ORIGINAL RESEARCH PAPER

Nâdi Shodhan Pranâyâma: A Promising Intervention in Improving PEFR and AQOL in Adolescent Girls

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ARTICLE INFO	ABSTRACT

This pilot study under CCRAS SPARK evaluated the effectiveness of *Nadi Shodhan Pranayama* on pulmonary function, specifically peak expiratory flow rate (PEFR), and its impact on the quality of life in adolescents. The randomized controlled trial involved 60 healthy adolescents aged 12–15 years, divided equally into an intervention group practicing *Nâdi Shodhan Pranâyâma* (NSP) for 15 min daily for 3 weeks and a control group (CG) following usual activities for 3 weeks. The PEFR measurements were recorded at baseline and post-intervention. The quality of life was assessed using the KIDSCREEN 10 questionnaire. The results showed a significant improvement in PEFR values in the NSP group compared with the CG ($P < 0.0001$). In addition, the NSP group exhibited a marked enhancement in overall quality of life, suggesting that NSP is an effective, non-pharmacological intervention for enhancing pulmonary function and quality of life in adolescents. Further research is needed to explore the long-term effects and potential mechanisms underlying the benefits of NSP.

1. INTRODUCTION

If you were drowned at sea, I would give you my lungs so you could breathe,[1] but if your lungs are not Bonafide then you cannot!" Moreover, the post-covid scenario is indeed a drowning phase for everyone's lungs and deteriorating health. It has been noticed that up to 75% of the affected population failed to regain normal health after recovering from COVID-19, including children and adolescents.[2] A recent study found that almost 1/3rd of children had developed psychosocial problems, presenting as symptoms of anxiety and depression, suicidal ideation, etc.[3] An unprecedented challenge in the form of lingering respiratory symptoms such as chest pain, dyspnea, cough, trouble breathing during exercises, anxiety, depression, and sleep disturbances is also seen irrespective of age, gender, etc. As per Global Burden of Diseases, 2017, India has one of the highest burdens of chronic respiratory diseases (CRD) and contributes 15.69% of global CRD.[4] Children with lasting symptoms may need a lung function test or peak expiratory flow rate (PEFR) to check their lung efficacy. "Peak Expiratory Flow Rate" is a measure of how quickly a person can exhale air from their lungs. It is essential in monitoring disease progression and response in asthma treatment. Ayurveda aims for reinstating health and this has been successfully accomplished by Yogic practices.[5] One such miraculous practice is Pranayama which focuses on improving *Pranic* (vital) energy in the body. It is well elaborated in Hatha Yoga Pradipika' "*Pranayamamam tatah kuryannium saatvikaya dhaya, yatha sushumnanadistha malah shudhim prayanti ch.*"[6] When the whole system of *nâdis,* which is full of impurities, is cleaned, then the yogi becomes able to control the *Prâna.* The purpose of this study is to examine the effectiveness of *Nâdi Shodhan Pranâyâma* (NSP) in ameliorating quality of life comprising general well-being and pulmonary function in relation to PEFR in children. NSP has unequivocal effects in improving lung function by increasing oxygen intake and promoting better respiratory efficiency hence PEFR of lungs and harmonizing the left and right hemispheres of the brain.[7]

1.1. Objectives

1. To estimate the efficacy of NSP on pulmonary function in relation to PEFR
2. To compare the baseline PEFR with age-appropriate PEFR
3. To study the impact of NSP on adolescent quality of life (AQOL)
4. To establish the association between pulmonary function and quality of life through NSP

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5. To offer evidence-based recommendations for individuals seeking non-pharmacological interventions to enhance their respiratory well-being.

2. MATERIALS AND METHODS

2.1. Study Design and Study Type

This study is based on a randomized control trial and the study population was selected through screening by a cross-sectional study pattern.

2.2. Diagnostic Criteria

2.2.1. Eligibility criteria

Participants were selected when they met the complete inclusion criteria and exhibited none of the exclusion criteria accepted for the study.

2.2.2. Inclusion criteria

a. School-going adolescents between 12 and 15 years of age group
b. Participants are to be in good general health and not have any known respiratory disorders or other clinical disabilities
c. No prior experience with NSP.

2.2.3. Exclusion criteria

a. Children of age group below 12 years and above 15 years
b. Previous experience with NSP
c. Any medical condition that would contraindicate *pranâyâma* practice
d. Children with respiratory illness.

2.2.4. Discontinuation criteria

a. Participants practicing the NSP procedure irregularly or in an ineffective manner
b. Participants with incompletely or inaccurately filled record form
c. Participants who are not able to perform PEFR as per prescribed protocol.

