ORIGINAL PAPER

Physiotherapy Quarterly (ISSN 2544-4395)
2024, 32(4), 25–28

Effect of yoga exercises on lung volumes, vital capacity, and attention span in school going students

DOI: https://doi.org/10.5114/pq/172367

Reema Joshi, Manish Rathi, Komal Preet Kaur
Dr. DY Patil College of Physiotherapy, Dr DY Patil Vidyapeeth Pune, India

Abstract

Introduction. The digital age has made children more dependent on digital sources for study and entertainment, which leads to increased physical inactivity that contributes to reduced work breathing and attention. Yogasana can be a promising form of physical activity that improves a child's lung function and attention span if, started at a young age. To find out the effect of yoga exercises on lung volumes, vital capacity, and attention span in school-going children.

Methods. A total of 56 children between the ages of 10–15 years were included using the chit method. The children were randomly divided into 2 groups: group A (yoga group, $n = 27$) and group B (control group, $n = 29$). The students of both groups were assessed for chest expansion, lung volumes, and attention span. Group A (yoga group) was trained to perform yoga exercises 3 days a week for 4 weeks. Group B (control group) children were asked to perform daily activities. At the end of the 4 weeks, post-assessment of both the groups was assessed, documented, and statistically analysed using Wilcoxon signed rank and Mann–Whitney *U*-tests.

Results. Respiratory parameters (FEV_1, FVC/FEV_1, and PEFR), chest expansion, and the attention span of group A were statistically significant compared to group B with a p-value < 0.05.

Conclusions. Yoga exercises led to improvement in lung volumes, vital capacity, and attention in school-going students.

Key words: yoga, lung volumes, attention span, Pranayama

Introduction

School-age children are constantly juggling between their physical activities and their personal obligations to meet academic commitments. As an important time for physical growth as well as mental growth, it requires large amounts of focus, attention, and optimum muscular activity to meet the demand [1].

Pulmonary function is a term that is used to define how the lungs are functioning in helping a person to breathe. Physical activity is important for lung health because physical training improves exercise capacity and outcomes for school-going children. Increased stress brought on by scholastic pressure and digital dependency, further causes reduced work of breathing, leading to reduced lung volumes and capacity [1].

The two most often used lung function indexes are forced expiratory volume in the first second (FEV_1) and forced vital capacity (FVC), which respectively reflect the mechanical characteristics of major airways and the maximum amount of air that can be forcedly expelled from the lungs [2].

FEV_1 is a dynamic measurement of lung volume most often used in conjunction with FVC. Forced expiratory volume measured at 6 seconds is useful because it closely approximates FVC [2]. The ratio of FEV_1/FVC can serve as an independent predictor of subsequent decline in lung function, and FVC is the capacity of the lungs that is decided by the strength of the musculature that helps in contraction and relaxation of the lungs, hence improving efficiency [2].

Attention span is defined as an individual's ability to attend to a stimulus or object over a period of time [3]. Development of the brain continues between the ages of 10–25 years, though the size of brain remains the same, whereas creases or folds keep increasing. Frontal lobe maturation goes on until prefrontal cortex development is accomplished, which is mainly responsible for all executive functions of the nervous system, including attention. Lack of attention among children causes their perception of understanding, and the environment becomes meaningless and perplexing. Cognitive processes like comprehension and reasoning heavily depend on attention in academics [4]. Attention span contains many processes, such as visual scanning, mental flexibility, sustained attention, psychomotor speed, and information processing speed [5]. Mental flexibility, working memory, selective attention, and sustained attention are critical qualities for academic and professional success as they allow children to intentionally focus on a particular target in the environment and to avoid distraction over time, and it is strongly influenced by the amount of learning. Improvement in school-going children can be achieved by improving the qualities of traditional lecture patterns in selected schools highlighting a strong need to address this problem.

Family conditions and the home environment also contribute to a greater extent on the reduction of attention span in childhood, as it helps children to get oriented and examine objects in their environment. The financial background of the child has also been seen as a reason for reduced sustained attention due to peer pressure caused by social isolation and lower confidence [6].

Combining meditation with the relaxing aspects of yoga can help one to achieve a level of mental equilibrium. Studies have shown that meditation primarily engages the parasympathetic nervous system, which calms the mind and lessens anxiety and stress [7].

