International Journal of Contemporary Pediatrics
Shah VS et al. Int J Contemp Pediatr. 2025 Dec;12(12):1971-1974
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20253778

Original Research Article

Effects of Pilates on strength of respiratory muscles in obese adolescents: a randomized controlled trial

Vidhi S. Shah[1]*, Mansi Parab[2], Jahanvi T. Patel[3], Atul Varunkar[4]

[1]Department of Neuro-physiotherapy, Dr. D. Y. Patil College of Physiotherapy, Pune, Maharashtra, India
[2]Wadia Hospital, Mumbai, Maharashtra, India
[3]Merchant Physiotherapy College, Mehsana, Gujarat, India
[4]Department of Urology, Dr. D. Y. Patil Medical College, Pune, Maharashtra, India

Received: 09 September 2025
Revised: 09 October 2025
Accepted: 18 October 2025

***Correspondence:**
Dr. Vidhi S. Shah,
E-mail: vidhi.shah@dpu.edu.in

ABSTRACT

Background: Childhood obesity is a significant risk factor for adult obesity, as well as a higher chance of death and impairment later in life. Increased obesity may compromise the function of the respiratory muscles. The main objective is to study the effects of Pilates on strength of respiratory muscles in obese adolescents.
Methods: A randomized controlled trial (RCT) was conducted with 30 (12-19 years) obese adolescents. Participants were randomly allocated into Pilates group and conventional group using the envelop method. Both the groups received intervention for 5 days a week for 4 weeks. They were assessed pre and post intervention for respiratory muscle strength using surface electromyography.
Results: The result showed that there is significant difference within the groups for Pilates and conventional group [spontaneous activity (SPA), quotient of motor unit action potential (QMUP) and maximum voluntary activity (MVA) (p=0.0001)]. There was also significant difference between the groups for respiratory muscle strength [p=0.0077 for spa, 0.0136 for QMUP and 0.0488 for MVA].
Conclusions: The present study concludes that there was significant improvement in the strength of the respiratory muscles in Pilates group when measured using the surface electromyography. Clinically, the Pilates group has better improvement on the strength.

Keywords: Obese adolescents, Pilates, Respiratory muscle strength, Surface electromyography

INTRODUCTION

The period of life between childhood and adulthood, known as adolescence, lasts from the ages of 10 to 19. It is a distinct period in human development and crucial for setting the groundwork for long-term health.[1] Childhood obesity is a significant risk factor for adult obesity, as well as a higher chance of death and impairment later in life.[2] Obesity is defined as having a BMI-for-age that is greater than two standard deviations above the WHO growth reference median.[3]

Increased obesity may compromise the function of the respiratory muscles, presumably due to the strain placed on the diaphragm. The higher resistance imposed by excess adipose tissue on the chest and belly, which produces mechanical disadvantage to these muscles, can explain some of the reported respiratory muscle dysfunction.[4] Surface electromyography is a noninvasive, simple-to-use technique that can be used for long-term monitoring. It detects muscular contractions with remarkable sensitivity.[5] In both young adults and children, good reproducible and high-quality signals of

the diaphragm and intercostals muscles may be acquired using this surface EMG method.[6]

Because of the significant number of deaths caused by the global obesity epidemic each year, national and international institutions have stressed the importance of proper obesity treatment, including effective therapies to prevent and/or reduce disease-related comorbidities.[7]

The Pilates technique is a body and mind fitness programme that is gaining popularity and recognition across the world. It is characterized by no repetitive or strenuous exercise and is able to accommodate the needs of every individual. The intervention programme combines the use of equipment and special devices with movements to increase flexibility, strength, coordination, blood circulation, fitness, range of motion, and postural alignment, among other things. The approach employs low-impact muscle training based on isometric abdominal movements that generate force without motion while also stabilizing the spine. As a result, the approach can be used by persons of any age.[8]

The aim of the study to find out the effect of Pilates on strength of respiratory muscles by using surface electromyography in obese adolescents.

METHODS

Approval from the Institutional ethical committee (DYPCPT/IEC/34/2022) was obtained. The registration number for the CTRI trial is CTRI/2022/09/045765. The obesity screening of subjects was done using IAP 2015 growth charts for taking BMI of the participants. 120 subjects were screened from various government schools of Pimpri Chinchwad Municipal corporation.

