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RESEARCH

Effectiveness of low-intensity aerobic exercise with assisted bicycle exercises on quality of life and lung functions in duchenne muscular dystrophy

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ABSTRACT:

Background: Duchenne muscular dystrophy (DMD) is an X-linked recessive disorder caused by abnormalities in the dystrophin gene that affects one in every 3,500 males. In India, approximately 0.8 million were involved. Management is usually multidirectional and more focused on improving the quality of life (QOL), not mortality. Physiotherapy and exercise are an integral part of the management of DMD. Since there were no recommended exercises for DMD, there is a need to create an exercise protocol that improves the QOL. Low-intensity aerobic exercises are highly recommended for older people and are found effective. **Objective:** The study aimed to identify the effectiveness of low-intensity aerobic exercise with assisted bicycle exercises on QOL and lung functions in DMD. **Methods:** A randomized controlled trial was conducted at the Institute of Muscular Dystrophy and Research Centre, Jeevan Foundation, Veeravanalur, Tirunelveli Dist. Tamil Nadu, India. The institute has around 200 children with DMD. This study selected 34 children based on the criteria. I, the children, were provided with low-intensity aerobic exercise for seventeen children. Group II provided the children with assisted bicycle exercises for seventeen children. Both groups received exercises for 60 minutes and deep diaphragmatic breathing for 10 minutes. All are given a home program to the children. The total study duration is ten weeks. **Results:** Data were analysed following the assessment of Quality of life using DMD QoL and the Lung function using a spirometer (FVC, FEV1, FEV1/VC). All the data were collected on day 1, every two months. Parametric tests were used to compare the outcome measures. The student t value for the DMD QOL is 9.66 with p <0.001, the spirometry values of FEV1 are 7.67 with p< 0.001, and FVC is 14.78 with p < 0.001, respectively, and FEV1/VC is 10.81 with p < 0.001. **Conclusion:** This study concluded that low-intensity aerobic exercises and assisted bicycle training improve the QOL and lung functions. On comparing the interventions, it was found that low-intensity aerobic exercises are better improved than the assisted bicycle group.

Keywords: Duchenne muscular dystrophy; low intensity aerobic exercises; assisted bicycle training; lung function; quality of life.

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BACKGROUND

Specific genes can mutate to cause muscular dystrophy, an inherited disease. Because of these genetic abnormalities, proteins essential for muscle cell stability are defective or absent, leading to muscle weakness and gradual cell death[(1)]. Duchenne muscular dystrophy (DMD) is a genetic disorder (DMD; OMIM 310200), an inherited disease that affects children. Due to defects in a protein called dystrophin, which helps to maintain healthy muscle cells, DMD is a hereditary disorder characterized by progressive muscular weakness and degeneration. One in 3,500 persons have X-linked recessive illness, or dystrophin protein deficiency, because of a mutation in the dystrophin gene(2). DMD is characterized by progressive muscle degeneration and weakness due to alteration in the dystrophin muscle protein that helps the muscle cells stay intact(3). DMD affects about 0.8 million male children in India. DMD (1.7–4.2 per 100,000) is the most prevalent condition identified at 18.1 per 100,000(4). DMD accounts for more than 80% of all myopathies(5).

The most common muscular dystrophy incidence rate is 1:3500 male births(6). Dey and his co-workers stated in 2015 that the disease typically affects youngsters between three and fifteen and that most deaths occur by age twenty(7). As in the DMD, as age increases, their muscle fibers degenerate and replace fatty tissues in the muscles [6]. The appearance of threads with the central nuclei marks regeneration(8). There are currently no treatments for DMD, and it only aims to address problems and symptoms. Current management focuses on multidisciplinary approaches to manage symptoms and improve quality of life (QoL) and function(9, 10). Even though DMD cannot be cured, numerous trials of different treatment strategies have been advocated. The key to the management is to refer the patient to a neurologist. Physiotherapy also plays an integral part in management. The mainstay drug to date is corticosteroids, which have improved muscle strength and have been noted in numerous studies. The current interventions focus on the multidisciplinary approach to managing the symptoms and improving the QOL and functions(11, 12).

Exercises play an essential role in the improvement of DMD. Physiotherapy plays a vital role in DMD recovery. Physiotherapists advocate stretching, strength, positioning, and gait training(13). Physiotherapy works with family and parents and plays to improve the child's skills and QoL(13, 14). Low-intensity aerobic exercises focused on 1.5 metabolic equivalent tasks (METs), which help enhance the activity in the children(15). There have yet to be studies done on the application of low-intensity aerobic exercises(16). Assisted bicycle training offers high-quality practices that produce management and confidence goals for the children. These cycle exercises are done safely, requiring the development of fine motor and cognitive abilities(17). Since there are no comparative studies on low-intensity aerobic exercises with assisted bicycle training, this is the first study to focus on the DMD Children's Quality of Life(18). This instrument can be used in cost-effectiveness evaluations of new healthcare interventions. The DMD Childrens Quality of Life is a 14-item questionnaire available as a patient-reported version(19). Spirometry tests are used to measure the beneficial aspects of the lungs. It also helps to diagnose and monitor lung conditions. It helps to identify the lung function levels(20).

