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Effects of anuloma-viloma pranayama on aggressive behavior in adolescents

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Abstract
Background: Aggressive behavior during adolescence can adversely affect emotional regulation, peer relationships, and academic adjustment. Anuloma-Viloma pranayama may provide a complementary approach to managing aggression by promoting emotional self-regulation. This study examined its effects on aggressive behavior among higher secondary students.
Methods: A two-arm randomized controlled trial was conducted with 80 higher secondary students aged 15–17 years, equally allocated to experimental and waitlist control groups. The experimental group practiced Anuloma-Viloma pranayama for approximately 30 minutes daily across 30 sessions, while the control group continued its usual routine. Aggressive behavior was assessed before and after the intervention using the Buss–Perry Aggression Questionnaire (BPAQ), which measures physical aggression, verbal aggression, anger, and hostility. Data were analyzed using two-tailed paired-samples and independent-samples t-tests.
Results: The experimental group demonstrated significant reductions in physical aggression, verbal aggression, anger, hostility, and total BPAQ scores (all $p < .001$). The total score decreased from 89.80 ± 8.52 to 79.78 ± 8.37. The control group showed no significant changes in individual aggression domains, although there was a small reduction in the total score. Post-intervention comparisons favored the experimental group across all domains and the total score (all $p < .001$).
Conclusion: Anuloma-Viloma pranayama may serve as a complementary practice for reducing aggressive behavior among adolescents. Further research with active controls and longer follow-up is recommended.

Keywords: Anuloma-Viloma, aggressive behavior, adolescents, higher secondary students

Introduction

Adolescence is a developmental transition marked by rapid physical, cognitive, emotional, and social change. As young people navigate growing independence, peer relationships, and academic demands, they may be particularly vulnerable to difficulties with emotional regulation and impulse control. Aggressive behavior is a common behavioral concern reported in this age group (Bagherzadeh *et al*., 2025) [2]. It involves intentional actions that cause physical, verbal, or emotional harm to oneself or others. These actions range from taunting and physical fighting to relational hostility, and may intensify while regulatory capacities are still developing (Khanduri4, 2025). Increased competition, stress, anxiety, and inconsistent parenting practices have also been linked to adolescent aggression (A.G. *et al*., 2017) [1]. Aggression is commonly classified as physical, verbal, or indirect; indirect aggression, also known as relational aggression, harms peers' relationships through exclusion, rumors, or manipulation (Dou & Zhang, 2025; Voulgaridou & Kokkinos, 2023) [6, 23].

The mental health consequences are substantial and partly bidirectional. Longitudinal evidence indicates reciprocal relationships between aggressive behavior and symptoms of depression and anxiety, and high levels of aggression co-occur with conduct problems and hyperactivity or inattention (Kalogerakis *et al*., 2022) [12]. Aggressive adolescents report lower self-esteem, greater drug use and more mental disorders than their peers (Perez-Gramaje *et al*., 2019) [17], and aggression persisting into early adolescence strongly predicts continued aggression in late adolescence and later alcoholism (Hawkins *et al*., 1992) [9]. Psychosocially, uncontrolled aggression is followed by declining academic performance, rejection by peers and teachers, social maladjustment, smoking and substance abuse; aggression toward peers is the only significant predictor of juvenile delinquency in longitudinal models and also predicts early school withdrawal (Kupersmidt & Coie, 1990) [14]. Peer rejection, bullying, and loneliness commonly co-occur with physical aggression (Henriksen *et al*., 2020) [10].

Usual management relies principally on psychosocial approaches. School-based cognitive-behavioral anger interventions significantly reduce aggressive behavior, with the average participant showing a 62% reduction relative to untreated controls, maintained at one-year follow-up ; universal programs with more frequent contacts tend to produce the largest reductions (Wilson & Lipsey, 2007) [24]. These programs are grounded in cognitive-behavioral theory, which identifies attributions, expectations, interpersonal beliefs, and problem-solving deficits as determinants of responses to provocation and treats anger arousal as a mediator of aggressive behavior (Feindler & Engel, 2011) [7]. Cognitive-behavioral approaches are the most common therapeutic option for anger in young people, with mainly medium-to-large short-term effects, though long-term maintenance remains debated (Cole, 2008) [5].

