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Research Article

Comparison of Low-intensity Aerobic Exercise with Assisted Bicycle Exercise on Quality of Life and Lung Function in Duchenne Muscular Dystrophy

Anandan D[1], Anandh V[2], Arunachalam R[2], Rajkumar Krishnan Vasanthi[3], Daniel Rajasundaram S[4], Shanthidevi M[4], Arun B[5]

[1]PhD Scholar, [2]Professor, Department of Physiotherapy, Madhav University, Rajasthan, India.
[3]Faculty of Health and Life Sciences, INTI International University, Persiaran Perdana Nilai, Negeri Sembilan, Malaysia.
[4]Senior Physiotherapist, Department of Physiotherapy, Institute of Muscular Dystrophy and Research Centre, Jeevan Foundation, Veeravanalur, Tirunelveli District, Tamil Nadu, India.
[5]Physiotherapist Grade II, Physiotherapy Department, Government District Headquarters Hospital, Erode, Tamil Nadu, India.
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I N F O

Corresponding Author:
Anandan D, PhD Scholar, Department of Physiotherapy, Madhav University, Rajasthan, India.
E-mail Id:
anandmptneuro@gmail.com
Orcid Id:
http://orcid.org/0009-0005-5204-2733
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A B S T R A C T

Background: Duchenne muscular dystrophy (DMD) is a genetic disorder that affects males worldwide. Low-intensity aerobic exercises have been proven effective for older populations and may offer potential benefits for individuals with DMD.

Objectives: This study assessed low-intensity aerobic exercises and compared their effects with those of assisted bicycle exercises on the quality of life and lung functions of individuals with DMD.

Methods: A quasi-experimental study was conducted which involved 38 DMD children divided into two groups. Group I consisted of 19 children who received low-intensity aerobic exercises, while Group II, underwent assisted bicycle exercises. Both groups received a 60-minute exercise regimen and performed deep diaphragmatic breathing exercises for 10 minutes. A home programme was provided to ensure the continuity of the exercises. The study duration was ten weeks.

Results: The results showed significantly improved quality of life and lung function for both groups. The student t test values for DMD QoL, FEV1, FVC, and FEV1/VC were 8.22 ($p < 0.001$), 6.12 ($p < 0.001$), 11.28 ($p < 0.001$), and 9.12 ($p < 0.001$), respectively.

Conclusion: This study demonstrated that low-intensity aerobic exercises and assisted bicycle training can improve the quality of life as well as lung functions in individuals with DMD. Moreover, low-intensity aerobic exercises showed greater improvements compared to assisted bicycle exercises.

Keywords: Duchenne Muscular Dystrophy, Low-intensity Aerobic Exercises, Assisted Bicycle Training, Lung Function, Quality of Life, DMD QoL

Introduction

Muscular dystrophy (MD) is an inherited disease that results from specific gene mutations. These mutations lead to defective or absent proteins that are essential for maintaining muscle cell stability. Consequently, affected individuals experience gradual muscle weakness and cell death.[1] Duchenne muscular dystrophy (DMD) is a form of muscular dystrophy which is a hereditary illness, primarily affecting children.

This X-linked recessive disease is a result of abnormalities in the dystrophin protein, crucial for healthy muscle cell maintenance. As a result, individuals with DMD experience progressive muscle degeneration and weakness. This disorder affects about 1 in 3,500 people and is the most common form of muscular dystrophy, accounting for over 80% of all myopathies.[2]

In India alone, DMD affects approximately 0.8 million male children.[3] Worldwide, the prevalence of DMD ranges from 1.7 to 4.2 per 100,000 individuals, making it one of the most prevalent muscular dystrophy conditions.[4] As children with DMD age, their muscle fibres degenerate, and fatty tissues replace them. The appearance of fibres with central nuclei marks the regeneration of muscle fibres.[3,5]

Unfortunately, management for DMD is not clear, and recently adopted ways of management aim to handle the symptoms and address related problems.[6] Multidisciplinary approaches involving various healthcare professionals are used to improve patient's quality of life and function. Although corticosteroids are the mainstay drug for DMD management, several trials of different treatment strategies have been advocated. Referral to a neurologist and physiotherapist are integral components of DMD management.[7,8]

The pace of muscle deterioration is enhanced by prolonged immobilisation in DMD. MD is improved by being ambulatory, physical exercise, and physiotherapy. Though the mobility of individuals with MD can be increased by about two years by using glucocorticoids, there can be an adverse impact of continuous administration of steroids. There is no cure available for DMD as of now. Stem cell therapy and gene therapy are presently in their nascent stage. They may, in future, be helpful for individuals with MD.[9]

Physiotherapy plays a vital role in DMD recovery. Physiotherapists work with families to improve a child's skills and quality of life through stretching, strength training, positioning, and walking exercises. Rehabilitation aims to maintain the range of motion, prevent muscle stiffness and contractures, avoid creating deformities, and improve muscle strength.[10,11]

