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Effectiveness of a School-Based Multidisciplinary Programme of Postural Ergonomics, Physical Therapy and Yogic Mind–Body Practices on Adolescent Anxiety Across Urban, Semi-Urban and Rural Settings: A Cluster Randomised Controlled Trial

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Abstract

Background: Anxiety is common among adolescents in India and often presents with somatic complaints such as neck and upper-back pain, yet school mental health programmes seldom address somatic pathways. We evaluated a 12-week school-based programme combining postural ergonomics, physical therapy and yogic mind–body practices.

Methods: In this open-label, two-arm, parallel-group cluster randomised controlled trial, 18 secondary and higher secondary schools in Telangana and Maharashtra, India, were stratified by setting (urban, semi-urban, rural; six schools per stratum) and randomised within strata (nine intervention, nine control). The trial ran from 15 January 2025 to 31 July 2026. Of 1,420 adolescents screened, 1,200 aged 13–18 years with probable anxiety (standard 41-item Screen for Child Anxiety Related Emotional Disorders [SCARED] total ≥25) were enrolled (600 per arm). The intervention comprised ergonomic seating adjustments with a 2-minute active posture break every 45 minutes, physical therapy conditioning three times weekly, and daily 20-minute sessions of alternate-nostril breathing (Nadi Shodhana), mindfulness and restorative asanas. The control arm received standard school health education. The primary outcome was the change from baseline to 12 weeks in the 37-item SCARED score (panic/somatic, generalised anxiety, separation anxiety and social phobia subscales; range 0–74; school-avoidance items excluded). Secondary outcomes were the four subscales and neck/upper-back pain (100-mm visual analogue scale [VAS]). Outcome assessors and the trial statistician were blinded. Analysis was by intention to treat using linear mixed-effects models with school-level random intercepts.

Results: Mean age was 15.2 years (SD 1.4) and 48.6% were female. Twelve-week data were available for 574/600 intervention and 568/600 control participants. The 37-item SCARED score fell from 27.2 to 13.0 in the intervention arm and from 26.8 to 23.7 in the control arm (adjusted difference −11.1 points; 95% CI −12.4 to −9.8; $p < 0.001$). Neck/upper-back pain fell by an adjusted −25.2 mm more in the intervention arm (95%

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CI −28.4 to −22.0; $p < 0.001$). Effects were similar across urban, semi-urban and rural strata (interaction $p = 0.42$). No adverse events were reported.

Conclusions: In this open-label trial with self-reported outcomes, the programme was associated with markedly greater reductions in anxiety scores and neck/upper-back pain than standard health education. The size of the effect is unusually large and should be interpreted cautiously; confirmation in independent, longer trials with blinded or objective outcome measures is needed.

Keywords: adolescent anxiety; physical therapy; postural ergonomics; yoga; pranayama; school mental health; cluster randomised trial; India

1. Introduction

Adolescence is a critical developmental transition in which mental health conditions contribute substantially to the global burden of disease among those aged 10–19 years [1,2]. Anxiety disorders are among the most prevalent psychiatric conditions worldwide, with onset concentrated before early adulthood [3,4]. In India, the National Mental Health Survey documented considerable mental morbidity among adolescents [5], and a global meta-analysis estimated that about one in five children and adolescents experienced clinically elevated anxiety symptoms during the COVID-19 pandemic [6].

Adolescent anxiety is not purely cognitive or emotional. It commonly presents with somatic features, and psychological and chronic pain symptoms frequently co-occur in young people [7]. Pain in the neck, shoulder and back region is common in adolescence [8], and prolonged screen use has been linked to poorer mental health in young people [9]. Conventional school counselling rarely addresses posture, muscle tension or breathing, so the somatic component of anxiety often remains untreated.

Schools offer a non-stigmatising, accessible platform that reaches urban, semi-urban and rural communities. School-based yoga programmes have shown encouraging effects on stress and emotional well-being [10–13], and slow regulated breathing is proposed to enhance vagal tone and reduce sympathetic arousal [14–17]. Exercise-based and mindfulness-based interventions have likewise been associated with reduced anxiety symptoms in young people [18,19], although school-based anxiety prevention programmes have generally produced small average effects [20]. However, controlled trials of a unified package of postural ergonomics, physical therapy and yoga across different regional settings are lacking. Figure 1 summarises the rationale on which the programme was designed. We therefore conducted a cluster randomised controlled trial to test whether a 12-week multidisciplinary programme reduces anxiety scores and postural pain among adolescents with screening-defined probable anxiety, compared with standard health education.

