GRADIVA

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

Effect of Bicycle Ergometer Training in Cotton Labourers On Lung Function and Quality of Life – An Experimental Study

Dr. Ankur Khant[1], Dr. Yagnik Dave[2]*, Dr. Ashish Kakkad[3],
Dr. Ashika Tanna[4] & Dr. Himanshi Ruparelia[5]

1. HOD, Faculty of Physiotherapy, Marwadi University, Rajkot, Gujarat, India.
2,4,5. Assistant Professor, Faculty of Physiotherapy, Marwadi University, Rajkot, Gujarat, India.
3. Principal, Faculty of Physiotherapy, Marwadi University, Rajkot, Gujarat, India.
*Corresponding Author Email: yagnik.dave@marwadieducation.edu.in

Abstract

Background: Cotton is a natural fiber derived from the processing of cotton plants. Labourers involved in cotton production are at higher risk of inhaling cotton dust, which can lead to both acute and chronic respiratory complications such as constriction of bronchus, tightness of chest, and occupational lung diseases. Engaging in physical activities that involve strengthening the inspiratory muscles and training larger muscle groups is crucial for enhancing pulmonary ventilation, increasing exercise capacity, reducing breathlessness, and improving cardiorespiratory endurance. **Aim:** To investigate whether bicycle ergometer training is beneficial in cotton labourers to improve lung function and quality of life. **Materials and Methods:** 132 male cotton laborers, aged between 30 and 55 years, were randomly assigned to two equal groups: Group A (Experimental) and Group B (Control). Group A and B received supervised treatment four times per week for eight weeks, with a follow-up conducted one year later. Pulmonary function tests and the St. George's Respiratory Questionnaire (SGRQ) were utilized to assess the participants at baseline, after 8 weeks, and at the follow-up. **Results and Discussion:** No significant differences ($p>0.05$) were observed in the baseline characteristics between the two groups of laborers. However, within each group, statistically significant differences ($p<0.05$) were noted across all outcome measures. Comparing between groups, the experimental group observed statistically higher significant improvements ($p<0.05$) in the outcome measures for FVC, FEV1, FEV1/FVC, PEFR, and SGRQ scores. **Conclusion:** Incorporating bicycle ergometer training into pulmonary rehabilitation programs significantly enhances lung function and quality of life for cotton laborers.

Keywords: *Bicycle Ergometer Training, Pulmonary Function Test, SGRQ, Cotton Labourer.*

INTRODUCTION

Cotton, an organic fiber with numerous applications, has long been a primary material for clothing and ornamentation. India, the second-largest cotton producer after China, employs nearly 20 million people in its cotton industry. (1) In the past decade, India's cotton production has grown significantly.

From 2000-2001 to 2010-2011, production surged from 14 million to 32.05 million bales, with yield increases from 278 kg/ha to 496 kg/ha. (2) The textile industry is vital to India's economy, contributing significantly to international trade and providing extensive employment.

Processing cotton fibers produces cotton dust, which is a combination of fibers, stems, leaves, bracts, and inorganic materials. (3) According to OSHA guidelines, exposure to cotton

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

dust in yarn manufacturing should not exceed 200 µg/m³ of lint-free respirable dust over an 8-hour period. Cotton dust is categorized into trash (>50 µm), dust (50-500 µm), micro dust (15-50 µm), and breathable dust (≤15 µm).

Particles ≤2.5 µm can penetrate the lungs' gas exchange areas, leading to respiratory problems as they accumulate in the bronchioles of the central acinus.(4) Exposure to cotton dust can cause symptoms such as chest tightness, coughing, wheezing, phlegm, and dyspnea, and prolonged exposure can result in chronic reductions in FEV1 and worsened respiratory conditions.(5)

These health effects extend beyond respiratory issues, impacting laborers' income, healthcare costs, work performance, and overall productivity. A comprehensive pulmonary rehabilitation program optimizes the physical and social functioning of patients with chronic respiratory impairments. This approach reduces dyspnea, enhances exercise capacity, decreases healthcare utilization, and improves overall health.

