endurance of lower extremities (repetitions)	Experimental 1	6.75±3.45	11.25±5.49	29.84	0.001*	14.08	0.0001*
	Experimental 2	5.12±2.23	8.87±3.18	82.89	0.0001*		
	Control	3.12±2.41	2.87±2.23	0.63	0.45		
Cardio-respiratory endurance (ml/kg/min)	Experimental 1	29.72±0.28	30.29±0.43	8.44	0.023*	6.97	0.002*
	Experimental 2	29.7±0.58	29.95±0.64	1.35	0.28		
	Control	29.58±0.43	29.15±0.51	12.44	0.01*		
Dynamic balance (s)	Experimental 1	3.25±1.48	6.75±3.19	13.19	0.008*	6.44	0.007*
	Experimental 2	3.5±1.60	5.37±2.5	11.66	0.01*		
	Control	3.5±1.51	3.25±2.05	0.17	0.68		
Static balance with closed eyes (s)	Experimental 1	1.62±0.91	4±1.69	40.11	0.0001*	10.06	0.001*
	Experimental 2	1.87±0.83	3.12±0.83	9.21	0.019*		
	Control	1.5±1.06	1.62±1.3	0.3	0.59		
Agility (s)	Experimental 1	13.87±2.30	10±1.17	28.44	0.001*	18.7	0.0001*
	Experimental 2	16.15±4.23	11.6±1.8	12.87	0.009*		
	Control	15.59±4.10	16.21±4.02	7.5	0.02*		
Coordination (s)	Experimental 1	3.26±0.52	2.46±0.36	42.01	0.0001*	9.73	0.001*
	Experimental 2	3.55±0.93	2.95±0.36	7.5	0.02*		
	Control	3.89±0.30	3.99±0.9	0.11	0.78		

*Significance level: p ≤ 0.05**

Table 2 shows that both experimental group 1 (rebound therapy – aerobic exercise) and experimental group 2 (aerobic exercise – rebound therapy) improved endurance performance indices, lower extremities endurance, cardio-respiratory endurance, dynamic balance, static balance with eyes closed, agility and coordination in comparison with the control group ($p \leq 0.05$). There was no significant difference between the two experimental groups ($p < 0.05$).

DISCUSSION

The present study showed that both combinations of exercises of rebound therapy and aerobic exercise significantly improved endurance performance and cardiorespiratory endurance indices in intellectually disabled girls compared with the control group. To our knowledge, no research on a combination of training programs of aerobic-rebound therapy on girls has been conducted so far. Therefore, we have used all the research that has been related, directly and indirectly, to the subject under discussion. With this explanation in the same field, Haghighi et al. showed that eight weeks of aerobic exercise, four times per week, significantly increased the traveled distance in a 300-yard walking test in girls with intellectual disability in comparison with exercises performed three times a week. They indicated that the reason was the increase in peak oxygen uptake (VO_2peak) and losing weight [22].

Wu et al. [14] concluded that a circular training program for 12 weeks, five times per week, improves cardiovascular fitness in obese children with ID. Oviedo et al. [23] demonstrated that a combined training program including aerobic, strength and balance exercises for 14 weeks improves cardiovascular fitness in people with ID. Furthermore, Boer et al. [16] stated that performing interval training for 15 weeks, twice a week, compared with continuous aerobic exercise, improves physical fitness of intellectually disabled teenagers. Other researchers also reported similar results in their studies on the same subject [4, 24, 25]. In addition, Ghasemi et al. [26] investigated the improvement in cardiorespiratory endurance after eight weeks of rebound therapy exercises in children with ID. Sadeghi et al. [11] reported that performing eight weeks of rebound therapy just as aerobic exercises could improve aerobic capacity in men with asthma [11]. Also, Cugusi et al. [27] showed that jumping on a trampoline by overweight women in one session can speed recovery in vigorous sports. In contrast, Nasrabadi et al. [28] showed that eight weeks of combined training (three times a week) had no significant effect on cardiorespiratory fitness and maximum oxygen uptake in intellectually disabled girls. They suggested the probable cause of this result would be insufficient training time. But, in the present study both training programs provided sufficient stimulus for the desired changes in the subjects' endurance and aerobic performance indices, since these two indicators can be influenced by both physiological and functional adaptations, such as increasing cardiac output, plasma volume, cardiac contractility, stroke volume, arterial-venous blood oxygen difference, muscle oxidative capacity, and muscle capillarity [29] and also include changes that occur in other physical and motor fitness components, such as static and dynamic balance, coordination, agility and muscular endurance which all in all can develop endurance and aerobic performance indirectly.

Moreover, the present study showed that both programs of combined exercise, predominantly rebound therapy and aerobic exercise, significantly improve the lower extremities muscular endurance in intellectually disabled girls in comparison to the control group. Ahmadi and Daneshmandi [24] showed that a core stability training program for 6 weeks, three times a week, improves muscular endurance in boys with ID. Asgari [25] also stated that 10 weeks' water training improves lower body muscle endurance in boys with ID.