2. Methods

2.1 Study design, setting and ethics

This was an open-label, two-arm, parallel-group cluster randomised controlled trial conducted in 18 secondary and higher secondary schools in Telangana and Maharashtra, India. Schools were the unit of randomisation and were stratified by setting (urban, semi-urban or rural; six schools per stratum). The trial was conducted from 15 January 2025 to 31 July 2026. The protocol was approved by the Institutional Ethics Committee of Surabhi Institute of Medical Sciences and conducted in accordance with the Declaration of Helsinki [21]. The report follows the CONSORT 2010 statement and its extension to cluster randomised trials [22,23], and the

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intervention is described using the TIDieR checklist [24]. Because school-level roster sheets contained administrative discrepancies that could not be fully reconciled against master screening logs, participant flow is reported at the trial arm level rather than disaggregated by individual cluster.

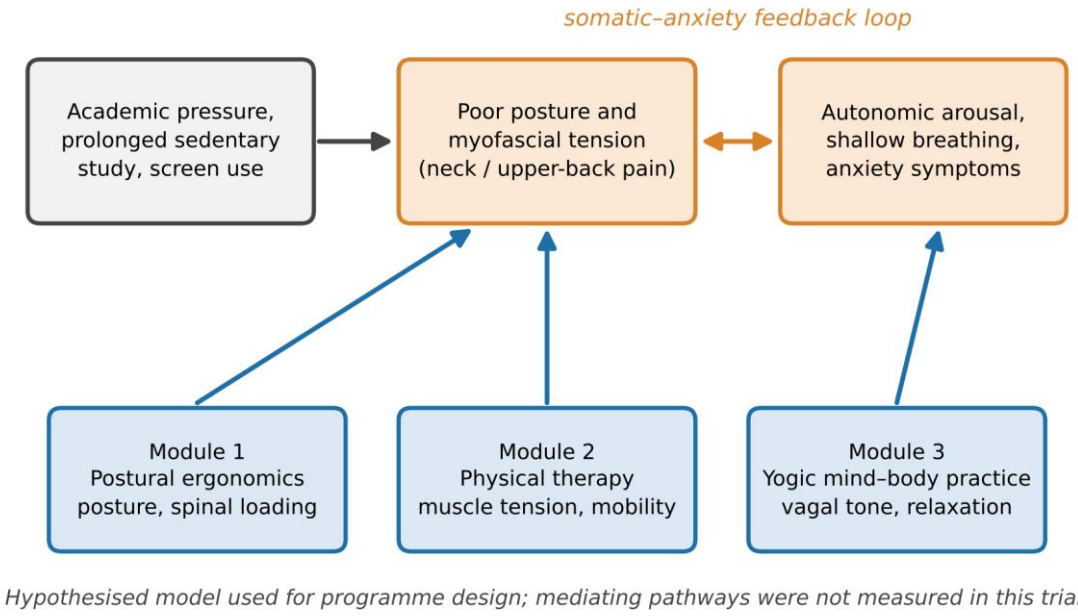

Figure 1. Hypothesised model underlying the programme. Each module targets a different node of the somatic–anxiety feedback loop. Mediating pathways were not measured in this trial.

2.2 Participants and screening

Students aged 13–18 years in grades 8–12 were screened using Telugu- or Marathi-language versions of the Screen for Child Anxiety Related Emotional Disorders (SCARED) [25,26]. Probable anxiety was defined as a score of ≥25 on the standard 41-item SCARED total (range 0–82). Exclusion criteria were diagnosed neurological disorders, severe intellectual disability, and physical disability precluding light stretching and yoga. Screening and baseline assessments were completed before allocation was disclosed. Written informed consent was obtained from parents or legal guardians and assent from each adolescent.

2.3 Sample size

The sample size was calculated for a cluster design. Assuming an intracluster correlation coefficient (ICC) of 0.05 and a mean cluster size of 66.7 students (1,200 students in 18 schools), the design effect was $1 + (66.7 - 1) \times 0.05 = 4.28$ [27]. A total of 1,200 students (600 per arm) therefore gave an effective sample size of approximately 280 and about 83% power to detect a standardised mean difference of 0.35 in the primary outcome at a two-sided α of 0.05 (approximately 82% if 15% of participants were lost to follow-up). Attrition of up to 15% was anticipated; observed participant attrition was 4.8%.

2.4 Randomisation, allocation concealment and blinding

An independent statistician generated a computer-based allocation sequence and randomised the 18 schools in blocks within strata (six schools per stratum: three intervention, three control). Allocation was concealed with opaque, sequentially numbered, sealed envelopes opened only after baseline testing was complete.

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Students, teachers and instructors could not be blinded because of the behavioural and physical nature of the intervention. Outcome assessors and the trial statistician remained blinded to allocation.

2.5 Interventions

The 12-week intervention was delivered in three integrated modules by trained physiotherapists and certified yoga instructors (Figure 2, Table 1). Fidelity and attendance were monitored weekly by independent supervisors using standardised checklists; mean attendance in intervention schools was 88.4%. The control arm received the standard school health education curriculum (periodic lectures on hygiene and nutrition and routine physical education classes) delivered by school health staff for 30–45 minutes per week, without ergonomic, physical therapy or mindfulness content. The intervention therefore involved considerably more contact time than the control condition.