Pulmonary rehabilitation includes bronchial hygiene, respiratory muscle strength training, chest mobility exercises, peripheral muscular endurance training, and quality of life improvement. (6-8) Aerobic exercise, such as running, jogging, walking, and cycling, is recommended for enhancing mental, physical, and emotional health.

Equipment like bicycle ergometers and treadmills significantly improve functional exercise capacity and assess fitness levels, especially for individuals over 40 with cardiovascular risk.(9-11) Exercise training helps reduce ventilatory demand and improves inspiratory muscle function.(2,5) In India, studies on cotton laborers reveal a decline in physical and functional performance, yet there is limited evidence on the benefits of bicycle ergometer training for this population.(7) Limited acceptance of these interventions has resulted in low adoption of evidence-based practices.

METHOD

Subjects

A study was conducted at Angel Fibers Pvt. Ltd. in Rajkot involved 132 male cotton laborers aged 30-55, selected using simple random sampling. Inclusion criteria included at least one year of industry experience, aged between 30 and 55 years, all BMI categories, smoker/nonsmoker and a FEV_1/FVC ratio >70%. Exclusions applied to those with a history of hospitalization within the past six months, uncontrolled vital signs, and lack of motivation for study participation.

Methodology

Researchers recruited 132 cotton labourers for this investigation. Participants were assigned equally into experimental (n=66) and control (n=66) groups. Each labourers was informed of the study's goal and process. Studies were registered at Clinical Trial Registry of India as CTRI/2017/02/007853.

Every labourers gave written informed permission before joining the study. Height, weight, and BMI were measured before intervention. Pre- and post-outcome measures included pulmonary function test (FEV_1, FVC, FEV_1/FVC, and PEFR) with RMS-Helios 702 spirometer and quality of life by St. George's Respiratory Questionnaire (SGRQ). The follow-up was conducted at one year.

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

In experimental group-A, aerobic training was done four times a week for eight weeks with preventive advice. The aerobic training regimen started with 10 minutes of walking, overhead stretching, and static cycling. Main exercise is 20 minutes on static cycle ergometer at 30–35% HRR.

Tracking pulse while training with pulse oximeter. Five minutes of walking and overhead arm stretching cool down. Duration and intensity increased by 5 minutes and 5% of HRR after two weeks. Control group-B received the same preventive instructions as an experimental group.

RESULTS

The analysis encompassed descriptive statistics, such as mean, standard deviation, and percentage calculations. Baseline values were compared using an independent t-test. Group comparisons, both within and between groups, were conducted using multivariate ANOVA. A 95% confidence interval was sat for all statistical analyses.

Table 1.1: Characteristics of labourers in group A and B

Characteristics	Group-A (Experimental) Mean±SD	Group-B (Control) Mean±SD	P-value
Age (year)	40.75 ± 6.25	40.00 ± 6.42	0.109
Height (cm)	155.11 ± 8.22	157.53 ± 8.57	0.091
Weight (kg)	63.67 ± 7.22	64.52 ± 9.08	0.548
BMI (kg/m^2)	22.68 ± 2.74	22.33 ± 2.48	0.445
Duration of Work (month)	84.53 ± 45.51	86.47± 52.63	0.815

Table 1.2: Baseline data analysis of labourers in group A and B

Outcome measures	Group-A (Experimental) Mean±SD	Group-B (Control) Mean±SD	t-value	P-value
FVC (l)	2.87 ± 0.23	3.02 ± 0.24	-2.457	0.011
FEV_1 (l)	2.67 ± 0.24	2.74 ± 0.24	-1.153	0.113
FEV_1/FVC (%)	91.73 ± 8.07	91.88 ± 5.72	-0.039	0.869
PEFR (l/s)	5.67 ± 1.11	5.66 ± 1.33	0.020	0.876
SGRQ	11.45 ± 5.81	11.06 ± 6.01	0.278	0.606