Yoga is a learning strategy that has its roots in India and strives to achieve the union of the mind, body, and spirit through its three primary components: exercise, breathing, and meditation [8].

Correspondence address: Reema Joshi, Dr. DY Patil College of Physiotherapy, Sant Tukaram Nagar, Pimpri Pune, India,
e-mail: jreema181@gmail.com; https://orcid.org/0000-0001-7467-9990

Received: 03.03.2023
Accepted: 15.09.2023

Citation: Joshi R, Rathi M, Kaur KP. Effect of yoga exercises on lung volumes, vital capacity, and attention span in school going students. Physiother Quart. 2024;32(4):25–28; https://doi.org/10.5114/pq/172367.

Pranayama is the fourth limb of ancient Ashtanga yoga that consists of breathing techniques consisting of slow and fast breathing along with breathing control for varying time periods that improves cardiovascular and respiratory functions by increasing the work of breathing. Breath control works to increase lung compliance and also improves lung capacity by reducing physiological dead space ventilation [9].

Yogasanas is a combination of physical stances and correct breathing practices that help the body and mind to maintain overall equilibrium. Yogasanas not only reduce stress and anxiety but also work on concentration and focused attention, which is used to maintain a static balance while performing the asana, leading to a remarkable improvement in attention span [10].

Subjects and methods

A randomised control trial was performed where 278 healthy school children between the ages of 10–15 years were screened for chest expansion measures less than 4 cm. Obese students with a BMI higher than the 85 percentile but less than the 95 percentile were classified as overweight [11] and those who are willing to perform yoga exercises were included and children diagnosed with medical conditions like bronchial asthma and any neurological condition were excluded from the study. Accordingly, 56 children were included in the study and were randomly divided using the chit method into 2 groups: group A (yoga group, $n = 27$) and group B (control group, $n = 29$) to avoid any bias in the study. Both groups of students finished the study. Pre- and post-assessments were performed for pulmonary function and attention span.

Assessments

For pulmonary function tests, a portable spirometer was used for assessment. Subjects were asked to sit in a chair while the procedure was explained. The subject was asked to take 2–3 normal tidal breaths and then inspire, a nose clip was applied, and then were asked to blow out the air continuously till the investigator said to stop. The same procedure was repeated, and readings were taken for FVC, FEV_1, the ratio of FVC/FEV_1, and peak expiratory flow rate (PEFR).

Single letter cancellation task (SLCT) is easy to understand and easy to administer in children. The task requires pen and paper where children need to search for the targeted letter and cancel or slash them in a given period of time of 90 s. For the scoring, we have to calculate the cancelled letters and the number of wrong letters that are cancelled. The net score is calculated by deducting the latter from the former [5].

Interventions

Group A students were given the whole protocol of Ashtang Yoga, which includes Yogasanas (Tadasana, Ustrasana, Phalakasana) and meditation followed by Pranayama for beginners, specifically anulom vilom along with the duration and how to perform it on the first day. Group B students were asked to remain active and conduct routine work like walking, running, jogging, and playing.

Yogasana was performed for 30 min (Yogasana for 10 min, Pranayama 10 min, and meditation for 10 min), once a day, 3 days a week for 4 weeks resulting in 12 supervised sessions. The progression in time duration was performed at 1 min per component until the 4th week.

Students were trained for transcendental meditation, which is based on mantras like OM chanting, while students were in a seated position like Padmasana/Sukhasana in a comfortable sitting position and were instructed to focus on breathing by closing their eyes and instructed to take a deep breath and repeating OM as long as they can pronounce. Transcendental meditation is a considerably non-religious method for relaxation, stress, and self-consciousness.

Post-intervention

At the end of the 4 weeks, all the studied parameters were measured again for both groups as post-test data with the same methods and were documented and analysed.

Statistical analysis

The data was analysed using SPSS software version 21. The Shapiro–Wilk test was applied to assess the normal distribution of the data using Q-Q plots and histograms. Normality was not found ($p \geq 0.005$), hence a non-parametric test was applied (Wilcoxon signed rank test) to check for the difference between pre- and post-interventions. The general characteristics and pre-study parameters maintained homogeneity. Data was summarised in mean and *SD* values and analysed to give results.

