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Moving to Learn and Cope: Physical Activity and Physical Education as a School-Based Lever for Concentration, Academic Stress and Aggression in Adolescents — A Narrative Review with Implications for Indian Schools

Running title: Physical activity, concentration, stress and aggression in adolescents

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Abstract

Background: Indian secondary pupils face heavy academic pressure. High levels of academic stress and aggression are common among them, and many report difficulty in concentrating. At the same time, most adolescents do not meet recommended levels of physical activity. Physical education is the one school subject that can raise activity for every pupil. Yet in examination years it is often treated as expendable.
Objective: To review evidence on whether physical activity, physical fitness and school-based physical activity programmes are related to three psychological characteristics of adolescents: concentration, academic stress and related emotional difficulties, and aggression. A second aim was to consider the implications for physical education in Indian secondary schools.
Methods: Narrative review. Studies identified during the first author's doctoral research were supplemented by targeted searches for recent systematic reviews and meta-analyses. The evidence was organised by outcome and by the mechanisms proposed to link activity with each outcome.
Results:

- **Concentration:** The evidence is most consistent here. Fitness explained about a quarter of the variance in adolescents' attention scores. Eight weeks of endurance, strength or coordination training improved attention. Short classroom active breaks raised concentration performance in a cluster-randomised trial. Meta-analyses report moderate gains in attention (SMD = 0.56) and smaller gains in executive function.
- **Emotional outcomes:** Physical activity interventions reduced depressive symptoms in children and adolescents (Hedges' $g = -0.29$), and evidence for anxiety is small but favourable. No trial was found that targeted academic stress itself.
- **Aggression:** Sports interventions reduced aggression overall (SMD = −0.37), but the effect was not robust. It appeared for non-contact sports and not for high-contact sports. Longitudinal data suggest that self-control may carry part of the link, although the indirect effect was small.
- **Indian evidence:** Almost all of this evidence comes from outside India. No Indian trial was found that tested physical activity against these outcomes in secondary pupils.

Conclusions: Physical activity is a plausible, low-cost lever for supporting concentration and emotional well-being in adolescents, and possibly for reducing aggression. The case is strongest for concentration. Indian schools should protect daily physical education, including in the board-examination years. Classroom active breaks and coordinative and non-contact activities deserve priority. Cluster-randomised trials in Indian state-board and national-board schools are needed.

1. Introduction

Adolescence is a period of rapid change. Brain systems that respond to reward and emotion mature ahead of the prefrontal systems that support self-control (Casey et al., 2008; Steinberg, 2008). This leaves young people vulnerable to stress, impulsive behaviour and lapses of attention just as

academic demands peak. In India, those demands centre on the public examinations at the end of Classes X and XII. A national survey of 3,79,842 pupils found that studies, examinations and results were the most frequently named causes of anxiety. Secondary-stage pupils were also more likely than younger pupils to blame poor concentration for falling behind (National Council of Educational Research and Training [NCERT], 2022). School-based studies report high academic stress in a large share of Indian adolescents (Haritay et al., 2025; Khumanlambam et al., 2025), and aggression or bullying in a substantial minority (Bahl et al., 2026; Kumar et al., 2023).

At the same time, adolescents are not active enough. A pooled analysis of 298 population-based surveys from 146 countries estimated that about four in five adolescents worldwide did not meet the recommendation of 60 minutes of moderate-to-vigorous physical activity a day in 2016. In India, about 72 per cent of adolescent boys were insufficiently active (Guthold et al., 2020). Add the figure for Indian girls from the paper's appendix. In a qualitative study in Delhi schools, adolescents commonly reported reduced opportunities for physical activity at school, and girls faced more social censure than boys for taking part (Satija et al., 2018).

Indian policy has recognised the issue. The National Education Policy 2020 called for less high-stakes examinations and for sport and physical activity to be integrated into schooling (Ministry of Human Resource Development [MHRD], 2020). The Central Board of Secondary Education (CBSE) has made Health and Physical Education compulsory for Classes I to XII, with one period a day. Participation in at least two sports activities is a condition of eligibility for the Class X and XII board examinations (Central Board of Secondary Education [CBSE], 2019). State whether the Uttar Pradesh Madhyamik Shiksha Parishad (UP Board) has equivalent requirements, with a citation. Whether such provisions are implemented in examination years, and whether they benefit pupils psychologically, is less clear.

