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Research Article

Aerobics or Pilates: Which is More Effective in the Performance of Wechsler Acid Profile Among Children with Learning Disabilities? A Randomized Comparison Trial

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Abstract

Background: The main purpose of this study was to determine whether Pilates exercise is as good as aerobic exercise on the performance of subtests of Wechsler ACID profile in female primary school students with learning disabilities. The Wechsler intelligence scale for children developed by Wechsler in 1949 was used to measure children's intelligence. One of the features of this scale is that, unlike similar individual scales, it is not designed based on the age level and items are arranged in order of difficulty in each test. Each subtest measures different abilities, the sum of which indicates the overall intelligence.
Methods: The statistical population consisted of all female students with learning disorders in Sarayan city in the academic year 2013 - 2014, 45 of who were recruited as the sample in this study. Subjects were randomly divided into two experimental groups (aerobics and Pilates) and one control group (each containing 15 subjects). The experimental groups were the subject of independent variables (aerobic or Pilates exercise protocols) for eight weeks. Learning disorder was confirmed through interviews with the children and parents, background reviewing, and the administration of the Wechsler test. The primary objective was the comparison of Pilates and aerobic exercises in the mean score of overall intelligence at the end of the study.
Results: The results showed that the mean score of overall intelligence was better in the Pilates group (n = 15, mean = 104) than in the aerobic group (n = 15, mean = 100). However, the results showed that eight weeks of aerobic and Pilates exercises improved the performance of the subtests of Wechsler ACID profile in the intervention groups compared to the control group, but no significant difference was found between the two intervention groups (P = 0.61).
Conclusions: It seems that eight weeks of aerobic and Pilates exercises can have positive effects on the performance of the subtests of Wechsler ACID profile in children with learning disabilities as a non-invasive method.

Keywords: Aerobic Exercise, Pilates Exercise, Learning Disabilities, Performance of Subtests in Wechsler ACID Profile

1. Background

Learning disability (LD) is one of the common problems among school students. It refers to any disorder in which the individual's academic achievement with respect to age, education, and intelligence is much less than expected (1, 2). LD affects the compatibility of students with society and lifestyle. Dyslexia and dyscalculia are of LDs (3). LDs children represent the largest single category of children receiving special education (4). Based on the evidence, the rate of LDs has tremendously grown since previous decades (5).

It seems that neurobiological malfunctions are major reasons for LDs that would affect not only brain development, but also cognitive performance, especially working memory (WM) (6). WM is part of short-term memory that is concerned with immediate conscious perceptual and linguistic processing (7). WM is a moderate variable for intelligence. According to Hill et al. (8), WM is an effective component of intelligence test performance. Hence, individual differences leading to variable educational programs are a key source of social disparities that highlight the necessity of interventions for improving academic achievement (9). Up to now, specialists in this area have tried to compensate for LDs in the affected children using specific methods of computerized cognitive training programs that would improve the performance of children with LDs. Physical exercise, such as mild to moderate aerobic training, would act in a similar way, as well (10-14).

Aerobic training is an adjuvant intervention to improve cognitive function such as WM in LDs. A review of the literature suggests that the effect of aerobic exercise on mental factors such as memory and learning has been the subject of growing attention (11). Gubble-Hall concluded that aerobic exercises (aerobic dances and rhythmic movements that increase the body's intake of oxygen) can affect the behavior and performance of the cognitive function in LDs.

Along with aerobic exercises, Pilates exercise has become popular for application to most disorders such as multiple sclerosis (15). Pilates refers to a series of specialized exercises that affect the body and mind to increase the overall strength and stamina of the body, as well as target the deepest muscles of the body. Pilates includes six principles that improve attention/motivation and increase cognitive performance while minimizing physical stress (16). Among many benefits of Pilates are enhanced muscle strength, cardiovascular endurance, flexibility, attention/concentration, proprioception, body control and most importantly, coordination of the mind and the body (17). In the view of eastern health philosophies, Pilates is an exclusive type of moderate exercise that mostly emphasizes mental aspects. As a cost-effective exercise model, it is useful for those involved in rehabilitation interventions that is well performed without additional equipment (18). Research also suggests that Pilates training is highly useful for the prevention of brain-damaging diseases and recuperation of cognitive disorders (19).

Given the above-mentioned points, it is important to plan for overcoming problems of LDs children and alleviating complications and negative side-effects associated with their reduced mental health as the young, active future workforce of the country. This group of children, who mostly have natural intelligence, cannot achieve desirable academic achievement, which involves the individual and society with many socio-economic, cultural, and emotional-psychological repercussions. Considering the importance of the subject and the paucity of research in this area, it is necessary to undertake a study with the aim of adopting appropriate interventions to help improve the performance of subtests in Wechsler ACID profiles of LD children.