Table 1. Components of the 12-week multidisciplinary programme (TIDieR summary).

Module	Components	Dose and frequency
1. Postural ergonomics	Standardised classroom desk and seat angles; education on forward head posture and spinal loading; screen and book alignment; active posture adjustment	2-minute active posture break every 45 minutes during the school day
2. Physical therapy conditioning	Guided active stretching, thoracic mobility drills, scapular stabilisation exercises and myofascial decompression drills to relieve stress-related muscle tension	Three supervised sessions per week, 20 minutes each
3. Yogic mind–body practice	Slow regulated alternate-nostril breathing (Nadi Shodhana pranayama), mindfulness and body-scan relaxation, restorative asanas	Daily, 20 minutes, at the start of the school day
Control: standard health education	Periodic lectures on general hygiene and nutrition; routine physical education	30–45 minutes weekly, delivered by school health staff

Intervention delivered by trained physiotherapists and certified yoga instructors; weekly fidelity checks by independent supervisors.

2.6 Outcomes

The primary outcome was the change in the 37-item SCARED score from baseline to 12 weeks. This score is the sum of four subscales (panic/somatic, generalised anxiety, separation anxiety and social phobia; range 0–74) and excludes the four school-avoidance items of the standard 41-item total. The four-subscale outcome was specified as primary because school attendance was compulsory in all participating schools; however, compulsory attendance does not by itself guarantee that school-avoidance symptoms do not vary, and this choice is considered in the limitations. The screening threshold (≥25) was applied to the 41-item total, whereas efficacy analyses used the 37-item score. Secondary outcomes were the four subscales and neck/upper-back pain intensity on a 100-mm VAS (0 = no pain, 100 = worst imaginable pain). Assessments took place at baseline, 6 weeks and 12 weeks (Table 2).

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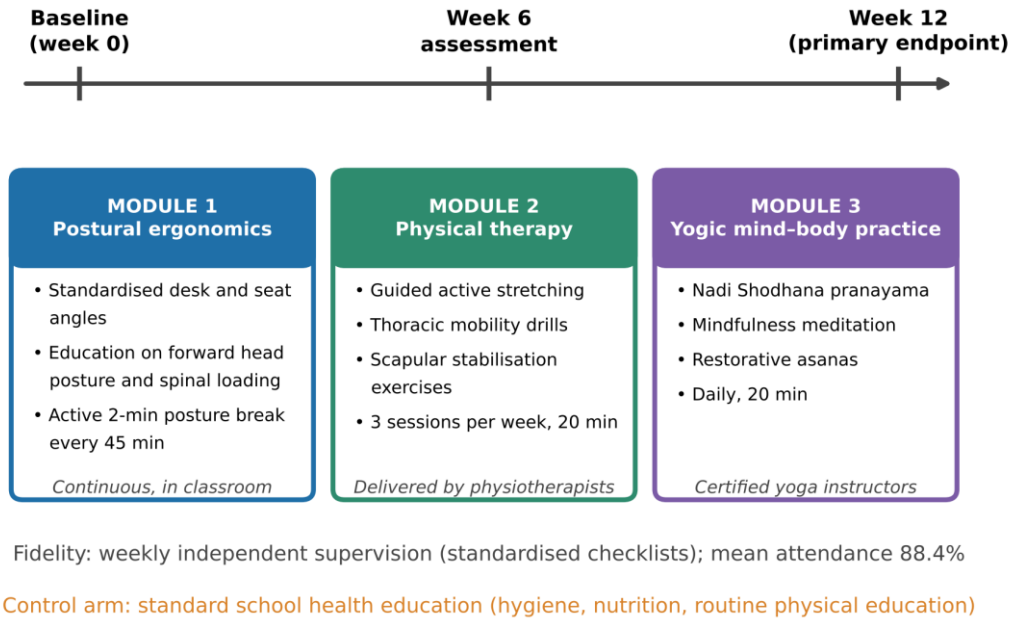

Figure 2. Structure of the 12-week programme, assessment schedule and delivery fidelity monitoring.

Table 2. Outcome measures.

Outcome	Instrument and range	Interpretation	Time points
Primary: anxiety	SCARED 37-item score (Telugu/Marathi versions): sum of four subscales, 0–74	Higher = greater anxiety	Baseline, 6 wk, 12 wk (primary endpoint)
Secondary: anxiety domains	SCARED subscales: panic/somatic, generalised anxiety, separation anxiety, social phobia	Higher = greater anxiety	Baseline, 6 wk, 12 wk
Secondary: postural pain	Neck/upper-back pain, 100-mm VAS	Higher = more pain	Baseline, 6 wk, 12 wk

SCARED, Screen for Child Anxiety Related Emotional Disorders; VAS, visual analogue scale.