In this scenario, yoga offers a complementary approach by supporting self-regulation. Patanjali defines yoga as the control of the mind's modifications (Maudgil *et al*., 2016) [16]. This definition presents yoga as a practice in self-

regulation. Research also suggests possible effects on the nervous system and brain. Yoga may strengthen inhibitory control by increasing vagal tone. This may help reduce prolonged sympathetic arousal and related cognitive and emotional dysregulation (Gard *et al*., 2014) [8]. Breathing techniques may affect hypothalamic-pituitary-adrenal and sympathetic activity. These changes may be associated with improved emotional well-being (Sullivan *et al*., 2018) [21]. Anuloma-Viloma Pranayama, a practice of alternate nostril breathing, is particularly relevant to this line of inquiry because its slow, rhythmic regulation of breath is thought to shift autonomic balance toward parasympathetic dominance, and yoga-based breathing interventions have been associated with lower aggression in adolescent samples (Jain & Sharma, 2026) [11]. Accordingly, the present study aims to examine whether a structured program of Anuloma-Viloma Pranayama reduces aggressive behavior among adolescent children, addressing the research question of whether this practice produces measurable changes in aggression relative to a control group.

Methodology

Sample and sample size

Eighty higher secondary students (40 subjects per group), aged 15 to 17 years and in grades 11 and 12, were recruited. Participants were selected from two government schools in the same district, and all were screened for eligibility before randomization to the intervention or control condition.

Ethical considerations

Participants and their parents or guardians were provided with a full explanation of the study, and written consent was obtained. The methodology was approved by the Institutional Ethics Committee.

Selection Criteria

The participants selected for the study were students aged 15 to 18 years who were studying in Grades 11 and 12. They exhibited aggressive behavior, as identified using the Buss–Perry Aggression Questionnaire (BPAQ). In addition, the participants were in good general health, ensuring their suitability for participation in the proposed intervention.

Students diagnosed with psychological conditions, including clinical anxiety, depression, or other psychiatric disorders, were excluded from the study. Participants with medical conditions that could interfere with psychological assessments were also excluded. Individuals taking medications that could affect cognitive function, emotional regulation, or physiological responses were not included. In addition, participants with respiratory conditions that could affect the safe and appropriate performance of pranayama practices were excluded from the study.

Study design and intervention

This two-arm randomized controlled trial with a waitlist control group assessed participants at baseline and immediately after the intervention. An independent researcher allocated the participants using computer-generated randomization. The experimental group practiced Anuloma-Viloma pranayama daily at 4:00 pm for 30 sessions under the supervision of a qualified instructor, in addition to their usual routine. The practice consisted of 60 rounds divided into three sets of 20 cycles, with a two-minute rest period after each set, and lasted approximately 30 minutes per session. The control group continued their usual lifestyle and was offered the same training after the intervention period.

Outcome measure

The primary outcome, aggressive behavior, will be measured with the BPAQ (physical aggression, verbal aggression, anger and hostility), which has high internal consistency and test-retest stability (Reyna *et al*., 2011) [20]. Total and subscale scores were recorded at baseline and after the 30 sessions.

Statistical Analysis

Descriptive statistics were expressed as mean ± standard deviation (M ± SD) for continuous variables and as frequencies (percentages) for categorical variables. Baseline comparability between the experimental and control groups was assessed using the independent-samples t-test (with Welch's correction) for continuous variables and the chi-square test for categorical variables. Pre-test and post-test BPAQ scores (physical aggression, verbal aggression, anger, hostility and total score) were compared within each group using the two-tailed paired-samples t-test, which controls for individual differences at baseline. Post-test scores and change scores of the two groups were compared using Welch's independent-samples t-test. Normality of the difference scores was checked with the Shapiro–Wilk test, and the Wilcoxon signed-rank test was used as a sensitivity analysis. The magnitude of change was expressed as Cohen's d (0.2 small, 0.5 medium, 0.8 large). The level of significance was set at $\alpha = .05$.

Table 1: Demographic and baseline characteristics

Variable	Experimental (n = 40)	Control (n = 40)	p
Age, Years (M ± Sd)	16.73 ± 1.04	16.45 ± 0.93	.216
Sex, N (%)			.361
Male	22 (55.0)	26 (65.0)	
Female	18 (45.0)	14 (35.0)	
Grade, N (%)			.025*
11th	13 (32.5)	23 (57.5)	
12th	27 (67.5)	17 (42.5)	
Socio-Economic Status, N (%)			.791
Low	9 (22.5)	11 (27.5)	
Middle	23 (57.5)	20 (50.0)	
High	8 (20.0)	9 (22.5)	
Height, Cm (M ± Sd)	164.67 ± 9.13	166.71 ± 9.25	.323
Weight, Kg (M ± Sd)	59.57 ± 11.16	60.33 ± 10.93	.759
Bmi, Kg/M² (M ± Sd)	21.81 ± 3.04	21.63 ± 2.94	.786