2.3. Study Setting

2.3.1. The proposed study comprises two salient phases

a) Phase 1 – The study population of healthy adolescents was identified based on screening with:
    *   Asthma and allergy symptom test from the American College of Allergy, Asthma, and Immunology checklist
    *   KIDSCREEN 10 – questionnaire for AQOL from the KIDSCREEN Group, 2004 (kidscreen.org)
    *   A total of 80 students were screened out in this phase. Out of 80, only 60 participants were enrolled in the phase two study
b) Phase 2 – The identified population of 60 participants was randomly recruited by lottery method into two groups, namely
    *   Intervention group (IG) – this group included 30 participants whom NSP intervened
    *   Control group (CG) – this group included 30 participants without any intervention. Baseline PEFR and AQOL were assessed in both groups before intervention.

2.4. NSP Intervention

i. Commencement of NSP in IG and practice for;
    *   Study duration – 3 consecutive weeks
    *   Sessions – two sessions per day
    *   Timings – morning and evening
    *   Time – 15 min for each session.

As our selected study population is of the early adolescent age group, so we considered "ADHAMA MATRA" (least proportionate time) of NSP (alternate nostril breathing) as per Gheranda Samhita, i.e., *Pooraka for 12 matras, Kumbhaka for 48 matras, and Rechaka for 24 matras.*

According to Gheranda Samhita – *uttama vimshatir matra madhyama shodashi smruta. adhama dvadashi matra pranayamastridha smrutah||(Gheranda Samhita 5/55).*[8]
ii. After intervention, again assessment of PEFR using a Peak flow meter and AQOL using the KIDSCREEN 10 checklist was done.

2.5. Materials Used

a) Instrument – In the current study we used a peak flow meter as an assessment tool to evaluate PEFR readings.
b) Checklists
    i. Asthma and allergy symptom test from the American College of Allergy, Asthma, and Immunology checklist.
    ii. KIDSCREEN – 10 Questionnaires.

2.6. Approved by Institutional Ethics Committee

The ethical principles followed in the study are:
A. Beneficence – (a) Freedom from harm and discomfort: Participants were not subjected to any risks for harm or discomfort during the study period. (b) Protection: Information provided by the participants was protected and not used against them in any way.
B. Respect for human dignity – The investigator followed the ethical principle of respect for human dignity. It includes the right to determination and the right to self-disclosure.
C. Justice: The researcher adhered to the ethical principle of justice; it includes participants' right to fair treatment and right to privacy.

3. OBSERVATIONS AND RESULTS

Screening of a total of 80 participants was done before the intervention. Out of 80, 20 participants were dropped out due to incompletely filled questionnaires, underlying health issues, unwillingness to participate in the study, etc.

As per Table 1 in the IG, with regard to the age in years, 17 (56.7%) participants were between the age group of 13–15 years, and 13 (43.3%) were 12 and <12 years of age. In the CG, with regard to the age in years, 23 (76.7%) participants were between the age group of 13–15 years, and 7 (23.3%) were 12 and <12 years of age.

Table 2 and Graph 1 show: The pre-NSP level of PEFR in the IG revealed that 16 (53.3%) of participants had age-appropriate PEFR values, and PEFR values of 14 (46.7%) participants were not age-appropriate. The post-test level of PEFR in the IG revealed that 25 (83.3%) of participants had age-appropriate PEFR values, and PEFR values of 5 (16.7%) participants were not age-appropriate. The pre-test level of PEFR in the CG revealed that 17 (56.7%) of participants had age-appropriate PEFR values, and the PEFR values of 13 (43.3%) participants were not age-appropriate. The post-test level of PEFR in the CG revealed that 15 (50%) of participants had age-appropriate PEFR values, and PEFR values of 15 (50%) participants were not age-appropriate.

Table 3 shows that, in the IG, the pre-test mean score of PEFR was 274.33 with a standard deviation (S.D) of 58.53, and the post-test mean score of PEFR was 324.00 with S.D 62.46. The calculated paired "t" value t = 8.2187 was found to be statistically significant at $P < 0.0001$

level. This clearly shows that the implementation of *Nadi Shodhana Pranayama* had shown a significant improvement in the post-test level of PEFR among participants in the IG than the participants in the CG.

In CG, the pre-test mean score of PEFR was 308.00 with S.D 79.59, and the post-test mean score of PEFR was 313.00 with S.D 74.61, and the calculated paired "t" value t = 0.2404 was found to be statistically no significant at $P > 0.05$ level. This clearly shows that practicing *Nadi Shodhana Pranayama* had shown a significant improvement in their post-test level of PEFR in the IG than the participants in the CG.