Physical educators therefore need to know whether the evidence supports physical activity as a means of improving concentration, easing academic stress and reducing aggression, and if so, what kinds of activity and delivery work best. Earlier reviews concluded that physical activity is

associated with better mental health and cognition in young people, but that effects were small and designs often weak (Biddle & Asare, 2011; Donnelly et al., 2016). Since then, several randomised trials and meta-analyses have appeared. This review brings that evidence together for the three characteristics. Its aims were to:

1. summarise the evidence linking physical activity and fitness with concentration, academic stress and related emotional outcomes, and aggression in adolescents;
2. describe the mechanisms proposed to explain these links;
3. identify the gaps in Indian evidence; and
4. draw out implications for physical education and research in Indian secondary schools.

2. Methods

This is a narrative review, not a systematic review. No protocol was registered, and no formal risk-of-bias assessment was made. The starting point was the literature on adolescent academic stress, aggression and concentration identified during the first author's doctoral research. It was supplemented by targeted searches, in October 2026, for systematic reviews, meta-analyses, randomised trials and Indian studies on physical activity and these outcomes. Name the databases searched (for example PubMed, Scopus, Google Scholar) and the search terms used.

Priority was given to:

- studies of adolescents aged about 12 to 18 years;
- randomised and cluster-randomised trials, and meta-analyses;
- school-based interventions; and
- Indian studies.

Laboratory studies and studies of clinical groups were used only to illustrate mechanisms. Findings were synthesised narratively by outcome.

3. Mechanisms Linking Physical Activity with the Three Characteristics

A systematic review of mechanisms grouped the pathways from physical activity to cognitive and mental health in young people under three headings: neurobiological, psychosocial and behavioural (Lubans et al., 2016). Each can be mapped onto the three characteristics considered here.

Neurobiological pathways. Aerobic fitness and regular activity are associated with changes in brain structure and function that support attention and cognitive control (Hillman et al., 2008). Executive functions, including inhibitory control and sustained attention, depend on prefrontal systems that are still maturing in adolescence (Diamond, 2013). Activities that are cognitively demanding as well as physical, such as coordinative tasks and games with changing

rules, may train these functions directly (Mao et al., 2024).

Psychosocial pathways. Physical activity can improve self-esteem and offer experiences of mastery and social belonging (Biddle & Asare, 2011). According to the transactional model, stress arises when demands are judged to exceed coping resources (Lazarus & Folkman, 1984). Activity that builds a sense of competence and social support could therefore change how academic demands are appraised. For aggression, structured sport offers rule-governed settings for practising self-control and managing frustration. Social learning theory, however, warns that sport can also model and reward aggression (Bandura, 1973).

Behavioural pathways. Physical activity may improve sleep and reduce loneliness. In a three-wave cohort of 2,965 Chinese adolescents, sleep (31.0 per cent of the total association) and loneliness (26.8 per cent) were the main pathways from academic stress to later depressive symptoms. Physical activity played a lesser part (Wang et al., 2025).

Links among the outcomes. The three characteristics are not independent. Attentional control theory holds that anxiety weakens goal-directed attention (Eysenck et al., 2007). Any activity that reduces academic stress could therefore benefit concentration indirectly. Anger sits at the centre of adolescent aggression (Yi et al., 2026), and self-regulation is common to both attention and the control of aggression (Diamond, 2013).

4. Evidence by Outcome

4.1 Concentration and attention

The evidence on concentration is the most consistent of the three. **Table 1** summarises the main studies.

Fitness and attention. In a preregistered cross-sectional study of 140 Viennese pupils aged 15 to 18, overall physical fitness explained about 26 per cent of the variance in performance on the revised d2 Test of Attention. Endurance, strength, coordination and flexibility were each positively related to attention, but speed was not (Altermann & Gröpel, 2024).

Exercise training. The same group then randomised 96 pupils of the same age to eight weeks of endurance, strength or coordination exercise (two 50-minute sessions a week) or to a control group. All

three exercise groups improved their attention relative to controls. The coordination group gained most and the strength group least (Altermann & Gröpel, 2025).

Younger children. A ten-week fancy rope-skipping programme among Chinese children aged seven to nine improved motor coordination and selective attention on the d2 test compared with controls (Deng et al., 2024).

Classroom active breaks. These are perhaps the most practical option for schools. A cluster-randomised trial in 39 upper-secondary classes in southern Italy compared two ten-minute active breaks a day for four months with normal routine. After adjustment, d2-R concentration performance was 56.7 points higher in the intervention classes (95% CI 21.7 to 91.6) (Martone et al., 2026). The intervention fitted within the school day and did not take time from teaching.