A few data are available regarding the effectiveness of Pilates as a comprehensive intervention to improve the performance of the Wechsler intelligence test. Thus, more research is required to consider whether Pilates provides unique benefits compared to moderate aerobic exercise.

2. Objectives

The purpose of the present study was to compare the effect of aerobic exercise and Pilates on the Wechsler intelligence test performance of LDs children and determine which type of these exercises is more effective on the performance of subtests in Wechsler ACID profile of female primary school students with learning disabilities.

3. Methods

The present study was a randomized comparison study with a pretest-posttest design that involved two experimental groups and one control group.

3.1. Participants

Among 75 voluntary individuals who were diagnosed with LDs, 45 were randomly chosen based on the inclusion criteria. They were randomly divided into two experimental groups (aerobics and Pilates) and a control group (each group of 15). The sample size was calculated using the following formula (20):

$$n = \frac{\left(\sigma_1^2 + \sigma_2^2\right)\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{d^2}$$

The sample consisted of 45 eight-year-old elementary school students in the academic year of 2013 - 2014 in the city of Sarayan, who were diagnosed with special learning disorders by specialists. The subjects had scores below the average score on reading and mathematics valid tests. In the present study, first, by interviewing children and parents, background reviewing, and Wechsler test implementing, a definite diagnosis of learning disorder was made in children. We also found that the children had no disorder or other illness, such as epilepsy. Participants were randomly divided into two experimental groups (aerobics and Pilates) and one control group (each with 15 subjects). Then, they were randomly assigned to constitute the experimental and control groups. After explaining the research method and objectives to parents, they filled out informed consent forms and stated their willingness to participate in the study. All of the training sessions were done at a standard gym and the Wechsler test was done at the children institute. The parents of children in the control group were told to keep their children away from any sports program except for school exercises during the intervention. At the end of the intervention, complying with the ethical rules of research, the same sports activities and exercises were administered to the control group to enjoy the benefits of participation in the intervention upon the completion of the research.

3.2. Performance of Subtests in Wechsler ACID Profile

Before the intervention, the revised Wechsler intelligence scale was administered to all participants. The Wechsler intelligence scale for children, developed by Wechsler in 1949, is used to measure children's intelligence. One of the characteristics of the scale deals with its structure that is based on the age level by which the items are arranged in order of difficulty in each test. Each subtest measures different abilities, the sum of which indicates the overall intelligence (21). This scale consists of six verbal subscales including digit span, similarities, information processing, math, vocabulary, and comprehension. Furthermore, six non-verbal or practical subscales including visual puzzle, picture adjustment, block design, symbol search, picture arrangement, and maze are found. The two subscales of maze and digit span are reserved in nature. The WISC-R test is one of the most commonly used tests for assessing children's intelligence. The validity of the test was reported as 0.97 for verbal intelligence and 0.93 for practical intelligence in a sample of 1400 children aged 13 - 6 in Shiraz. The validity of the test was confirmed using the doubling method for general intelligence, verbal intelligence, and nonverbal intelligence as 0.94, 0.91, and 0.96, respectively. Moreover, the correlation of the test with academic achievement was 0.88 with the test-retest rate of 0.85. The reliability of the test-retest and the two-half WISC-R was reported to be 0.44 - 0.44 and 0.42 - 0.98, respectively. Simultaneous validity using the correlation of scores with the practical subscale score of the Wechsler scale was 0.74 in preschool children. The test was administered individually by a single expert and trained person who was not aware of the intervention protocol and groups. In each subscale, easy items were first implemented, followed by difficult items. After determining the raw scores of all subscales, they were converted into standard scores in accordance with standardization tables.

3.3. Interventions

The experimental groups were the subject of interventions as independent variables for eight weeks, including three sessions of 45-min per week giving a total number of 24 sessions.

3.4. Aerobic Exercise

The aerobic exercise protocol consisted of 10-min warm-up with soft, slow, stretching movements, followed by 30-min basic aerobic exercises including impact movements and 5-min cool-down activities. The exercise protocol was used in a way that the movements of stability and mobility were mostly done. In the primary phases of training, the exercises were conducted from the simplest to the most difficult parts. Then, chain movements were performed by the combination of stability and mobility movements. The entire exercise protocol was supervised by instructors. The movements in the protocol included steps in place, step 7, step 8, knee, leg movements, hamstring, L. movement, and biceps. The exercise protocol was at the intensity of 60% to 65% of the heart rate reserve in subjects (22). The subjects' heartbeats were monitored by Karvonen formula with electronic stethoscopes during the training protocol. The heart rate was measured in a sitting position at 8 a.m. following 15 minutes of rest (15).