Table 1.3: Comparison of outcome measures in group A and B

Follow Up At	Outcome Measures	Group-A (Experimental) Mean±SD	Group-B (Control) Mean±SD
Week 8	FVC (l)	3.10 ± 0.28	3.20 ± 0.31
	FEV_1 (l)	3.07 ± 0.24	3.06 ± 0.28
	FEV_1/FVC (%)	94.04 ± 5.60	92.28 ± 3.12
	PEFR (l/s)	7.30 ± 0.70	7.04 ± 1.15
	SGRQ	5.54 ± 4.01	7.07 ± 5.04
1 Year	FVC (l)	3.04± 0.27	3.07 ± 0.23
	FEV_1 (l)	2.86 ± 0.27	2.82 ± 0.10
	FEV_1/FVC (%)	93.43 ± 4.60	91.25 ± 4.06
	PEFR (l/s)	7.12 ± 0.93	6.35 ± 1.06
	SGRQ	7.15 ± 3.39	10.79 ± 5.49

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

Table 1.4: Repeated measure multivariate ANOVA for within-group comparison of outcome measures

Outcome Measures	F	P-value	Effect Size (Partial Eta Squared)
FVC (l)	24.25	0.00	0.15
FEV_1 (l)	40.03	0.00	0.23
FEV_1/FVC (%)	14.73	0.00	0.09
PEFR (l/s)	78.93	0.00	0.37
SGRQ	81.52	0.00	0.37

Table 1.5: Repeated measure multivariate ANOVA for between-group comparison of outcome measures

Outcome Measures	F	P-value	Effect Size (Partial Eta Squared)
FVC (l)	5.16	0.02	0.03
FEV_1 (l)	0.15	0.01	0.00
FEV_1/FVC (%)	4.19	0.04	0.03
PEFR (l/s)	6.22	0.01	0.04
SGRQ	4.76	0.02	0.03

DISCUSSION

Long-term exposure to dust can lead to obstructive respiratory diseases such as pneumoconiosis. This study evaluated the effects of bicycle ergometer training on pulmonary function and quality of life in cotton laborers. The results showed a statistically significant difference ($p<0.05$) between the experimental and control groups. While the control group did show improvements in FVC, FEV1, FEV1/FVC ratio, PEFR, and SGRQ at the 8th week, these improvements were significantly less pronounced than those in the experimental group.

Bicycle ergometer training, based on the principles of exercise training, has consistently shown benefits in increasing exercise tolerance, reducing breathlessness, and improving the quality of life for those with chronic respiratory conditions. Wanke et al. (12) suggested that cycle ergometer training effectively boosts peripheral and respiratory muscle strength, alleviates dyspnea, and enhances exercise capacity.

Similarly, Sarmlento et al. (13) noted a significant increase in both the proportion of type I fibers and the size of type II fibers in the external intercostal muscles. This study infers that the improvements in respiratory muscle strength, neuromuscular adaptation, and increased respiration depth from bicycle ergometer training lead to better pulmonary function and quality of life.

Chaitra B et al. (14) concluded that aerobic training led to improved pulmonary functions among the experimental group. They emphasized that individuals engaging in higher levels of physical activity typically exhibit greater fitness levels and that physical activity can enhance cardiorespiratory fitness. (7,9)

In the present study, it may conclude that increase in strength of respiratory muscles, neuromuscular adaptation and increase the rate of the depth of respiration indicates an improvement in pulmonary function and quality of life during bicycle ergometer training. In our study, there was a statistical significance difference ($p<0.05$) between the groups at 1 year follow-up and decline the FVC, FEV_1, FEV_1/FVC ratio, PEFR and SGRQ values in both groups.

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

This indicates that pulmonary function and quality of life decline slowly to baseline in both groups, but in the experimental group, the decline ratio was less compared to the control group. The decline of pulmonary function suggests that exposure of cotton dust and no training during the follow-up period, which leads to deconditioning effect.