Table 4 shows that, in the IG, the post-test mean score of PEFR was 324.00 with S.D 62.46. In the CG, the post-test mean score of PEFR was 313.00 with S.D 62.46. The calculated unpaired "t" value t = 0.6192 was found to be not statistically significant at the $P = 0.5382$ level. As per the protocol of the current study, randomization of the participants in both groups was done by lottery method, the baseline PEFR in the CG showed a higher range of PEFR as compared to the IG. Hence, on unpaired T-test evaluation, statistically insignificant results were obtained.

Tables 5 and 6, Graph 2 show: The pre-test level of AQOL in IG revealed that 5 (16.7%) of participants had their overall health excellent, 12 (40%) had very good health, 11 (36.6%) had good health, 2 (6.7%) had fair health. The post-test level of AQOL in IG revealed that 14 (46.7%) of the participants had their overall health excellent, 10 (33.3%) had very good health, 3 (10%) had good health, 1 (3.3%) had fair health, 2 (6.7%) had poor health.

The pre-test level of AQOL in CG revealed that 8 (26.7%) of participants had their overall health excellent, 10 (33.3%) had very good health, 7 (23.3%) had good health, and 5 (16.7%) had fair health. The post-test level of AQOL in CG revealed that 10 (33.3%) of participants had their overall health excellent, 15 (50%) had very good health, 4 (13.3%) had good health, and 1 (3.4%) had fair health.

4. DISCUSSION

This study was conducted at Kanya Gurukul Senior Secondary School, BPSMV, Khanpur Kalan, Sonipat. The data were collected in 2 months from February to April before commencing NSP. Prior permission from the authorities was obtained. The objective and purpose of the study were explained, and confidentiality was maintained. The investigator gave brief information about self and the purpose of the study to the participants.

They were assured that no physical or emotional harm would be done in the course of the study. The participants were selected by a simple random sampling technique based on sample selection criteria. A total number of of 60 adolescents were recruited in the study for intervention and CG, out of which each group containing 30 subjects. The participants were made to sit comfortably in a well-ventilated room, and confidentiality regarding the data was assured. After obtaining informed consent from parents and assent from adolescents for willingness to participate in the study was obtained. The investigator conducted the pre-test to assess the PEFR and AQOL in the experimental and CG.

The participants of the IG were taught to practice *Nadi Shodhana Pranayama* daily for 21 days 2 sessions per day each of 15 min at 6:30 am and 6:30 pm by investigators. The CG received routine school activities. At the end of the 3rd week (21 days), a post-test was conducted to assess the PEFR and AQOL in the intervention and CG.

4.1. The First Objective was to assess and Compare the Pre- and Post-test Levels of PEFR among Adolescents in the Intervention and CG

- The analysis of the pre-test level of PEFR in the IG revealed that 16 (53.3%) of participants had age-appropriate PEFR values and PEFR values of 14 (46.7%) participants were not age-appropriate. The analysis of the post-test level of PEFR in the IG revealed that 25 (83.3%) of participants had age-appropriate PEFR values and PEFR values of 5 (16.7%) participants were not age-appropriate. The analysis of the pre-test level of PEFR in the CG revealed that 17 (56.7%) of participants had age-appropriate PEFR values and the PEFR values of 13 (43.3%) participants were not age-appropriate. The analysis of the post-test level of PEFR in the CG revealed that 15 (50%) of participants had age-appropriate PEFR values and the PEFR values of 15 (50%) participants were not age-appropriate.
- The reasons why some participants have PEFR which is not age-appropriate might include factors such as Nutritional deficiency (hostlers), any persisting illness, respiratory issues, and not appropriate height and weight. However, here we have selected healthy participants as per screening.

In the IG, the pre-test mean score was 274.33 with a standard deviation of 58.53 and the post-test mean score was 324.3 with a standard deviation of 62.46. The calculated paired "t" value was 8.2187 which was highly significant at $P < 0.0001$. This clearly shows that the implementation of *Nadi Shodhana Pranayama* enhanced the PEFR among Adolescents in the IG than the CG.

This data of the present study has been supported by a few previous studies such as a study conducted by Sivapriya *et al*. (2010) to assess the effectiveness of *Nadi Shodhana Pranayama* on respiratory parameters in school students. The sample size was 115 of the 8–14 age group. The practice of *Nadi Shodhana Pranayama* was done for 45 days. The result revealed that there is a significant improvement in PEFR after the practice of *Pranayama.* The students paired *t*-test was used to compare Pre- and post-training values. The increase is statistically significant ($P < 0.0001$).