Pooled evidence. A meta-analysis of 21 randomised trials with 3,544 participants under 18 found that exercise improved attention (SMD = 0.56) and executive function (SMD = 0.21), with considerable heterogeneity (Liu et al., 2025). Cognitively engaging physical activity improved executive function in children and adolescents (SMD = 0.32, 95% CI 0.14 to 0.51), and inhibitory control in particular (SMD = 0.35). Heterogeneity was again high (I^2 = 91 per cent) (Mao et al., 2024). These findings agree with earlier reviews that reported positive but inconsistent effects of physical activity on cognition and academic achievement (Donnelly et al., 2016).

Measurement. Most of these studies measured concentration with performance tests such as the d2 and d2-R, whose construct validity is well established (Bates & Lemay, 2004). Self-report concentration scales used in Indian research measure something different, and their results are not directly comparable.

4.2 Academic stress and related emotional outcomes

Academic stress itself has rarely been the outcome of physical activity trials. Most evidence concerns depression and anxiety, which are closely linked to academic stress among Indian adolescents (Jayanthi et al., 2015; Khumanlambam et al., 2025; Trevethan et al., 2022).

Depressive symptoms. A meta-analysis of 21 controlled studies with 2,441 children and adolescents (mean age 14 years) found that physical activity interventions reduced depressive symptoms (Hedges' g = −0.29, 95% CI −0.47 to −0.10) (Recchia et al., 2023). Effects were larger in participants aged 13 years or older (g = −0.44) and in those with a diagnosed mental illness or depression (g ≈ −0.75). In healthy participants the effect was small (g = −0.09). Larger effects were also seen with sessions three times a week and with programmes shorter than 12 weeks.

Anxiety and self-esteem. An earlier review of reviews found small beneficial effects of physical activity on anxiety and short-term benefits for self-esteem, but noted that the evidence base was limited and designs were often weak (Biddle & Asare, 2011).

Academic stress. Observational evidence is mixed. In the Chinese cohort described above, physical activity was a minor pathway between academic stress and later depression compared with sleep and loneliness (Wang et al., 2025). Academic stress has wide costs, including lower achievement and motivation, a higher risk of dropping out, and poorer sleep and mental health (Pascoe et al., 2020). It is therefore a worthwhile target. However, no randomised trial was found that tested physical activity against a standardised measure of academic stress in secondary pupils.

Interpretation. Physical activity is likely to support emotional well-being modestly in the general pupil population, and more strongly in older and more distressed adolescents. Its effect on academic stress specifically remains to be tested.

4.3 Aggression

Pooled evidence. A meta-analysis of 15 studies of sports interventions in children and adolescents (six randomised and nine quasi-experimental) found an overall reduction in aggression (SMD = −0.37, 95% CI −0.69 to −0.06). Heterogeneity was very high (I^2 = 88 per cent), and the result lost significance when some individual studies were removed (Yang et al., 2023). The type of sport mattered:

- non-contact sports reduced aggression (SMD = −0.65, 95% CI −1.17 to −0.13);
- high-contact sports did not (SMD = −0.15, 95% CI −0.55 to 0.25).

Hostility was also reduced (SMD = −0.29), while the reduction in anger was not significant.

Longitudinal and network evidence. In a one-year, three-wave cohort of Chinese

adolescents, greater physical activity predicted lower aggression partly through better self-control, though the indirect effect was small (−0.035) (Yue et al., 2025). A network analysis of 1,276 Chinese secondary pupils found that direct links between individual physical-activity behaviours and aggression items were few and weak. Anger-related items were the most influential in the aggression network (Yi et al., 2026).

School context. Physical activity is one influence among several. Parent–child relationships and teachers' caring behaviour predicted later aggression (Li et al., 2025). Whole-school programmes that change school climate also matter (Bradshaw et al., 2009; Thapa et al., 2013). Physical education contributes to that climate through its rules, its handling of competition and the conduct it models.

Interpretation. The evidence suggests that physical activity may reduce aggression modestly, particularly through non-contact, structured activities that build self-control. It is not a stand-alone solution, and high-contact or poorly supervised competitive sport may not help.