Results

The study included 80 participants (40 per group; age 15–17 years). The groups were comparable in age (16.73 ± 1.04 vs. 16.45 ± 0.93 years), sex, socio-economic status, height, weight and BMI (all $p > .05$), but differed in grade ($p = .025$). Baseline BPAQ scores did not differ between the groups in any domain (all $p > .05$), including the total score (89.80 ± 8.52 vs. 89.55 ± 6.76; $p = .88$), indicating that the groups were equivalent before the intervention. In the experimental group, all domains decreased significantly from pre-test to post-test (all $p < .001$): physical aggression from 25.05 ± 2.60 to 22.45 ± 2.52 (d = 1.78), verbal aggression from 15.22 ± 1.80 to 13.43 ± 1.91 (d = 1.55), anger from 22.45 ± 2.33 to 19.93 ± 2.84 (d = 1.48), hostility

from 27.07 ± 1.93 to 23.98 ± 2.47 (d = 1.87), and total score from 89.80 ± 8.52 to 79.78 ± 8.37 (d = 2.97). In the control group, no subscale changed significantly (p = .086–.346; d = 0.15–0.28), and the total score fell slightly from 89.55 ± 6.76 to 88.40 ± 7.16 (p = .021, d = 0.38). At post-test, the experimental group scored significantly lower than the control group across all domains and the total score (79.78 ± 8.37 vs. 88.40 ± 7.16; all p < .001, d = 0.81–1.13). Change scores were also significantly greater in the experimental group (total score, d = 2.77).

Table 2: Pre- and post-intervention BPAQ scores (paired-samples t-test, two-tailed)

Domain	Group	Pre-test (M ± SD)	Post-test (M ± SD)	p	Cohen's d
Physical aggression	Experimental	25.05 ± 2.60	22.45 ± 2.52	< .001***	−1.78
	Control	24.88 ± 2.22	24.55 ± 2.69	.195	−0.21
Verbal aggression	Experimental	15.22 ± 1.80	13.43 ± 1.91	< .001***	−1.55
	Control	15.20 ± 1.29	14.93 ± 1.56	.086	−0.28
Anger	Experimental	22.45 ± 2.33	19.93 ± 2.84	< .001***	−1.48
	Control	22.43 ± 1.78	22.18 ± 2.11	.133	−0.24
Hostility	Experimental	27.07 ± 1.93	23.98 ± 2.47	< .001***	−1.87
	Control	27.05 ± 1.54	26.75 ± 2.44	.346	−0.15
Total score	Experimental	89.80 ± 8.52	79.78 ± 8.37	< .001***	−2.97
	Control	89.55 ± 6.76	88.40 ± 7.16	.021*	−0.38

Note: M = Mean; SD = Standard deviation; p < .05; **p < .001. Level of significance: α = .05. Cohen's d is the paired-samples effect size (mean difference divided by the SD of the differences). A negative value means the score decreased after the intervention.

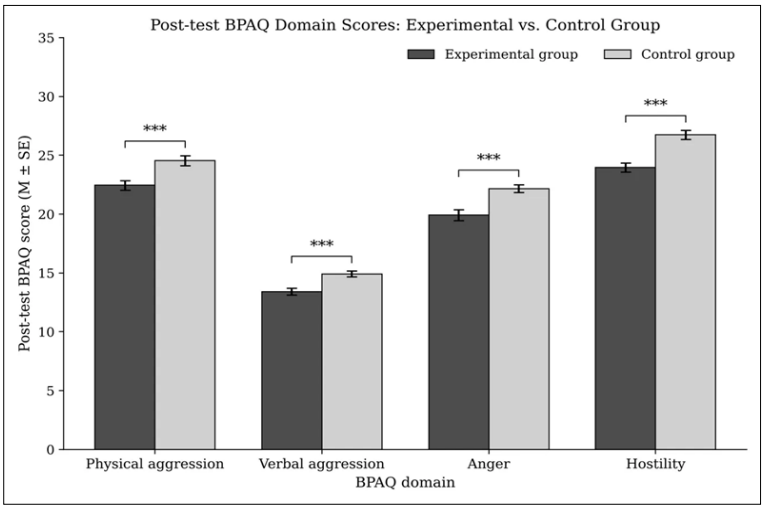


Fig 1: Post-test Buss-Perry Aggression Questionnaire (BPAQ) domain scores of the experimental (n = 40) and control (n = 40) groups. Bars represent the mean (M); error bars represent the standard error (SE). Dark grey = experimental group; light grey = control group. Brackets show the result of Welch's independent-samples t-tests: ***p < .001. Level of significance: α = .05.