3.5. Pilates

The Pilates exercises protocol was performed in the morning shift under the supervision of a Pilates instructor. All the exercises used in this study were in line with the training programs derived from the review of books and articles (17). Each session was divided into three parts. 10-min warm-up, 30-min basic exercises including a stretch of the spine, rolling on the back, spine turning, single leg stretching, double leg stretching, saw, side impact, leg stretching from the back, leg stretching from the front, and 5-min cooling down. The intensity of the exercises for each participant was controlled based on the tolerance limit of the exercise and participants' pain so that they were able to continue exercises without the feeling of any pain or fatigue. The exercises started with six repetitions and ended with 10 repetitions. In each session, in addition to the previous session exercises, new exercises were also introduced. This was to motivate the subjects and preserve the principle of overload in exercises. The pace of exercises was identical for all subjects and they were advised to continue performing the exercises unless they felt pain or discomfort. If necessary, the exercises were moderated for subjects who had pain during exercises or were unable to maintain their correct postures. The exercises were initially selected from Pilates' simple movements, and were mostly aimed at familiarizing children with the principles of Pilates. Gradually with the advancement of basic exercises and modification of movements, the intensity and complexity of exercises were increased. Moreover, a 30-second rest period was considered between the movements. The posttest was conducted for the groups at the end of the training protocol.

3.6. Statistical Analysis

Statistical analysis was performed using SPSS software (version 18.0) for Windows. Data were presented as means $\pm$ standard deviation. The normality of data distribution was assessed by the Kolmogorov-Simonov test ($P > 0.05$). A 2×3 mixed-model multivariate analysis of variance

(MANOVA) was performed between group (aerobic, Pilates, and control) as the independent variable and time (pretest and posttest), with the total intelligence score as the dependent variable. When MANOVA revealed a significant effect, a 2 $\times$ 2 analysis of variance for each section was used to identify the main effect. The statistical significance was considered at $P < 0.05$. The study was approved by the local Ethics Committee of the University of Birjand (ref. no.: 12321).

4. Results

The physical characteristics of the participants are shown in Table 1, along with the anthropometric characteristics including weight, height, and body mass index (BMI). The study measures are reported in Table 2.

Table 2 reveals that after eight weeks' intervention, the mean scores of verbal intelligence in the control, aerobic, and Pilates groups (n = 15 in each group) were 43.2, 49.8, and 47.6, respectively, and the mean score of practical intelligence in the control, aerobic, and Pilates groups were 49.1, 50.3, 57.2, respectively while the mean scores of overall intelligence in the three groups were 92.3, 100, and 104, respectively.

The MANOVA test was performed to determine the significance of differences observed between the training and control groups at pretest and posttest. The results indicated that the interactions were significant between aerobic and control groups (Wilks λ [16, 13] = 3.16, P = 0.01) and between Pilates and control groups (Wilks λ [16, 13] = 2.49, P = 0.04). However, the interaction was not significant between aerobic and Pilates groups (Wilks λ [16, 13] = 0.84, P = 0.61). The results are shown in Table 3.

5. Discussion

Our finding indicated that physical training, either aerobic or Pilates training, have benefits for the subtests scores of Wechsler ACID profile in the Wechsler intelligence test. However, no significant difference was found between the aerobic and Pilates exercises. Our finding was similar to the studies reporting the beneficial effects of exercise on cognitive function (10-12, 23). The findings imply the importance of incorporation exercises in common intervention services for these children. The present study explored the respective contribution of Pilates and aerobic training to the global cognitive function of LDs children. The finding suggests that both aerobic and Pilates training significantly increased overall intelligence. One possible justification pertains to the issue that both exercise modes are mostly based on the performance of sequential movements in nature. In order to facilitate the learning of Pilates training, Pilates stated that sustained attention plays a key role in cognitive ability while performing the subtests of the Wechsler intelligence test. Since Pilates' exercises create harmony between the body and the mind and control the mind so that the brain takes the full control of the body and also given its effect on the rhythm of the alpha wave of the brain, it can be contended that Pilates training can improve intelligence and brain function (24). Pilates requires the mind to pay attention to performance, and research shows that in this situation, the brain cells grow at a faster rate and the nervous system creates better connections through the body (16). Thus, this mechanism may affect the cognitive function of the brain.