2.7 Statistical analysis

Analyses were conducted in SPSS 29.0 and R 4.3.2 under the intention-to-treat principle. Continuous outcomes were analysed with linear mixed-effects models with school-level random intercepts, adjusting for the baseline value of the outcome, age, sex, socioeconomic status (Kuppuswamy scale) and geographic stratum. Because only 18 clusters were randomised, the Kenward–Roger small-sample degrees-of-freedom correction was used [28,29]. Missing outcome data were handled by maximum likelihood under a missing-at-random assumption. Heterogeneity of effect by setting was examined with a stratum-by-arm interaction term. Two-sided $p < 0.05$ was considered statistically significant. No adjustment for multiplicity was applied to the secondary outcomes, which should therefore be regarded as supportive. The sample size and power calculations assumed an intracluster correlation coefficient (ICC) of 0.05. This report presents the a priori planning value; the empirical post-hoc ICC derived from the final fitted mixed-effects models was not formally extracted, which represents a methodological limitation regarding cluster-level variance estimation.

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3. Results

3.1 Participant flow and baseline characteristics

Of 1,420 adolescents screened in 18 schools, 220 were excluded (142 scored below the SCARED screening threshold of 25, 48 declined participation and 30 met exclusion criteria). The remaining 1,200 participants were enrolled across 18 schools: nine schools and 600 participants in each arm (Figure 3). At 12 weeks, outcome data were available for 574 intervention and 568 control participants (1,142/1,200; overall attrition 4.8%); the recorded reasons were absence or relocation. No adverse events or injuries were reported.

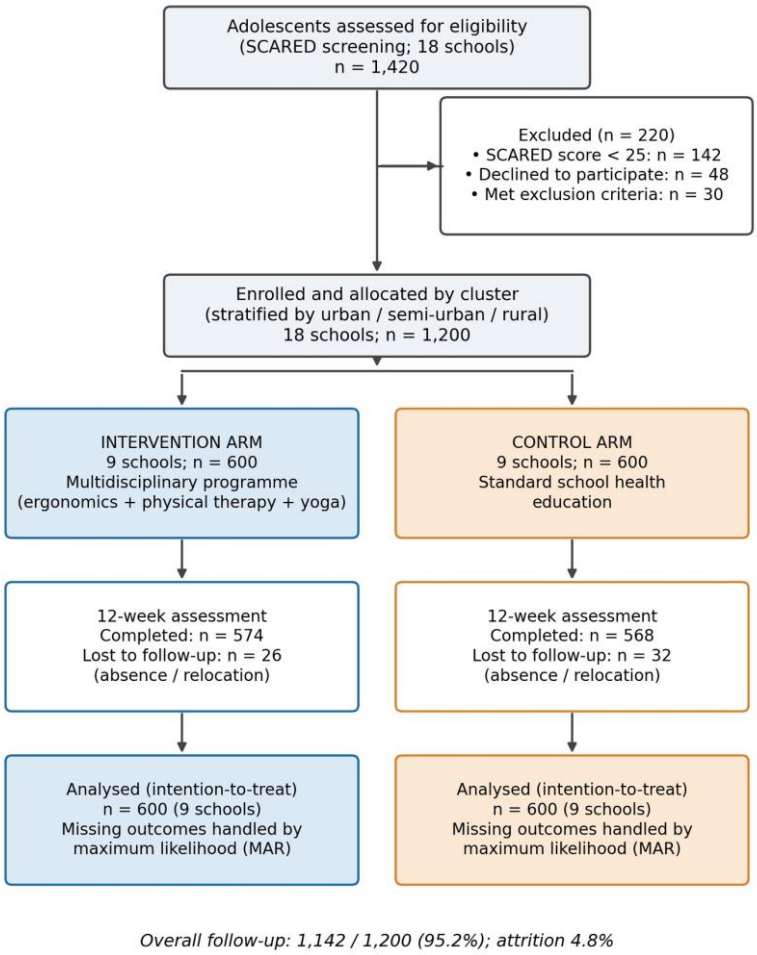

Figure 3. CONSORT flow diagram of cluster and participant progress through the trial (participant counts reported by study arm).

Mean age was 15.2 years (SD 1.4) and 48.6% were female. Baseline characteristics were well balanced between arms (Table 3). The mean baseline 37-item SCARED score was 27.2 in the intervention arm and 26.8 in the control arm, and was highest in urban schools (28.4), followed by semi-urban (26.9) and rural schools (25.5) (Figure 4).

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Table 3. Baseline characteristics of participants.