4.2. The Second Objective to Assess and Compare the Pre- and Post-test Levels of PEFR among Adolescents between Intervention and CG

In the IG, the post-test mean score of PEFR was 324.00 with S.D 62.46. In the CG, the post-test mean score of PEFR was 313.00 with S.D 62.46. The calculated unpaired "t" value t = 0.6192 was found to be not statistically significant at the $P = 0.5382$ level. As per the protocol of the current study, randomization of the participants in both groups was done by lottery method, the baseline PEFR in the CG showed a higher range of PEFR as compared to the IG. Hence, on unpaired *t*-test evaluation, the statistically insignificant results were obtained.

4.3. The Third Objective was to Assess and Compare the Pre- and Post-test Levels of Quality of Life among Adolescents in Intervention and CG

- The analysis of the pre-test level of AQOL in IG revealed that 5 (16.7%) of participants had their overall health excellent, 12 (40%) had very good health, 11 (36.6%) had good health, and 2 (6.7%) had fair health
- The analysis on post-test levels of AQOL in IG revealed that 14 (46.7%) of participants had their overall health excellent, 10 (33.3%) had very good health, 3 (10%) had good health, 1 (3.3%) had fair health, 2 (6.7%) had poor health

- The analysis on the pre-test level of AQOL in CG revealed that 8 (26.7%) of participants had their overall health excellent, 10 (33.3%) had very good health, 7 (23.3%) had good health, 5 (16.7%) had fair health
- The analysis of the post-test level of AQOL in the CG revealed that 10 (33.3%) of the participants had their overall health excellent, 15 (50%) had very good health, 4 (13.3%) had good health, and 1 (3.4%) had fair health.

The reasons for diminished quality of life may include factors such as health issues, personal life stressors, family problems, academic pressure, or significant life changes. These could negatively impact one's quality of life. NSP has a variety of significant effects on physical, mental, and cognitive functions. Hence, after post-intervention the improvement in AQOL has been observed. Moreover, the current acute illness of two participants had contributed to poor health status on AQOL screening.

Assessment of AQOL in both IG and control is done by the KIDSCREEN questionnaire which is based on participants' overall health condition and rated as, i.e., excellent, very good, good, fair, or poor. Based on the raw score of the rating, the percentage is calculated on pre- and post-SNP. Hence, statistical analysis by the "t" test is not applicable here.

5. CONCLUSION

- The present study assessed the pulmonary health of adolescents where 27 (45%) of total participants (60) in both IG and CG showed that their PEFR values were not age.
- Appropriate before the commencement of NSP. Post-NSP the level of PEFR in the IG revealed that 25 (83.3%) out of 30 participants had age-appropriate PEFR. This shows the highly effective results of NSP on pulmonary health
- The study findings concluded that there was a statistically significant difference in the level of PEFR. A significant difference is also seen in adolescent quality of life after practicing *Nadi Shodhana Pranayama*
- In a nutshell, NSP is proving to be an effective alternative adjunct therapy and non-pharmacological therapy to improve pulmonary functions and quality of life.

7. AUTHORS' CONTRIBUTIONS

All the authors contributed equally to the design and execution of the article.

9. ETHICAL APPROVALS

This study is approved by the institutional ethical committee.

10. CONFLICTS OF INTEREST

CCRAS, New Delhi has initiated the Spark 2023–24 program to install research orientation in undergraduate students. They have sponsored this program with a studentship amount of rupees 50,000 after submitting the final research report. We have no conflict of interest to disclose other than this.

11. DATA AVAILABILITY

This is an original manuscript, and all data are available for only review purposes from principal investigators.

12. PUBLISHERS NOTE

This journal remains neutral with regard to jurisdictional claims in published institutional affiliation.