Results

Table 1 shows the sample's characteristic features, which include ages, genders, heights, weights and calculated BMIs. In this study, the mean age of group A (yoga exercises) was 11.64 ± 0.55, and group B (control group) was 11.67 ± 0.47. On statistical analysis, the *p*-value was > 0.005 and there was no significant difference between both groups.

Table 2 presents the group analysis of group A (experimental group), indicating Yogasana meditation showed a significant difference in lung volumes (FEV1), capacity (FVC), and PEFR with a *p*-value < 0.005; however, FVC/FEV_1 did not show a statistical difference. Similarly, within the group analysis of group B (control group), FVC and FVC/FEV_1 were statistically significant with *p*-values < 0.005, whereas FEV_1 and PEFR did not show any statistical differences.

Table 3 presents the group comparisons of pre- and post-attention span in group A (experimental group), showing statistically significant differences with a *p*-value < 0.005 compared to the control group.

Table 1. Baseline characteristics of participants

Characteristics	Group A ($n = 27$) mean ± *SD*	Group B ($n = 29$) mean ± *SD*	*p*-value
AGE (years)	11.70 ± 0.54	11.62 ± 0.49	0.55
BMI	35.94 ± 15.76	36.23 ± 12.16	0.93
FVC	1.65 ± 0.60	1.72 ± 0.84	0.083
FEV_1	1.24 ± 0.49	1.42 ± 0.58	0.38
FVC/FEV_1	80.56 ± 20.56	87.95 ± 21.09	0.90
PEFR	175.86 ± 35.50	173.70 ± 45.50	0.20
Attention span	54. 51 ± 30.23	71.81 ± 41.30	0.10

BMI – body bass index, FVC – forced vital capacity
FEV_1 – forced expiratory volume in 1 second
FVC/FEV_1 – ratio of forced vital capacity upon forced expiratory volume in 1 second, PEFR – peak expiratory flow rate

Table 2. Within group analysis of study participants

Characteristics	Pre (mean ± *SD*)	Post (mean ± *SD*)	*p*-value
Group A (*n* = 27)			
FEV_1	1.24 ± 0.49	1.80 ± 0.24	0.002
FVC	1.65 ± 0.60	2.39 ± 0.31	0.0008
FVC/FEV_1	80.56 ± 20.56	81.86 ± 2.49	0.88
PEFR	175.86 ± 35.50	226.78 ± 58.62	0.0008
attention span	54.51 ± 30.23	108.82 ± 54.66	0.0001
Group B (*n* = 29)			
FEV_1	1.42 ± 0.58	1.40 ± 0.42	0.81
FVC	1.72 ± 0.84	2.17 ± 0.46	0.005
FVC/FEV_1	87.95 ± 21.09	64.06 ± 13.77	< 0.0001
PEFR	173. 70 ± 45.50	165.71 ± 42.02	0.13
attention span	71.81 ± 41. 30	78.71 ± 54.88	0.60

FVC – forced vital Capacity, FEV_1 – forced expiratory volume in 1 second, FVC/FEV_1 – ratio of forced vital capacity upon forced expiratory volume in 1 second, PEFR – peak expiratory flow rate

Table 3. Between-group analysis of study participants

Characteristics	Group A (mean ± *SD*)	Group B (mean ± *SD*)	*p*-value
FEV_1	1.79 ± 0.23	1.39 ± 0.42	0.0001
FVC	2.38 ± 0.30	2.17 ± 0.47	0.05
FVC/FEV_1	81.65 ± 12.32	63.63 ± 13.84	0.0001
PEFR	225.86 ± 57.78	164.44 ± 42.27	0.0001
Attention span	107.96 ± 54.66	78.51 ± 55.91	0.04

FVC – forced vital capacity, FEV_1 – forced expiratory volume in 1 second, FVC/FEV_1 – ratio of forced vital capacity upon forced expiratory volume in 1 second, PEFR – peak expiratory flow rate

Discussion

This study was conducted to find the efficiency of yoga on lung functions, volume, and attention span in a population of school-going children (aged between 10–15). In Table 1, all the baseline parameters, along with the pre-assessment values, were statistically insignificant, and the samples were homogeneous without any bias except for attention span. This could be because the study was performed in a school where the authorities were informed about purpose of the study, and thus samples in the experimental group were intentionally selected with decreased attention spans compared to the control group.