Characteristic	Intervention (n = 600)	Control (n = 600)	Overall (N = 1,200)
Age, years, mean (SD)	15.1 (1.3)	15.3 (1.5)	15.2 (1.4)
Female sex, n (%)	291 (48.5)	292 (48.7)	583 (48.6)
Socioeconomic status (Kuppuswamy scale), n (%)			
Upper / upper-middle	210 (35.0)	204 (34.0)	414 (34.5)
Middle / lower-middle	312 (52.0)	321 (53.5)	633 (52.8)
Lower	78 (13.0)	75 (12.5)	153 (12.8)
Schools, n	9	9	18
SCARED 37-item score, mean (SD)	27.2 (3.4)	26.8 (3.2)	27.0 (3.3)
Neck/upper-back pain, VAS mm, mean (SD)	54.6 (10.2)	53.9 (9.8)	54.3 (10.0)
Baseline SCARED 37-item score by stratum, mean			
Urban schools	28.6	28.2	28.4
Semi-urban schools	27.0	26.8	26.9
Rural schools	25.6	25.4	25.5

SD, standard deviation; SCARED, Screen for Child Anxiety Related Emotional Disorders; VAS, visual analogue scale. Percentages are of arm totals; overall percentages are of N = 1,200. SCARED values are the 37-item four-subscale score (range 0–74) used for efficacy analyses; the baseline 41-item totals used for screening are not reported.

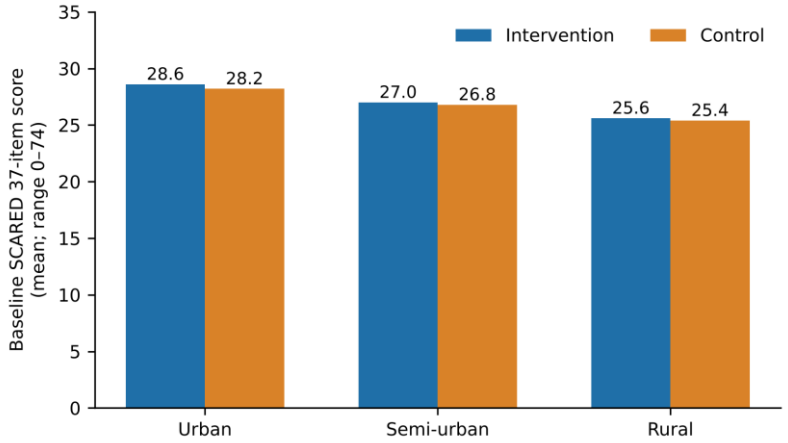

Figure 4. Baseline SCARED 37-item score (range 0–74) by geographic stratum and study arm.

3.2 Anxiety outcomes

At 12 weeks, the mean 37-item SCARED score fell from 27.2 to 13.0 (−14.2 points; 52.2%) in the intervention arm and from 26.8 to 23.7 (−3.1 points; 11.6%) in the control arm. The model-adjusted between-group

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difference in change was −11.1 points (95% CI −12.4 to −9.8; p < 0.001; Table 4, Figures 5 and 6). All four subscales improved more in the intervention arm (p < 0.001 for each), with the largest difference in panic/somatic symptoms (−4.1; 95% CI −4.8 to −3.4).

Table 4. Change in anxiety scores and postural pain from baseline to 12 weeks.

Outcome	Intervention (n = 600 randomised): baseline → 12 wk (change)	Control (n = 600 randomised): baseline → 12 wk (change)	Adjusted mean difference (95% CI)	p
SCARED 37-item score	27.2 → 13.0 (−14.2)	26.8 → 23.7 (−3.1)	−11.1 (−12.4 to −9.8)	<0.001
Panic/somatic	9.4 → 4.2 (−5.2)	9.1 → 8.0 (−1.1)	−4.1 (−4.8 to −3.4)	<0.001
Generalised anxiety	7.8 → 3.5 (−4.3)	7.6 → 6.9 (−0.7)	−3.6 (−4.2 to −3.0)	<0.001
Separation anxiety	4.2 → 2.1 (−2.1)	4.3 → 3.8 (−0.5)	−1.6 (−2.0 to −1.2)	<0.001
Social phobia	5.8 → 3.2 (−2.6)	5.8 → 5.0 (−0.8)	−1.8 (−2.3 to −1.3)	<0.001
Neck/upper-back pain (VAS, mm)	54.6 → 22.7 (−31.9)	53.9 → 47.9 (−6.0)	−25.2 (−28.4 to −22.0)	<0.001

Values are observed means with change in parentheses. Adjusted differences are from mixed-effects models (baseline value, age, sex, socioeconomic status, stratum) with school-level random intercepts and the Kenward–Roger correction. Twelve-week outcome data were available for 574 intervention and 568 control participants. “SCARED 37-item score” is the sum of the four core subscales (range 0–74); the ≥25 screening threshold applied to the 41-item total (range 0–82). Relative reductions are derived from unadjusted means.