CONCLUSION

The present research proves that bicycle ergometer training yields positive outcomes for cotton laborers. Both experimental and control groups exhibited improvements in pulmonary function (FEV_1, FVC, FEV_1/FVC, and PEFR) and quality of life. Overall, these findings suggest that incorporating bicycle ergometer training into pulmonary rehabilitation programs can effectively enhance pulmonary function and quality of life among cotton laborers.

Acknowledgement

This study owes its realization to the invaluable support of my supervisor, the late Dr. Neela Soni. The contributions and guidance of all involved greatly enhanced the quality of this research, although any remaining errors are solely my own responsibility.

References

1) Prabhakararao K, Srinivasarao C, Sumangali P. A study of pulmonary function tests in cotton mill labourers of Guntur District. Bull Pharm Med Sci (BOPAMS). 2013;1(3):206–9.
2) Dube KJ, Ingale LT, Ingle ST. Respiratory impairment in cotton-ginning labourers exposed to cotton dust. Int J Occup Saf Ergon. 2013;19(4):551–60.
3) Kumar RS. Cotton dust - Impact on human health and environment in the texttile industry. Texttile Magazine. 2008. p. 1–7.
4) Dangi B, Bhise A. Cotton dust exposure: Analysis of pulmonary function and respiratory symptoms. Lung India. 2017;34(2):144.
5) Pope CA, Burnett RT, Thurston GD, Thun MJ, Calle EE, Krewski D, et al. Cardiovascular 5. Mortality and Long-Term Exposure to Particulate Air Pollution: Epidemiological Evidence of General Pathophysiological Pathways of Disease. Circulation. 2004;109(1):71–7.
6) Soni N, Khant A, Rathod P. Lung Function and Six Minute Walk Distance Response to Inspiratory Muscle Training in Cotton Industry Labourers-A Pilot Study. Indian J Physiother Occup Ther - An Int J. 2017;11(4):40.
7) Khant A, Dave Y, Tare H et al. Effectiveness of respiratory muscle training on pulmonary function and quality of life in cotton industry labourers. Int. J. Exp. Res. Rev., Vol. 32: 160-165(2023).
8) Griffiths TL, Phillips CJ, Davies S, Burr ML, Campbell I a. Cost effectiveness of an outpatient multidisciplinary pulmonary rehabilitation programme. Thorax. 2001;56(10):779–84.
9) Bourbeau J, Julien M, Maltais F, Rouleau M. Reduction of Hospital Utilization in Patients With Chronic Obstructive Pulmonary Disease. Arch Intern Med. 2003;163(1):585–91.

Volume 64 | Issue 02 | February 2025
DOI: 10.5281/zenodo.14864773

10) Troosters T, Gosselink R, Decramer M. Short- and long-term effects of outpatient rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. Am J Med. 2000;109:207–12.

11) Rathod P, Khant A, Soni N. Pulmonary Function Response to Aerobic Exercise in Cotton Industry Labourers. Indian J Physiother Occup Ther - An Int J. 2017;11(4):161.

12) Wanke T, Formanek D, Lahrmann H, Brath H, Wild M, Wagner C, et al. Effects of combined inspiratory muscle and cycle ergometer training on exercise performance in patients with COPD. Eur Respir J. 1994;7(12):2205–11.

13) Sarmiento AR, Orozco-Levi M, Güell R, Barreiro E, Hernandez N, Mota S, et al. Inspiratory Muscle Training in Patients with Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med. 2002;166(11):1491–7.

14) Chaitra B, Narahare P, Puranik N, Maitri V. Effect of aerobic exercise training on pulmonary function tests: A pragmatic randomized controlled trial. Int J Pharma Bio Sci. 2011;2(4):455–60. Miyamoto K. Pulmonary Rehabilitation. Japanese J Rehabil Med [Internet]. 2002;39(12):821–7. Available from: http://joi.jlc.jst.go.jp/JST.Journalarchive/jjrm1964/39.821?from=CrossRef