The study period was October 2021 to February 2023. The Pilates exercises and surface electromyography was performed at Dr, D. Y. Patil college of physiotherapy, Pimpri. Informed consent was taken from parents of the selected children for participation in the study. Pre and post assessment was done using surface electromyography for the respiratory muscle strength. The electrodes for the surface electromyography were placed: on the 2nd and 7th intercostal level, on the costal margin and at the 2nd lumbar spine level. SPA, QMUP and MVA were recorded. Subjects were not able to see their breathing on the monitor and were advised not to move or speak throughout the tests. The intervention was given to each individual for 5 days a week for 4 weeks. To start with the program, individual started with warm up session followed by the intervention and ended with a cool down session. Statistical analysis was done using Wilcoxon test to compare within group differences and Mann-Whitney U test to compare between group difference. The $p \leq 0.05$ was considered statistically significant. All statistical calculations were done using computer programs, Microsoft excel 2010 (Microsoft Corporation, NY, USA) and MedCalc software version 17.1

Study design

This RCT was conducted in schools and residential areas in and around PCMC, Pune. Obese adolescents between the age group of 12 to 19 years were eligible. The exclusion criterion was adolescent whose cognition is impaired, smoker, musculoskeletal, neurological, cardio-respiratory, psychological condition and juvenile diabetes mellitus. The sample size of the study was taken as 30. Random allocation of the participants was done using the envelope sampling method.

RESULTS

The total numbers of subjects selected for the study were 30. Each group had 15 participants each.

Table 1: Baseline data of participants.

Variables		Pilates	Conventional
Age (in years)		17.26±2.69	17.4±2.65
Gender	Male	33.33%	26.67%
	Female	66.67%	73.33%

Table 2: Pre and post intervention comparision of muscle strength (SPA, QMUP and MVA) in pilates group.

Parameter of sEMG	Pre	Post	Difference	P value
SPA	1.55±0.57	3.41±1.09	1.86±0.86	0.0001
QMUP	10.58±7.89	33.58±12.88	23±10.52	0.0001
MVA	63.26±26.35	120.45±37.56	57.18±37.35	0.0001

Table 3: Pre and post intervention comparisoin of muscle strength (SPA, QMUP and MVA) in conventional group.

Parameter of sEMG	Pre	Post	Difference	P value
SPA	1.41±0.49	2.53±1.01	1.11±0.91	0.0001
QMUP	7.4±8.16	20.46±17.66	13.06±11.12	0.0001
MVA	58.68±21.22	91.33±27.29	32.65±15.12	0.0001

Table 4: Comparison of muscle strength (SPA, QMUP and MVA) in both the group.

Parameter of sEMG	Pilates	Conventional	Difference	P value
SPA	1.86±0.86	1.11±0.91	0.75±1.27	0.0077
QMUP	23±10.52	13.06±11.12	9.94±12.86	0.0136
MVA	57.18±37.35	32.65±15.12	24.53±39.33	0.0488

When both the groups were compared for the respiratory muscle strength, the p=0.0077 for spa, 0.0136 for QMUP and 0.0488 for MVA shows that there is significant difference between the two groups.

DISCUSSION

This study studied the effect of Pilates on the respiratory muscle strength in obese adolescents. The strength was assessed using the surface electromyography. The main finding of the study was that the strength of the respiratory muscles improved in the Pilates group as compared to the conventional group.

In this study the prevalence of obesity was found to be more in females as compared to males. There were more females as compared to males in the study population. Due to significant changes in body composition, insulin sensitivity, eating and activity patterns, and psychological changes, adolescence is considered a "high-risk period" for weight gain. The teenage body experiences physical growth and reproductive maturation as it makes the transition to adulthood. Changes in hormone levels, glucose metabolism, and insulin resistance happen simultaneously with changes in body shape and composition at a velocity that frequently confounds the people who are experiencing it. Many teenagers may find it challenging and uncomfortable to get used to their physical changes. Girls' diet and activity patterns vary during their adolescent years.

Reduced reliance on parental food supplies and food preferences, along with a decline in sport and physical activity participation, can lead to an energy imbalance that increases the risk of weight gain. The likelihood of an adolescent girl sustaining unhealthy amounts of body fat during her reproductive years increases if she gains too much weight during this crucial transitional time.[9]

A study done by Chandra et al to study the prevalence of obesity in children in Hyderabad showed that the prevalence of obesity was more in girls than in boys (32.8% versus 17.3%).[10] One more study done by Ghonge et al to find out the prevalence of obesity and overweight among school children of Pune city showed overall prevalence of obesity was more among female population (6.8%) as compared to that in males (4.62%).[11]

In this study the strength of the respiratory muscles improved in the Pilates group as compared to the conventional group. The positive results found in the strength of respiratory muscles (p<0.0077 for spa, p<0.0136 for QMUP and p<0.0488 for MVA) could be one of the principles of the Pilates method: Breathing. Breathing control is essential when performing PM exercises. Using the Pilates principle of centralization, training in the Pilates technique promotes an increase in the recruitment and activation of the abdominal muscles, especially during the concentric portion of the action. The abdominal muscles also have two inspiratory functions: increased intraabdominal pressure during forced expiration performs a passive stretch of the diaphragm's costal fibres, preparing it for the next inspiration; and the increased pressure generated by the descent of the diaphragm during inspiration must be countered by abdominal muscle tension.