Since Pilates exercise with a holistic approach requires the activation and coordination of several muscle groups simultaneously with the aim of improving the general health of the body and underlining the strengthening of the core (body), posture, increased attention and concentration, and coordination of breathing with body movements, it can play the role of a multifactorial interventionist program in children with learning disabilities. In contrast, the movements of aerobic exercise are more repetitive in nature, emphasizing a child to observe predetermined patterns in training, and upon repetition and training, memory scales, especially active memory, are likely to improve, probably due to the generation of neural communication circuits between neurons, which stimulates higher parts of the nervous system involved in memory and cognition. Moreover, in rhythmic motor training, the repetition of a rhythmic movement enables children to predict the next component of a movement. Maintaining the rhythm of rhythmic training in mentally handicapped children can enhance the memory and mitigate the problems of functional scales (25).

There is some research demonstrating that fitness and exercise have beneficial effects on memory status by the positive changes of hippocampal structure and function. Hippocampus is responsible, in part, for encoding information into memory (26-28). In addition, a study has shown that a molecule called Irisin, which is produced during endurance exercise in the body, can have a neuroprotective effect. The elevated level of Irisin in the blood can increase the activity of genes involved in learning and cognitive function (12). Nevertheless, finding the underlying mechanisms involved in the outcome (molecular and structural changes in the central nervous system) is beyond the scope of this study. More research to clarify the mechanism of changes contributes to our knowledge regarding the effectiveness of exercise on students with learning disabilities.

Table 1. The Mean and Standard Deviation of Height, Weight, and BMI of Students with Learning Disabilities

Group	No.	Weight, kg	Height, cm	BMI, kg/m^2
Aerobic group	15	23.8 ± 5.6	123.5 ± 8.8	15.6 ± 2.7
Pilates group	15	23.9 ±5.5	123.7 ± 8.6	16.6 ± 2.8
Control group	15	23.7 ±5.7	123.3 ± 9	15 ± 2.10
P value		0.74	0.83	0.79

Table 2. Descriptive Indices of Total Intelligence Scores in Experimental and Control Groups at Pretest and Posttest[a]

Groups	Pilates		Aerobics		Control		Significance Level
	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	
Verbal intelligence	47.6 ± 7.65	46.2 ± 7.34	49.8 ± 9.85	46.8 ± 10.4	43.2 ± 7.65	45.4 ± 8.6	0.82
Functional intelligence	57.2 ± 7.75	54.3 ± 5.42	50.3 ± 6.1	47.7 ± 6.7	49.1 ± 6.42	49.4 ± 5.27	0.24
Overall intelligence	104 ± 13.3	100 ± 10.9	100 ± 12.4	94.6 ± 13.2	92.3 ± 10.2	94.8 ± 10.6	0.85

[a]Values are expressed as mean ± SD.

Table 3. Multivariate Analysis of Variance on the Posttest and Pretest Differences in the Total Intelligence Scores of the Groups

Wilks λ Test, Group	Effect Size	F	df of Assumption	df of Error	Significance Level
Aerobic and control	0.72	3.16	13	16	0.01
Pilates and control	0.63	2.49	13	16	0.04
Pilates and aerobics	0.40	0.84	13	16	0.61

Overall, the findings of this study suggest that eight weeks of aerobic and Pilates exercises could be effective in improving the cognitive performance of LD children and yield positive outcomes. However, there were no significant differences between aerobic and Pilates exercises regarding their effect on the performance of subtests in Wechsler ACID profile. According to much research, one explanation for this result is that there is a positive link between external motivation factors and intelligence test performance. Some individuals with extrinsic and intrinsic motivation would respond differently to intelligence tests (8). Thus, it is possible that aerobic or Pilates exercise may influence motivation, either extrinsically or intrinsically. On the other hand, a high level of WM ability had a stronger link with intelligence (8). Therefore, both kinds of exercise in this study may affect WM. Thus, the results of this study suggest that aerobic and Pilates exercises could be used as a non-pharmacological approach to improving the performance of subtests in Wechsler ACID profile of children with learning disabilities.

The limitations of this study are related to the cross-sectional design of the study and the low number of participants that should be considered in future studies. Another limitation of the study was the single-sex and age variables. All of the participants in this study were eight-year-old girls; so, it is suggested that future research examines the benefits of these two training protocols in various sex and age groups.

Footnotes

Authors' Contribution: Study concept and design and study supervision: Ali Seghatoleslamy; acquisition of data and drafting of the manuscript: Maryam Masoudi; analysis and interpretation of data and statistical analysis: Marzieh Saghebjoo; critical revision of the manuscript for important intellectual content and administrative, technical, and material support: Morteza Taheri.

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