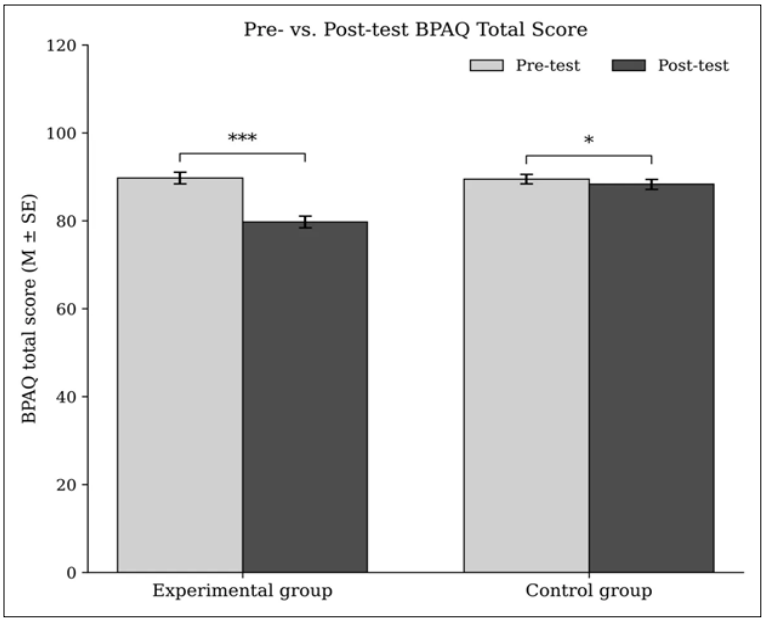


Fig 2: Pre-test and post-test BPAQ total scores of the experimental and control groups (n = 40 per group). Bars represent the mean (M); error bars represent the standard error (SE). Light grey = pre-test; dark grey = post-test. Brackets show the result of two-tailed paired-samples t-tests: p < .05; **p < .001. Level of significance: α = .05.

Discussion

Aggression is among the most prevalent behavioral concerns of adolescence, and it has been described as a complex psychological and behavioral construct that is often associated with adverse consequences for individual well-being and social functioning (Jain & Sharma, 2026) [11]. It has emerged as a key behavioral and emotional concern in this age group, alongside increasing academic pressure, social comparison, and digital overstimulation, all of which contribute to heightened irritability, frustration, and reduced emotional regulation (Khanduri4, 2025) [18]. Its expression is largely attributable to increased competition, stress and anxiety, and to poor parenting practices (A.G. *et al*., 2017). From an educational psychology perspective, this matters because aggression undermines the conditions on which learning depends: it predicts early school withdrawal in longitudinal models (Kupersmidt & Coie, 1990) [14], school-based programs with more frequent contact produce the largest reductions in aggressive and disruptive behavior (Wilson & Lipsey, 2007) [24], and whole-school approaches are more effective than classroom curricula or social skills training delivered alone (Cantone *et al*., 2015) [4].

In the present study, each BPAQ domain carries distinct psychological meaning (Reyna *et al*., 2011) [20]. Physical aggression is the most visible and immediately disruptive form, carrying risks of injury and disciplinary exclusion. It decreased from 25.05 ± 2.60 to 22.45 ± 2.52 in the pranayama group ($p < .001$, $d = -1.78$), whereas the control group changed only from 24.88 ± 2.22 to 24.55 ± 2.69 ($p = .195$, $d = -0.21$). This indicates that the intervention affected a child's ability to control themselves. Because physical aggression is the behavior most likely to attract school sanctions and escalate into injury, a measurable reduction suggests that the practice targeted the outward expression of aggression, not only how students felt.

Verbal aggression is another of the most frequent classroom expressions of hostility and a common route to peer rejection. It decreased from 15.22 ± 1.80 to 13.43 ± 1.91 ($p < .001$, $d = -1.55$), while the control group's change from 15.20 ± 1.29 to 14.93 ± 1.56 did not reach significance ($p = .086$, $d = -0.28$). Because verbal hostility is the most habitual and socially tolerated form of aggression. The reduction observed here is meaningful for everyday classroom relationships. It suggests greater restraint in routine peer interaction rather than change confined to rare confrontations, and the absence of a comparable shift in the control group makes it unlikely that the change simply reflects familiarity with the questionnaire.