When comparing the two groups, group A showed a significant increase in pulmonary function tests in particular FEV_1, FVC/FEV_1, and PEFR values. In this study, FEV_1 was statistically significant in group A. The result may be due to the fact that during Pranayama yoga, the lungs expand, which increases lung compliance, and the airway resistance decreases, leading to efficient movement of the diaphragm and an increase in lung volume. Our results were supported by those who found short-term yoga exercises improve lung volumes and breath holding in children aged 10–12 years and further improve cardiovascular endurance [11]. D'souza and Avadhany [12] stated that breathing exercises open the small airways in the lungs and reduce the airway resistance and showed short durations of yoga therapy can also improve lung volumes and function in children aged 7–9 years at the end of 3 months of yoga training.

PEFR was also found to be improving in group A which can be due to stimulation of the pulmonary stretch receptors resulting from maximum inflation of the lungs. These stretch receptors reflexively relax the smooth muscle of the larynx and tracheobronchial tree. This, in turn, modulates the airway calibre, reducing airway resistance and increasing PEFR after Pranayama practice. Jasrotia et al. [13] supported this study's results by stating that yoga helps asthmatics as well as healthy children cope better with vigorous physical activities.

In the present study, both groups showed a beneficial effect on FVC, suggesting that Yogasana is as effective as being active throughout the day. A study stated that 6 months of yoga training has a favourable effect on respiratory muscle strength [10].

In this study, the pre-intervention values for the attention span of group A showed that the attention span was reduced in this age group which could be because the children participated in the study with a mean age of 11 ± 0.64. At this adolescent age, the brain continues to be refined and develop morphologically until complete cognitive development occurs. At this age, advances in brain frontal lobe maturation occur and progress to the primary motor cortex, and finally, the prefrontal cortex matures, which primarily monitors attention and may affect critical reading and writing skills in adolescent which affects their academic performance [14, 15]. The World Health Organization (WHO) created a set of physical activity guidelines that suggested that children should perform 60 min of vigorous to moderate physical activity each day to benefit psychological well-being as well as promote better cognitive development in adolescents [16].

The attention span in group A was statistically significant after the 4 weeks of yoga practice in this study. The reason for such significant results might be that Yogasanas are utilised to build inner strength of the mind and concentration which promotes mental and emotional equilibrium. Our results were supported by those who stated that Yogasanas are an option to stimulate social and emotional intelligence and also improve concentration while allowing movements that could stimulate the growth and development of the brain [17].

Improved results of attention span can also be due to the type of Yogasanas practised in this study, as Tadasana, Phalakasana, and anulom vilom require intense concentration and sustained attention, which instantly increases a child's ability for prolonged attention when performed for prolonged time periods which is noticed later while performing a variety of tasks leading to improved academic performance. A pilot study that supported our results that yoga can improve sustained attention in children and has positive effects on sustained attention in 7–8-year-old children. This is because Yogasana uses purposeful meditation, including Pranayama, to help enhance blood flow to the brain, including the prefrontal cortex helping improve attention span and other executive functions [18].

This study demonstrates how yoga, when practised for the recommended amount of time, can increase schoolchildren's lung capacities, compliance, and attention span. Therefore, yoga practice should be encouraged in schools so that their academic performance can be enhanced.

Conclusions

The study concluded that regular practice of Ashtanga yoga, including meditation-focusing breathing techniques,

helps to enhance pulmonary functions as well as cognitive functions such as attention span in adolescents.

Acknowledgements

We would like to thank the Indian Academy of Fitness Training, Mangalore, India and Dr. DY Patil College of Physiotherapy, and Pune, India, for providing their support during the study.

Ethical approval

The research related to human use has complied with all relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Ethical Committee (approval No.: DYPCPT/ISEC/43/2022).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

Funding

This study was partially funded by the Indian Academy of Fitness Training, Mangalore, India.

References

[1] Galantino ML, Galbavy R, Quinn L. Therapeutic effects of yoga for children: a systematic review of the literature. Pediatr Phys Ther. 2008;20(1):66–80; doi: 10.1097/PEP.0b013e31815f1208.