Golubovic et al. [6] showed that a six-month program three times per week for 45 minutes of moderate physical fitness could improve muscle strength and endurance in children with ID. Ghasemi et al. [26] also showed that a program of rebound therapy for eight weeks, three times a week, developed muscle endurance in 7–11-year-old children with ID. Others have shown improved muscular endurance by doing different exercises [4, 14]. The researchers attributed this finding to the relationship between increased strength and muscular endurance, since possibly strength training has increased muscle endurance to some extent, but a greater increase in muscular endurance depends on the specificity of training. In other words, muscle endurance can be increased by lowering exercise intensity and increasing the duration or repetitions of a single movement. Since the subjects in the present study performed 30 minutes continuous activity, improvement in muscle strength and endurance which has been observed during the period of the study is due to this matter. On the other hand, perhaps muscle recruitments and use of core muscles during running and trampoline movements, as well as the continuous use of lower limb muscles in daily activities have improved muscular endurance.

The other result of the present study was that both combination exercises with predominantly rebound therapy and aerobic exercise significantly improved the static and dynamic balance in comparison with the control group. Kachouri et al. [17] demonstrated that a combined strength and proprioceptive training program for eight weeks improved static balance with closed and opened eyes in boys with ID. Asgari [25] also showed an improvement in this indicator with 10 weeks' water training in mentally retarded boys. Wu et al. [14] observed an improvement in dynamic balance by implementing a 12-week circular exercise program in obese mentally retarded boys. Moreover, Khaliltahmasebi et al. [10] showed that doing eight weeks of rebound therapy exercises will improves the static and dynamic balance of educable children with intellectual disability. Giagazoglou et al. [30] also found that 12 weeks of trampoline training could be useful for developing the balance and motor function of children with mental disabilities. They have also shown that 12-week training on a trampoline improves balance in children with developmental coordination disorder [31]. Najafifard et al. [32] have shown that eight weeks of rebound therapy exercises improve the static and dynamic balance of male students with hearing impairment. They indicated this as a positive effect of muscle vibration that is caused by the use of trampolines, because the trampoline can create an unstable surface that causes more muscle recruitment and thus improves balance. Balance improvement in this study may be due to development in muscle strength and changes in the sensory-motor system of individuals participating in both training programs. In addition to the mentioned effect of various exercises, we can point out to neuromuscular adaptation, especially in the lower extremities, such as increasing the velocity of nerve conduction, increasing coordination between the agonist and antagonist muscles and reducing activity of the Golgi tendon organ [33].

This research showed that both programs of combined exercises, predominantly rebound therapy and aerobic, significantly improved the agility index compared with the control group. Ghasemi et al. [26] showed that a rebound therapy program could improve agility in intellectually disabled children. Ilker et al. [4] showed that performing 10 weeks of swimming and water exercises improves the agility index in mentally retarded subjects [4]. Ahmadi and Daneshmandi [24] also found that six weeks of core stability training can improve agility in mentally retarded students. On the other hand, Faal Moghanlou et al. [34] did not report any significant effect on the agility index after 24 sessions of Spark motor program in the mentally retarded boys. The researchers highlighted the subjects' age, their low motivation and insufficient speed index as the explanation. The velocity of the stretch-shortening cycle is necessary for changing the speed and direction (agility). The rate of muscle contraction is recognized due to factors such as arousal and contractility of the musculoskeletal system, the number of active sarcomeres along the muscular fibers, the percentage of fast-twitch and slow-twitch fibers of the motor unit, and adenosine triphosphate (ATP) activity [35]. This mechanism is likely to improve agility performance in both groups of subjects. In addition, balance is one of the most important determinants of agility in men. In fact, agility consists of two components, speed and strength along with maintaining balance and coordination, thus, these indicators have developed in both training groups and improved the agility.

Another result of this study is that both combination programs of predominantly rebound therapy and aerobic exercise significantly improved the coordination index compared with the control group. Giagazoglou et al. [31] stated that 12-week training on a trampoline improves coordination in children with developed coordination disorders. Moghanlo et al. [34] showed that performing 24 sessions of the Spark motor program improves gross motor skills, such as double-sided coordination in educable mentally retarded boys. Asgari [25] also showed an improvement in the coordination index due to the implementation of 10 weeks of swimming and water exercises in boys with ID. Mitsiou et al. [36] stated that a training program with a trampoline improves neuromuscular coordination in 6–11-year-old students with developed coordination disorder. In contrast, Ghasemi Kahrizsangi et al. [33] showed that implementation of a rhythmic motor program in 8 weeks, three sessions per week, has no significant effect on perceptual-motor abilities of intellectually disabled girls. The researchers stated that the type and volume of the training program as their limitation caused subjects to fail to benefit from the class time in the same way as other girls, which probably led to non-significant results. However, various factors can affect the growth of basic motor skills, such as environment, geographical location and practice opportunity. Practice opportunity by using various facilities and equipment can provide suitable field to develop the perception of movement, strengthen muscles and develop basic motor skills. Sensory motor integration resulting from sequential jumps and improved balance ability, all of which can be gained from aerobic and rebound therapy, allows children to play their favorite games with their peers. Moreover, enhanced learning and experience of subjects in executing of various training programs as well as the development of other indicators affecting coordination, such as agility and balance in both training groups, has been effective in these results.

CONCLUSIONS

It is recommended that coaches use the two combinations of aerobic training and rebound therapy with different ratios to improve the quality of physical and motor fitness of intellectually disabled girls by taking into account their interests and training conditions.

This study did not distinguish different types of intellectual disability and possible differences between genders. Future studies can focus on this issue. Due to the fact that the length of the training program can affect the benefits gained by subjects, it is recommended that researchers utilize protocols of more than 30 minutes and 8 weeks in duration, then compare and evaluate the short- and long-term effects of the protocol.

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