Anger represents the affective and arousal component of aggression and is treated in cognitive-behavioral accounts as a mediator of aggressive behavior (Feindler & Engel, 2011) [7]. The score decreased from 22.45 ± 2.33 to 19.93 ± 2.84 ($p < .001$, $d = -1.48$), with a non-significant change in the control group from 22.43 ± 1.78 to 22.18 ± 2.11 ($p = .133$, $d = -0.24$). Anger is the arousal state that converts provocation into action; its reduction suggests that the slow, alternate-nostril breathing component moderated reactivity to provocation, consistent with the psycho-physiological correlates of slow breathing (Zaccaro *et al*., 2018) [25] and with evidence that slow breathing practices reduce symptoms of arousal, anxiety, depression, and anger (Bhagat *et al*., 2020) [3].

Hostility, the cognitive component comprising resentment and negative appraisal of others, showed the largest change, from 27.07 ± 1.93 to 23.98 ± 2.47 ($p < .001$, $d = -1.87$), while the control group remained essentially unchanged (27.05 ± 1.54 to 26.75 ± 2.44; $p = .346$, $d = -0.15$). This is notable because cognitive facets are often considered more resistant to change than arousal-based ones. Its decline suggests that the intervention may have influenced how participants appraise and interpret others' intentions, not only their emotional reactivity.

The total BPAQ score decreased from 89.80 ± 8.52 to 79.78 ± 8.37 in the pranayama group ($p < .001$, $d = -2.97$). The control group showed a small but statistically significant reduction, from 89.55 ± 6.76 to 88.40 ± 7.16 ($p = .021$, $d = -0.38$); however, none of its domain-level changes reached significance, and its effect sizes were negligible to small, in contrast to the large effects observed in the pranayama group. Post-test scores favored the experimental group in every domain (all $p < .001$). The consistency of the pattern across all four domains suggests a broad effect rather than a domain-specific one.

These results rest on assumptions that should be stated. Aggression was measured only by self-report, so the findings describe perceived rather than observed behavior. The waitlist design provided no active comparator, meaning the structured routine, instructor contact and daily attention cannot be separated from alternate-nostril breathing itself. Attendance and fidelity were assumed, and the control group's usual lifestyle was assumed to remain unchanged. Although baseline BPAQ total scores were comparable (89.80 ± 8.52 vs 89.55 ± 6.76), the groups differed in grade distribution ($p = .033$). Despite this potential grade-level influence, the reductions across BPAQ domains suggest that Anuloma-Viloma helped the participants manage aggression.

The findings agree with earlier work. Yoga significantly decreased beliefs supporting aggression and significantly increased beliefs favoring alternatives to aggression compared with physical exercise (A.G. *et al*., 2017) [1]. Twelve weeks of daily Surya Namaskar with breathing practices reduced aggression in 60 adolescent girls, with large effect sizes (Jain & Sharma, 2026) [11], and four months of school yoga reduced anger in high school children, from a mean of 46.20 to 42.41 (Mani *et al*., 2016) [15]. Based on various studies, pranayama practice has been associated with reduced aggression and lower Buss-Perry Aggression Questionnaire scores (Rana & Sharan, 2024) [19]. The combined practice of Bhramari and Nadi Shodhan pranayama improved anger control, consistent with the proposed autonomic and self-regulatory mechanisms of slow breathing (Gard *et al*., 2014; Sullivan *et al*., 2018) [8, 21]. Taken together, these findings suggest that pranayama operates on several levels of the aggression construct simultaneously, rather than on a single behavioral outcome, and that its effects may extend beyond momentary calm to adolescents' interpretations of and responses to interpersonal provocation (Thakur, 2024) [22]. A comparable pattern has been reported in youth receiving an integral yoga intervention, in which aggression scores fell significantly even though gains in emotional regulation were not statistically significant (Quiñones *et al*., 2025) [18].

Conclusion

The present study examined whether 30 sessions of Anuloma-Viloma pranayama would reduce aggressive behavior among adolescent schoolchildren, as assessed

using the Buss-Perry Aggression Questionnaire. Based on the analysis, the study found that participants in the pranayama group showed significant reductions in physical aggression, verbal aggression, anger, hostility, and total BPAQ scores, whereas the waitlist control group showed no statistically significant changes. Therefore, the findings suggest that Anuloma-Viloma pranayama may nonetheless serve as a low-cost adjunct to school-based anger management programs.

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