[2] Gold WM, Koth LL. Pulmonary function testing. In: Broaddus VC, Ernst JD, Lazarus SC, Nadel JA, Gotway MB (eds.) Murray and Nadel's Textbook of Respiratory Medicine. 2016: pp. 407–35.e18; doi: 10.1016/B978-1-4557-3383-5.00025-7.

[3] Bradbury NA. Attention span during lectures: 8 seconds, 10 minutes, or more?. Adv Physiol Educ. 2016;40(4):509–13; doi: 10.1152/advan.00109.2016.

[4] Sreenivas SB, Sujan MU, Trishala D, Ramachandran S, Shashidhara YN. Effectiveness of yoga on attention of medical students: a prospective study. Biomed. 2022;42(1):91–7.

[5] Van der Elst W, van Boxtel MP, van Breukelen GJ, Jolles J. The Letter Digit Substitution Test: normative data for 1,858 healthy participants aged 24–81 from the Maastricht Aging Study (MAAS): influence of age, education, and sex. J Clin Exp Neuropsychol. 2006;28(6):998–1009; doi: 10.1080/13803390591004428.

[6] Razza RA, Martin A, Brooks-Gunn J. Associations among family environment, sustained attention, and school readiness for low-income children. Dev Psychol. 2010;46(6):1528; doi: 10.1037/a0020389.

[7] Pradhan B, Nagendra HR. Immediate effect of two yoga-based relaxation techniques on attention in children. Int J Yoga. 2010;3(2):67–9; doi: 10.4103/0973-6131.72632.

[8] Chanavirut R, Khaidjapho K, Jaree P, Pongnaratorn P. Yoga exercise increases chest wall expansion and lung volumes in young healthy Thais. Int J Yoga. 2006;19(1):1–7.

[9] Kuppusamy M, Dilara K, Ravishankar P, Julius A. Effect of Bhrāmarī prā-āyāma practice on pulmonary function in healthy adolescents: a randomised control study. Anc Sci Life. 2017;36(4):196–9; doi: 10.4103/asl.ASL_220_16.

[10] Akhani P, Banode S, Shah N. Effect of 4 weeks yoga practice on respiratory function tests in young adults. Natl J Physiol Pharm Pharmacol. 2019;9(6):493–7; doi: 10.5455/njppp.2019.9.0309122032019.

[11] Joshi R, Rathi M, Kulkarni N, Kathewadi F. Efficacy of yoga therapy on lung functions and lung volumes in children – a experimental study. Indian J Physiother Occup Ther. 2021;15(2):1–7; doi: 10.37506/ijpot.v15i2.14499.

[12] D'souza C, Avadhany ST. Effects of yoga training and detraining on physical performance measures in prepubertal children – a randomised trial. Indian J Physiol Pharmacol. 2014;58(1):61–8; doi: 10.4103/0973-6131.123478.

[13] Jasrotia RB, Mondal S, Gandhi A, Kumar V. A quasi-experimental study of the effects of yogic practices on pulmonary functions and exercise-induced bronchial lability in children with controlled asthma. Int J Med Sci Public Health. 2019;8(12):1046–51; doi: 10.5455/ijmsph.2019.0824128092019.

[14] Rabiner DL, Carrig MM, Dodge KA. Attention problems and academic achievement: do persistent and earlier-emerging problems have more adverse long-term effects? J Atten Disord. 2016;20(11):946–57; doi: 10.1177/1087054713507974.

[15] Adolescent and young adult health. Available from: https://www.who.int/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions (12.08.2021).

[16] WHO Guidelines on Physical Activity and Sedentary Behaviour. Recommendations. Geneva: WHO; 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK566046/ (08.11.2021).

[17] Dewi KAP PF. The Stimulation of elementary school students' social-emotional development through Yoga Asanas. Hinduism Milleneal Era. 2019; doi: 10.33363/internasional-seminar.v0i1.26.

[18] Kiselev S. Yoga exercises can improve sustained attention in children with ADD. Eur Psychiatry. 2021;64(Suppl 1):214; doi: 10.1192/j.eurpsy.2021.569.