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Table 1: Frequency and percentage distribution of demographic variable in respect to age

Age group	Intervention group (*n*=30)		Control group (*n*=30)	
	f	**%**	**f**	**%**
13–15 years	17	56.7	23	76.7
12 and <12 years	13	43.3	07	23.3

Table 2: Pre- and post-test levels of age-related PEFR among adolescents within intervention and control group

PEFR	Intervention group (*n*=30)				Control group (*n*=30)			
	Pre-NSP		**Post-NSP**		**Pre-NSP**		**Post-NSP**	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Age appropriate PEFR	16	53.3	25	83.3	17	57.7	15	50.0
Not age-appropriate PEFR	14	46.7	5	16.7	13	43.3	15	50.0

PEFR: Peak expiratory flow rate, NSP: *Nâdi Shodhan Pranâyâma*

Table 3: Comparison of pre- and post-test levels of PEFR among participants in the intervention and control group

S. No	Group	Pre-NSP		Post-NSP		Paired "t" test
		Mean	**SD**	**Mean**	**SD**	
1	Intervention	274.33	58.53	324.00	62.46	t=8.2187 $P<0.0001$S
2	Control	308.00	79.59	313.00	74.61	t=0.2404 $P=0.8117$NS

*$P<0.05$, **$P<0.01$, ***$P<0.001$, S: Significant, NS: Non-significant, PEFR: Peak expiratory flow rate, NSP: *Nâdi Shodhan Pranâyâma*

Table 4: Comparison of post-test level of PEFR among adolescents between intervention and control group

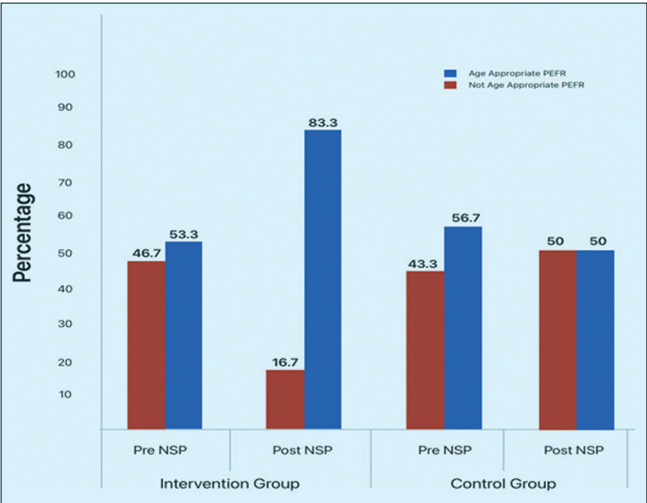| S. No	Group	Post-NSP		Unpaired "t" test
		Mean	**SD**	
1	Intervention (*n*=30)	324.00	62.46	t=0.6192NS
2	Control (*n*=30)	313.00	74.61	

PEFR: Peak expiratory flow rate, NSP: *Nâdi Shodhan Pranâyâma*

Table 5: Description of Pre-test level of AQOL among adolescents within intervention and control group

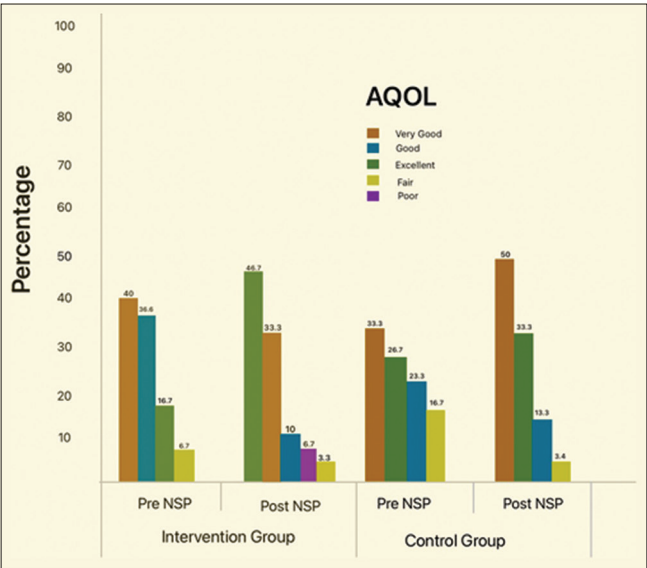| Group	Overall health pre-NSP					Total participants
	Excellent	**Very good**	**Good**	**Fair**	**Poor**	
			f			
Intervention	05	12	11	02	00	30
Control	08	10	07	05	00	30

NSP: *Nâdi Shodhan Pranâyâma*, AQOL: Adolescent quality of life

Table 6: Description of post-test level of AQOL among adolescents within intervention and control group

Group	Overall health post-NSP					Total participants
	Excellent	**Very good**	**Good**	**Fair**	**Poor**	
			f			
Intervention	14	10	03	01	02	30
Control	15	10	04	01	00	30

AQOL: Adolescent quality of life

Graph 1: Percentage distribution of pre- and post-test level of age-appropriate peak expiratory flow rate in intervention and control group

Graph 2: Assessment of pre- and post-test levels of adolescent quality of life among adolescents within intervention and control group