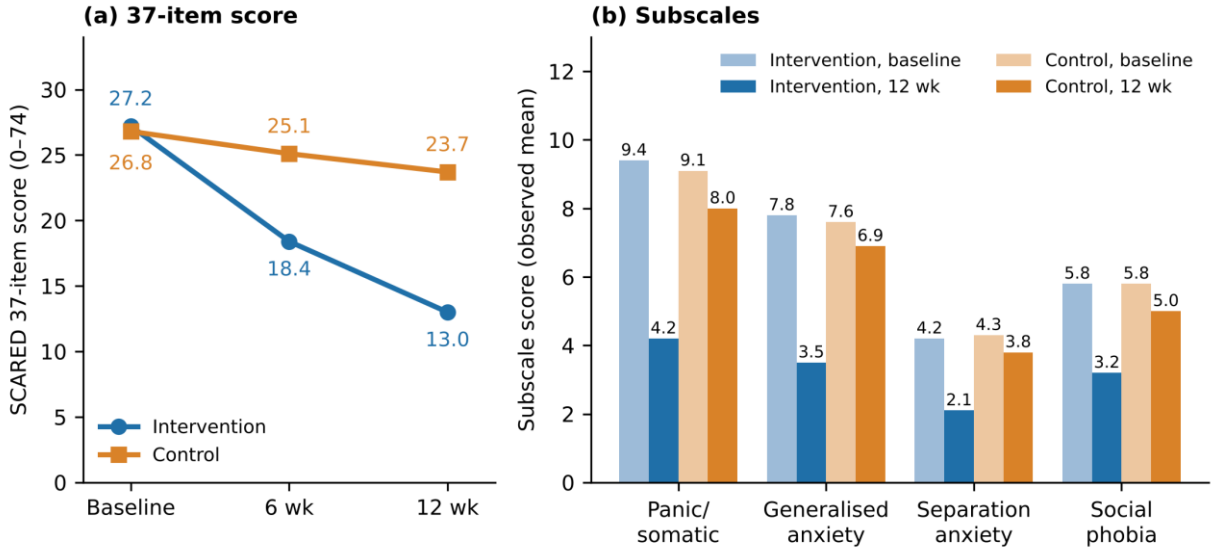

Figure 5. SCARED scores. (a) 37-item score by arm at baseline, 6 and 12 weeks. (b) Subscale scores at baseline and 12 weeks (observed means).

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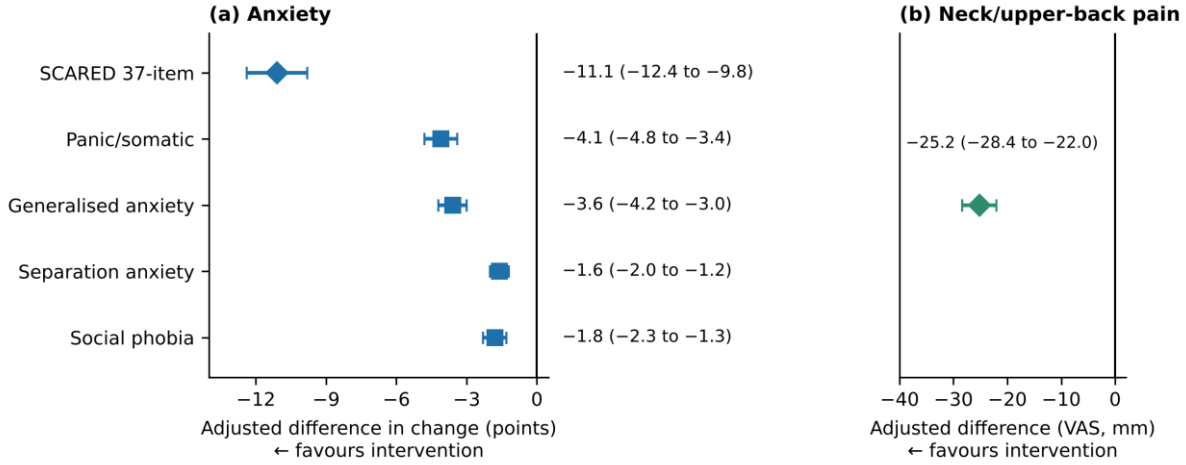

Figure 6. Model-adjusted between-group differences in change from baseline to 12 weeks with 95% confidence intervals. (a) SCARED 37-item score and subscales. (b) Neck/upper-back pain (VAS, mm). Values to the left of zero favour the intervention.

3.3 Postural pain

Neck and upper-back pain fell from 54.6 mm to 22.7 mm in the intervention arm (58.4% relative reduction) and from 53.9 mm to 47.9 mm in the control arm (11.1% relative reduction), giving an adjusted difference of −25.2 mm (95% CI −28.4 to −22.0; $p < 0.001$; Figures 6b and 7).