The exercises play a significant role in DMD, whereas some studies have identified that the exercises may destroy muscle function. There are limited studies on the part of aerobic exercises in DMD children, and this is the first kind of study that tries to compare low-intensity aerobic exercises with assisted bicycle training on QoL and lung functions in DMD children. This study aimed to identify the effectiveness of low-intensity aerobic exercise with assisted bicycle exercises on QoL and lung functions in DMD.

METHODS

A randomized controlled trial was conducted involving children with DMD. The study was conducted at the Institute of Muscular Dystrophy and Research Centre, Jeevan Foundation, Veeravanalur, Tirunelveli Dist. Tamil Nadu, India. The institute has 212 children with DMD. All the children reside in the center and receive treatment for DMD. This study was conducted with thirty-four children selected based on the criteria. Before the study, each child, parent, and teacher was given a clear explanation. The study obtained ethical approval (IEC NO: MU/ IEC/ 21/15, dated 24.07.2021) from Madhav University, Rajasthan. Initially, the parents were given explicit instructions, and written consent was obtained from every parent.

The study was conducted with the age group of 7 years to 13 years. A senior neurologist diagnoses DMD, DNA established diagnosis of DMD, Children who participate in regular exercises, Children with AROM in full-on upper and lower limbs, children able to do their activities of daily living, and children who complain of cardiovascular problems, severe deformities in the lower limbs, any recent upper limb injuries and with severe respiratory disorders are not involved. Study children were selected from their homes, and the exercises were given in their respective homes. Children have been getting treatment for the past 2—8 years, with an average of 6 years, with regular physiotherapy, diet, physician visits, and proper medications.

Physiotherapists working in the institute were trained on assisted bicycle training and low-intensity aerobic exercises. They were given seventeen(17) children in each group and advised to do the exercises for sixty minutes. In group I, seventeen DMD children were given low-intensity aerobic exercises for 30—45 minutes following subsequent breaks. In addition to that, they all underwent diaphragmatic breathing exercises for 10 minutes. Low-intensity aerobic exercises were given in addition to the regular physiotherapy interventions. Low-intensity aerobic exercises include wand exercises to encourage the movements of the shoulder, arms circling, arm curls, triceps dips, wall angels, chest press, deltoid raise, leg circle, toe raise, hip movements, and half squats(15, 16).

They also received deep breathing exercises in the position of semi-reclined positioning. In addition to that, they received coastal breathing exercises for both the lower lobes. These techniques were applied for 10 minutes and advised three times daily.

Group II, seventeen DMD children, were given assisted bicycle training for 30—45 minutes following subsequent breaks. Bicycle training for the lower and upper limbs was provided per the protocols explained by Jansen et al., 2010(17, 21). All the children were instructed to do cycle training at 700—1000 revolutions for the legs and the arms. Cycles are modified per the child’s height and physique(21).

All the interventions were given a week thrice with 60% of the maximal heart rate (MHR). MHR is measured with 220-Age. Warming up exercises for 5 minutes and included the cooldown for 10 mins. A subsequent rest period was given to every participant. The children’s parent was also taught these exercises and advised to supervise them. The outcomes measured in this study are QoL and lung functions. The QoL is calculated using the DMD Children Quality of Life questionnaire, and the lung function is measured using FEV1, FVC, and Fev1/VC. This study uses an personal spiormeter Alveoair ® Digital spirometer. Children made to sit comfortably with the nose was clamped to avoid air leakage and asked the child to take a deep breath and forcefully exhale it through the mouthpiece. Three times, it was repeated, and the best values were taken for analysis. Before the measurement, the children were given two trial blows to familiarise themselves with the spirometer. Statistical analysis was applied using SPSS version 24.0. A parametric test was used to compare post-intervention data. An $\alpha < 0.05$ is the level of significance in all the analyses.

RESULTS

The effect of the exercises was analyzed using the QoL questionnaire and the lung function test. The collected data were analyzed using SPSS 24.0. Since this study efforts to detect the changes between the sets of observations, this study uses the paired 't-test. All the test was set with the p=0.05%. Tables I, II, and III describe the demographical analysis and the outcome analysis.

Table I. Demographic analysis.