As a result, the central tendon of the diaphragm is not adequately stabilized to accomplish the lateral expansion of the chest wall without effective compliance of those muscles. As a result, in both phases of respiration, an increase in abdominal muscle activity occurs as labour of breathing increases. As a result, abdominal muscular training can lead to improved diaphragmatic function.[8]

A study done by Mateus Beltrame Giacomini et al in sedentary women showed significant improvement in the respiratory muscle strength and performance, MIP (p=0.001) and MEP (p=0.031).[12] A study done by Franco et al in cystic fibrosis patients concluded that Pilates mat exercises have beneficial effects on respiratory muscle strength, MIP in male (p=0.017) and MIP and MEP in females (p=0.005 and p=0.007 respectively).[13]

The limitation of the study was the long-term effects were not evaluated. The future scope of the study is to study the effects of Pilates in various respiratory diseases in pediatric population.

CONCLUSION

The present study concludes that there was significant improvement in the strength of the respiratory muscles in Pilates group when measured using the surface electromyography. Clinically, the Pilates group has better improvement on the strength of respiratory muscles.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. World Health Organisation. Available at: https://www.who.int/health-topics/adolescent-health#tab=tab_1. Accessed on 05 October 2025.
2. McClean KM, Kee F, Young IS, Elborn JS. Obesity and the lung: 1. Epidemiology. Thorax. 2008;63(7):649-54.
3. WHO factsheets: overweight and obesity.
4. Mafort TT, Rufino R, Costa CH, Lopes AJ. Obesity: systemic and pulmonary complications, biochemical abnormalities, and impairment of lung function. Multidiscip Respir Med. 2016;11:28.
5. Caruso P, Albuquerque AL, Santana PV, Cardenas LZ, Ferreira JG, Prina E, et al. Diagnostic methods to assess inspiratory and expiratory muscle strength. J Bras Pneumol. 2015;41(2):110-23.
6. Duiverman ML, van Eykern LA, Vennik PW, Koëter GH, Maarsingh EJ, Wijkstra PJ. Reproducibility and responsiveness of a noninvasive EMG technique of the respiratory muscles in COPD patients and in healthy subjects. J Appl Physiol. 2004;96(5):1723-9.
7. Petridou A, Siopi A, Mougios V. Exercise in the management of obesity. Metabolism. 2019;92:163-9.
8. Niehues JR, Gonzáles I, Lemos RR, Haas P. Pilates Method for Lung Function and Functional Capacity in Obese Adults. Altern Ther Health Med. 2015;21(5):73-80.
9. Todd AS, Street SJ, Ziviani J, Byrne NM, Hills AP. Overweight and obese adolescent girls: the importance of promoting sensible eating and activity behaviors from the start of the adolescent period. Int J Environ Res Public Health. 2015;12(2):2306-29.
10. Chandra N, Anne B, Venkatesh K, Teja GD, Katkam SK. Prevalence of Childhood Obesity in an Affluent School in Telangana Using the Recent IAP Growth Chart: A Pilot Study. Indian J Endocrinol Metab. 2019;23(4):428-32.
11. Ghonge S, Adhav PS, Landge J, Thakor N. Prevalence of obesity and overweight among school children of Pune city, Maharashtra, India: a cross sectional study. Int J Res Med Sci. 2017;3(12):3599-603.
12. Giacomini MB, da Silva AM, Weber LM, Monteiro MB. The Pilates Method increases respiratory muscle strength and performance as well as abdominal muscle thickness. J Bodyw Mov Ther. 2016;20(2):258-64.
13. Franco CB, Ribeiro AF, Morcillo AM, Zambon MP, Almeida MB, Rozov T. Air stacking: effects of Pilates mat exercises on muscle strength and on pulmonary function in patients with cystic fibrosis. J Bras Pneumol. 2014;40(5):521-7.

Cite this article as: Shah VS, Parab M, Patel JT, Varunkar A. Effects of Pilates on strength of respiratory muscles in obese adolescents: a randomized controlled trial. Int J Contemp Pediatr 2025;12:1971-4.