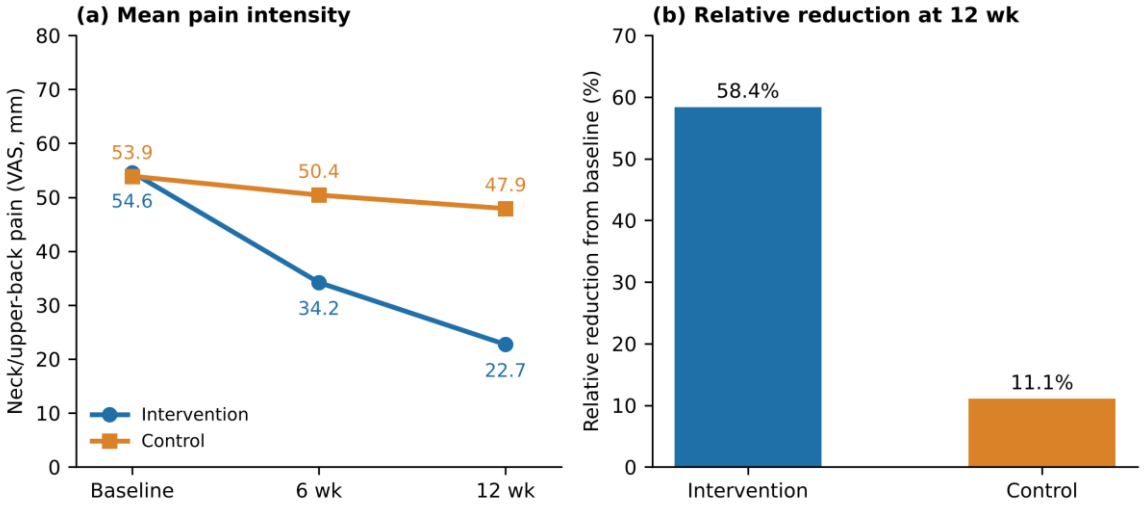

Figure 7. Neck/upper-back pain on a 100-mm VAS. (a) Mean pain at baseline, 6 and 12 weeks. (b) Relative reduction from baseline to 12 weeks.

3.4 Six-week outcomes

At the 6-week assessment, the mean 37-item SCARED score was 18.4 (SD 3.1) in the intervention arm and 25.1 (SD 3.2) in the control arm (adjusted difference −6.8 points; 95% CI −7.5 to −6.1; $p < 0.001$). Neck/upper-back pain was 34.2 mm (SD 8.5) and 50.4 mm (SD 9.1), respectively (adjusted difference −16.2 mm; 95% CI −18.1 to −14.3; $p < 0.001$) (Table 5, Figures 5a and 7a). Improvement therefore emerged by the midpoint and continued to week 12.

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Table 5. Intermediate (6-week) outcomes.

Outcome at 6 weeks	Intervention, mean (SD)	Control, mean (SD)	Adjusted mean difference (95% CI)	p
SCARED 37-item score	18.4 (3.1)	25.1 (3.2)	−6.8 (−7.5 to −6.1)	<0.001
Neck/upper-back pain (VAS, mm)	34.2 (8.5)	50.4 (9.1)	−16.2 (−18.1 to −14.3)	<0.001

Adjusted for baseline value, age, sex, socioeconomic status and stratum. Six-week subscale results were not analysed.

3.5 Effect by geographic setting

Reductions in the 37-item SCARED score from baseline to 12 weeks were similar across settings: urban −11.5 points (95% CI −13.2 to −9.8), semi-urban −11.0 (95% CI −12.7 to −9.3) and rural −10.8 (95% CI −12.5 to −9.1) (Table 6, Figure 8). A model including a stratum-by-arm interaction showed no statistically significant difference in treatment effect across settings (interaction p = 0.42). This indicates no evidence of heterogeneity, although with six schools per stratum the test has limited power to detect modest differences.

Table 6. Adjusted between-group difference in change in SCARED 37-item score (baseline to 12 weeks) by stratum.

Stratum	Adjusted mean difference (95% CI)
Urban	−11.5 (−13.2 to −9.8)
Semi-urban	−11.0 (−12.7 to −9.3)
Rural	−10.8 (−12.5 to −9.1)
Overall	−11.1 (−12.4 to −9.8)

Stratum × arm interaction p = 0.42.

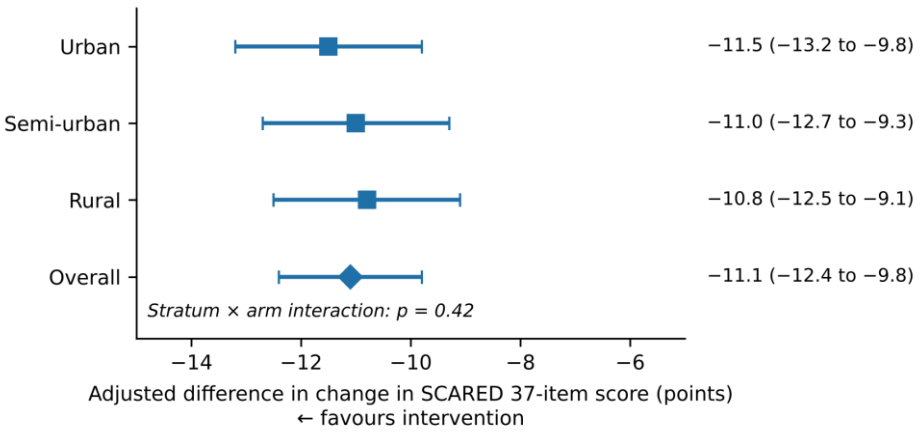

Figure 8. Adjusted between-group difference in change in SCARED 37-item score by geographic stratum with 95% confidence intervals. Values to the left of zero favour the intervention.