Variables	Mean	sd
Age group	9.45	2.089
Duration of symptoms	5.70	1.922
First child	10.17	2.250
Second child	8.37	1.302

Table II. Intervention analysis within group variables

Outcome measures	Groups	Pre test (mean ± sd)	Post- test (mean ± sd)	Percentage of change	Paired 't' value	Cohen's D	p value
DMD QoL	Group I	45.35 ±1.32	29.71 ± 2.11	34.50%	23.37	8.89	0.0001
	Group II	44.12 ±1.41	35.88 ± 1.58	22.95%	15.89	5.50	
FEV1	Group I	27.29 ± 2.37	42.65 ± 1.84	56.25%	17.73	7.24	0.0001
	Group II	27.82 ± 2.74	38.18 ± 1.55	37.21%	14.44	4.65	
FVC	Group I	32.93 ± 1.83	45.54 ± 1.74	38.28%	18.85	7.06	0.0001
	Group II	32.98 ± 1.54	35.55 ± 2.17	7.80%	4.267	1.37	
FEV1/FVC	Group I	44.88 ± 1.32	59.06 ± 1.89	31.59%	23.32	8.70	0.0001
	Group II	44.53 ± 1.42	52.53 ± 1.62	17.97%	14.22	5.25	

Note: FEV1: forced expiratory volume in 1 second; FVC: forced vital capacity

Table III. Interventional analysis between the group variables.

Outcomes	Group I (mean ± sd)	Group II (mean ± sd)	Percentage of change	Student t test values	Cohens D	p value
DMD QOL	29.71 ± 2.11	35.88 ± 1.58	17.21%	9.66	3.31	0.001
FEV1	42.65 ± 1.84	38.18 ± 1.55	10.48%	7.67	2.63	0.001
FVC	45.54 ± 1.74	35.55 ± 2.17	21.94%	14.78	5.08	0.001
FEV1/FVC	59.06 ± 1.89	52.53 ± 1.62	11.06%	10.81	3.71	0.001

Note: FEV1: forced expiratory volume in 1 second; FVC: forced vital capacity

The Table I shows that the p-value is small, which means the chance of the type I error is very small, and the smaller p-value supports the H1. Since the p-value < α, H0 is rejected. The table shows the observed effect size of the three more significant variables, which indicates that the difference between the average and μ0 is substantial.

The Table II shows a significant improvement observed between the pre-test and post-test on the QoL questionnaire and spirometer measurements in all the participants. A marked difference was noted between the pre-test and the post-test values. It was reported in both groups. On comparing the low-intensity aerobic exercises with the assisted bicycle training, it was recorded that the low-intensity aerobic exercises showed marked improvement. The Table III shows that the Between-group comparison on the quality of life offers a substantial improvement; in addition, there are improvements in the lung function values. This table shows a significant difference between group I and group II children. The findings of this study show that the magnitude of the difference between the average and is μ0 large, which offers an apparent discrepancy between the interventions.

DISCUSSION

The study aims to identify the effect of low-intensity aerobic exercises on QoL, and lung functions in children with DMD. Exercises play an essential role in the management of DMD. The activities will help to improve muscle tone and to increase overall fitness. Exercises should be conducted slowly and without joint or muscle injury(22). Historically, it was thought exercises would accelerate muscle loss in DMD children. Still, recent research has identified that moderate aerobic exercises don't strain the muscles and improve children's quality of life(23).

Aerobic exercises are effective interventions that enhance the QoL, fitness, and physical functioning(24). Aerobic exercises help to maintain overall fitness and respiratory function. However, some muscles limit the regenerative capacity of the muscle tissues. Low-intensity exercises protect muscle strength and isolated strengthening with a range of motion exercises. It improves the distal and proximal strength(18).

Low-intensity aerobic exercises improve the contractility of the expiratory muscles. The exact mechanism is unknown, but respiratory muscle function was improved due to respiratory muscle activation, reduction of fat mass, and weight loss, which plays a significant role(16). Repeated exercises may result in respiratory muscle hypertrophy, and it was evident that respiratory indices are related to respiratory muscle power(25).

Low-intensity exercise improves muscle power and reduces the atrophy in the muscles, and frequent breaks may reduce the incidence of fatigue(26). Exercise maximizes muscle function and prevents atrophy. Some reviews and randomized controlled trials have identified the effectiveness of strength and aerobic exercise training in people with muscle diseases(27, 28).

Similar studies conducted by various researchers found many positives to strength training in the DMD. All these exercises improve muscle functions, which can be expected after six weeks(29). Improving muscle strength and endurance would increase the QoL. Training improves the maximal oxygen consumption and the improvement of the biogenesis in mitochondria[21].

The exercises maximize independence in boys with DMD; it is important to postpone the loss of functional abilities for all everyday tasks. The major limitation of this study is the lack of sample size and the lack of cooperation by some of the parents due to physical, emotional, and community problems. The duration of the study needs to be longer to identify the more significant effect of the exercises. Muscle biopsy studies are required to determine the physiological changes in the muscles.

CONCLUSION

This study concluded that low-intensity aerobic exercises and assisted bicycle training improve the QoL and lung functions. On comparing the interventions, it was found that low-intensity aerobic exercises are better improved than the assisted bicycle group.

Authors' contribution: Anandh, Arunachalam, and Ananadan conceived and planned the experiment. Daniel and Shanthi carried out the experiment. Arun and Rajkumar contributed to the interpretation of the results, provided critical feedback, and helped shape the manuscript. All authors reviewed the results and approved the final version of the manuscript.

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