Low-intensity aerobic exercises with an activity level of 1.5 equivalent metabolic tasks (METs) can help improve patients' performance.[12] However, there are limited studies on the role of aerobic exercises in DMD children. Therefore, a comparative study that focuses on the impact of low-intensity aerobic exercises compared with the effect of assisted bicycle training on quality of life and lung function in DMD children is essential.[13,14]

A DMD QoL is a questionnaire consisting of 14 items. It is available as a patient-reported version and can be utilised to analyse the cost-effectiveness of new healthcare interventions. Additionally, spirometry tests diagnose and monitor lung conditions, helping identify lung function levels.[15]

Exercise is essential in managing DMD as it can help improve muscle function and overall quality of life. However, there is limited research on the efficacy of aerobic exercise in DMD children, and some studies have suggested that exercise may even lead to muscle function deterioration. Therefore, it is essential to conduct further studies on the role of exercise in DMD patients to determine the best approach to improving their health and well-being.[13,16]

This study aims to compare the effects of low-intensity aerobic exercise with assisted bicycle training on the quality of life and lung functions of DMD children. This is the first study to investigate this particular exercise intervention in DMD, and its findings will be critical in forming future management strategies for this debilitating condition. By shedding light on the potential benefits of this exercise intervention, this study will improve the overall care and management of DMD patients.

Materials and Methods

A quasi-experimental study was conducted on children diagnosed with DMD at the Institute of Muscular Dystrophy and Research Centre, Jeevan Foundation, Veeravanalur, Tirunelveli Dist., Tamil Nadu, India. One hundred and two children with DMD at the institute were recruited for the study, and post-assessment 38 DMD children were selected based on selection criteria. They were selected through a systematic sampling method. The study received ethical approval from Madhav University, Rajasthan, and written consent was obtained from the parents or guardians of each child before commencing the study. This study was conducted from May 2022 to February 2023.

This study included DMD children in the age group of 7 to 13 years who had been receiving treatment for DMD for an average of 6 years, with regular physiotherapy, proper

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medication, and physician visits. Children who were able to do active range of motion (AROM) in their upper and lower limbs, who could do their daily activities on their own, and children who had severe cardiovascular problems, lower limb deformities, recent upper limb injuries, or severe respiratory disorders were not included in the study. The exercises were carried out in the respective homes of the children.

The physiotherapists working in the institute were trained with low-intensity aerobic exercises and assisted bicycle training. The children were divided into groups of 19 each, and the exercises were conducted for 60 minutes thrice a week for a duration of ten weeks. In Group I, the children were given low-intensity aerobic exercises, including wand exercises, arm curls, wall angels, chest presses, half squats, and diaphragmatic and costal breathing exercises.[16,17] In Group II, the children received assisted bicycle training for the upper and lower limbs, as per the protocol explained by Jansen in 2000.[17] All the exercises were performed at 60% of the maximal heart rate (MHR). The outcomes were measured using the DMD QoL questionnaire and lung function tests, including FEV1, FVC, and FEV1/VC.

The statistical analysis was conducted using SPSS version 24.0, and a parametric test was used to compare post-intervention data. The significance level in all the analyses was set at $p < 0.05$. This study provides useful insights into the effectiveness of different types of exercises in managing DMD in children.

Results

Table 1 provides information on the demographic characteristics of the study participants, including age and duration of symptoms. The participants were between 7 and 13 years of age and had been receiving treatment for DMD for an average of 6 years. The study included 19 participants in each of the two groups.

Table 2 presents the results of the paired t tests to compare the pre-test and post-test values for quality of life and lung function measures within each group. The table shows a significant improvement in both groups for all the outcome measures. The improvements were more marked in the low-intensity aerobic exercise group. The effect sizes for the significant variables indicated that the differences between the means and the reference value (μ0) were substantial.

Table 3 shows the results of the between-group comparison for quality of life and lung function measures. The table indicates a significant difference between the two groups in terms of quality of life and lung function measures. The low-intensity aerobic exercise group improved more in both measures than the assisted bicycle training group.