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4. Discussion

In this cluster randomised trial, a 12-week school-based programme integrating postural ergonomics, physical therapy and yogic mind–body practices was associated with substantially greater reductions in self-reported anxiety and neck/upper-back pain than standard health education. The adjusted difference of 11.1 SCARED points favoured the intervention across total and subscale scores, and the largest subscale difference was in panic/somatic symptoms, the domain closest to the physical complaints the programme targeted.

The direction of effect is consistent with earlier work on yoga, slow breathing, mindfulness and exercise for psychological distress in young people [10–13,18,19]. Slow breathing practices such as Nadi Shodhana are proposed to increase vagal tone and reduce sympathetic hyperarousal [14–17], while ergonomic adjustment and physical therapy may interrupt a feedback loop in which muscular tension and pain sustain anxious interpretations of bodily sensations [7]. These mechanisms are plausible but were not measured here, and the trial cannot attribute the effect to any single component.

4.1 Magnitude of the effect

The adjusted difference of 11.1 points is very large relative to the standardised difference of 0.35 assumed in the sample-size calculation, and relative to the small average effects reported for school-based anxiety prevention programmes [20]. Dividing 11.1 by the baseline standard deviation of approximately 3.3 gives a ratio of about 3.4; this is a descriptive ratio rather than a valid standardised treatment effect, because the baseline standard deviation is compressed by screening on a threshold score. Nonetheless, the magnitude warrants cautious interpretation. Self-reported outcomes in an open-label trial, in which participants know they are receiving an attention-intensive programme, are susceptible to expectancy and social-desirability effects, and the control condition provided far less contact time. The result should be regarded as a hypothesis-strengthening signal that requires replication rather than as a settled estimate of effect.

4.2 Geographic setting

Baseline anxiety scores were highest in urban schools and lowest in rural schools; possible explanations, such as academic pressure and sedentary routines, are hypotheses rather than mechanisms measured in this study. The programme achieved 88.4% attendance and 4.8% overall attrition. Effect estimates were similar across urban, semi-urban and rural settings and the interaction test was not statistically significant ($p = 0.42$). A non-significant interaction is not proof that effects are identical, particularly with only six schools per stratum.

4.3 Strengths and limitations

Strengths include the cluster randomised design stratified by setting, a large sample, use of regional-language instruments, blinded outcome assessors and statistician, high follow-up and a standardised, TIDieR-described intervention. Limitations are as follows. The trial was open-label, and the SCARED and VAS are self-reported, so blinding of assessors does not remove participant-level bias. The package was delivered as a bundle, preventing isolation of component effects. Furthermore, the control condition differed from the intervention arm in both content and contact time (with control sessions limited to 30–45 minutes weekly of standard health education), meaning that part of the observed effect may be attributable to general attention, social contact and time-use differences rather than the specific ergonomic and yogic components alone. Only 18 clusters were randomised, which limits precision and the power of the interaction test [29]. The SCARED is a screening instrument and does not establish a clinical diagnosis. The primary outcome excluded the

school-avoidance subscale, results for which are not reported, and subscale results at 6 weeks were not analysed. Limitations also include the omission of a disaggregated school-level participant flow table owing to administrative reconciliation discrepancies in cluster-level recruitment logs, and the absence of an empirical ICC from the fitted models (see Section 2.7). Finally, follow-up ended at 12 weeks, so the durability of benefit is unknown.

5. Conclusion

A 12-week school-based programme integrating postural ergonomics, physical therapy and yogic mind–body practices were associated with greater reductions in self-reported anxiety and neck/upper-back pain than standard school health education across urban, semi-urban and rural schools in India. Given the open-label design, self-reported outcomes and the unusually large effect, these findings should be confirmed in independent trials with blinded or objective outcomes, longer follow-up and active, contact-matched comparators before the programme is recommended for wider school health policy.

Declarations

Funding: Self-funded by the authors.

Conflict of interest: The authors declare no competing financial or non-financial interests.

Ethical approval and consent: Approved by the Institutional Ethics Committee of Surabhi Institute of Medical Sciences. Written parental consent and adolescent assent were obtained before enrolment.

Data availability: De-identified participant datasets are available from the corresponding author on reasonable academic request.

Author contributions: AGA: conceptualisation, methodology, intervention design, standardisation of physical therapy and ergonomics protocols, supervision of field instructors, review of the statistical analysis, project administration, and writing – original draft. AA: investigation, data collection, participant recruitment, and writing – review and editing. Both authors approved the final manuscript.

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