Table 1.Demographic Analysis

Variables	Mean	SD
Age group (years)	9.22	1.112
Duration of symptoms (years)	6.11	1.862

Table 2.Within-Group Intervention Analysis

Outcome Measures	Groups	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Change Percentage	Paired t Value	p Value
DMD QoL	Group I	45.26 ± 1.31	29.53 ± 4.92	34.69	16.32	0.0001
	Group II	46.26 ± 2.34	36.37 ± 2.78	21.53	9.56	
FEV1	Group I	28.47 ± 2.67	38.42 ± 2.94	35.00	7.99	0.0001
	Group II	28.11 ± 2.49	37.58 ± 2.72	33.60	6.86	
FVC	Group I	32.59 ± 1.68	41.55 ± 5.25	21.57	6.07	0.0001
	Group II	34.21 ± 1.50	35.05 ± 4.33	2.55	2.67	
FEV1/VC	Group I	45.28 ± 1.32	56.11 ± 4.59	23.96	12.13	0.0001
	Group II	44.05 ± 1.44	51.05 ± 3.14	15.887	10.32	

DMD QoL: Duchenne Muscular Dystrophy Quality of Life questionnaire, FEV1: Forced Expiratory Volume in 1 second, FVC: Forced Vital Capacity, FEV1/VC: Ratio of the Forced Expiratory Volume in 1 second with Vital Capacity

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Outcomes	Group I (Mean ± SD)	Group II (Mean ± SD)	Change Percentage	Student t Test Values	Cohen's D	p Value
DMD QoL	29.53 ± 4.92	36.37 ± 2.78	17.21	8.22	3.38	0.001
FEV1	38.42 ± 2.94	37.58 ± 2.72	10.48	6.12	4.69	0.001
FVC	41.55 ± 5.25	35.05 ± 4.33	21.94	11.28	6.30	0.001
FEV1/VC	56.11 ± 4.59	51.05 ± 3.14	11.06	9.12	4.21	0.001

The effect sizes suggested a substantial difference between the means of the two groups.

DMD QoL: Duchenne Muscular Dystrophy Quality of Life questionnaire, FEV1: Forced Expiratory Volume in 1 second, FVC: Forced Vital Capacity, FEV1/VC: Ratio of the Forced Expiratory Volume in 1 second with Vital Capacity

Overall, this study's statistical analysis suggests that low-intensity aerobic exercises and assisted bicycle training can improve quality of life and lung function measures in children with DMD. However, low-intensity aerobic exercises may be more effective.

Discussion

The primary objective of this study is to examine the impact of low-intensity aerobic exercises and assisted bicycle training on the quality of life and lung functions of children with DMD. Exercise is crucial in managing DMD as it helps improve muscle tone and overall fitness. It is important to perform exercises slowly without causing joint or muscle injuries.[18]

In the past, there was a belief that exercises could accelerate muscle loss in children with DMD.[19] However, recent research has debunked this notion by demonstrating that moderate aerobic exercises do not strain the muscles and contribute to an improvement in the quality of life of these children.[16] Aerobic exercises are effective interventions that enhance overall fitness, physical functioning, and quality of life.[20] They also help in maintaining respiratory function. Low-intensity exercises protect muscle strength and promote isolated strengthening through range-of-motion exercises, thereby improving distal and proximal strength.[21,22]

Furthermore, low-intensity aerobic exercises have been found to enhance the contractility of expiratory muscles. Although the exact mechanism behind this improvement is not fully understood, it is believed that respiratory muscle activation, reduction of fat mass, and weight loss play significant roles in enhancing respiratory muscle function.[22] Repeated exercises may lead to respiratory muscle hypertrophy, and it has been observed that respiratory indices are closely related to respiratory muscle power.[20]

Engaging in low-intensity exercise has been found to improve muscle power and reduce muscle atrophy, while frequent breaks during exercise sessions can help minimise fatigue.[16] Regular exercise maximises muscle function and prevents atrophy. Several reviews and randomised controlled trials have highlighted the effectiveness of strength and aerobic exercise training in individuals with muscle diseases.[22,23]

Overall, the evidence suggests that low-intensity aerobic exercises can positively impact the quality of life and lung functions of children with DMD. Assisted bicycle training contributes to muscle power enhancement, muscle atrophy reduction, and fatigue prevention.[14] Strength training has demonstrated favourable outcomes in individuals with various muscle diseases, including DMD.[24]

The study highlights the importance of low-intensity aerobic exercises in enhancing the quality of life and lung function in children with DMD. The findings suggest that moderate aerobic exercises do not accelerate muscle loss and are beneficial for children with DMD. The exercises help to improve muscle strength and endurance, prevent atrophy, and maximise independence in daily activities.

The study also identifies some limitations, such as the small sample size and the need for more cooperation from some parents. The duration of the study needs to be extended to identify more significant effects, and further studies are required to determine the physiological changes in the muscles.

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Overall, the study provides valuable insights into the benefits of low-intensity aerobic exercises for children with DMD and emphasises the importance of incorporating exercise interventions in the management of DMD.

Conclusion

The results showed that both interventions improved the quality of life and lung functions, but low-intensity aerobic exercises were more effective than the assisted bicycle group. The study highlights the importance of exercises in managing DMD and suggests that low-intensity aerobic exercises can benefit children with DMD. However, the study had limitations like a short duration and a small sample size. Further research is required to confirm the findings and determine the physiological changes in the muscles.

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