Table 1. Key studies of physical activity and adolescents' concentration, emotional outcomes and aggression

Study	Design and sample	Activity	Outcome measure	Main result
Altermann & Gröpel (2024)	Cross-sectional; 140 pupils aged 15–18, Austria	Physical fitness (German Motor Test)	d2-R attention	Fitness explained about 26% of variance
Altermann & Gröpel (2025)	RCT; 96 pupils aged 15–18	Endurance, strength or coordination; 2 × 50 min/week, 8 weeks	d2 attention	All exercise groups improved vs control; coordination most
Martone et al. (2026)	Cluster RCT; 529 pupils, 39 classes, Italy	Two 10-min classroom active breaks daily, 4 months	d2-R concentration	+56.7 points (95% CI 21.7 to 91.6)
Liu et al. (2025)	Meta-analysis; 21 RCTs, 3,544 participants < 18	Physical exercise	Attention, executive function	Attention SMD = 0.56; executive function SMD = 0.21
Mao et al. (2024)	Meta-analysis; 23 trials, 2,857 participants aged 4–16	Cognitively engaging physical activity	Executive function	SMD = 0.32 (0.14 to 0.51); I^2 = 91%
Recchia et al. (2023)	Meta-analysis; 21 studies, 2,441 participants	Physical activity interventions	Depressive symptoms	g = −0.29 (−0.47 to −0.10); larger at age ≥ 13
Yang et al. (2023)	Meta-analysis; 15 studies	Sports interventions	Aggression	SMD = −0.37 (−0.69 to −0.06); non-contact −0.65;

Study	Design and sample	Activity	Outcome measure	Main result
				high-contact −0.15 (ns)
Yue et al. (2025)	Cohort, 3 waves; 1,866–2,011 adolescents, China	Self-reported physical activity	Buss–Perry aggression	Indirect effect via self-control −0.035

Note. CI = confidence interval; ns = not significant; RCT = randomised controlled trial; SMD = standardised mean difference.

5. The Indian Context and Evidence Gaps

The Indian burden is clear:

- academic stress is widespread and linked with depression and suicidal ideation (Haritay et al., 2025; Jayanthi et al., 2015; Khumanlambam et al., 2025);
- aggression and bullying are common (Bahl et al., 2026; Kumar et al., 2023);
- most adolescents are insufficiently active (Guthold et al., 2020).

Barriers to activity include limited opportunities at school and, for girls, social disapproval (Satija et al., 2018). Policy on paper is supportive (CBSE, 2019; MHRD, 2020).

The evidence on whether physical activity improves these outcomes for Indian pupils, however, is thin. Among the studies reviewed here, the trials and meta-analyses on concentration, depressive symptoms and aggression were conducted almost entirely outside India, mainly in Europe and China. No Indian randomised trial was found that tested a school physical-activity programme against concentration, academic stress or aggression in secondary pupils. Four further gaps stand out:

1. **Examination years.** Pupils in Classes X and XII face the highest academic pressure and may be most likely to lose physical education time. No study was found that examined what happens to their activity, stress and concentration across the examination cycle.
2. **Board and school type.** National-board and state-board schools differ in management, resources, medium of instruction and the social background of their pupils. Whether they provide physical education in the same way, and whether pupils of either board benefit differently, has not been studied.
3. **Yoga.** Yoga is part of the Indian physical education curriculum, and an Indian concentration scale includes yoga among its domains (Muchhal & Kumar, 2022). Yet no controlled evidence on school yoga and these three outcomes in Indian secondary pupils was identified in this review. If the authors know of such trials, add them here.
4. **Measurement.** Indian studies of these characteristics rely heavily on self-report scales. Performance-based attention tests such as the d2-R, used in most international trials, have rarely been used with Indian pupils.

6. Implications for Physical Education Practice

The following recommendations are consistent with the evidence, with the caveat that most of it comes from outside India.

1. **Protect the daily physical education period, including in Classes X and XII.** The strongest trial evidence links activity with better concentration, which pupils need most in examination years.
2. **Add short classroom active breaks.** Two ten-minute breaks a day improved concentration without reducing teaching time (Martone et al., 2026). They need no special facilities and can be led by any teacher.
3. **Include coordinative and cognitively engaging tasks.** Coordination training produced the largest attention gains (Altermann & Gröpel, 2025), and cognitively engaging activity improved executive function (Mao et al., 2024).
4. **Favour structured, non-contact activities when reducing aggression is a goal.** Pair them with explicit teaching of self-control and fair play (Yang et al., 2023; Yue et al., 2025). Supervise contact sports and competitive games closely.
5. **Make physical education gender-sensitive.** Address the social barriers that keep girls inactive (Satija et al., 2018).
6. **Link physical education with school mental-health support.** Physical activity reduces depressive symptoms most in distressed pupils (Recchia et al., 2023). It should complement, not replace, screening and counselling.

7. Research Agenda

1. **Cluster-randomised trials in Indian secondary schools.** These should sample schools from both national and state boards, and from rural and urban areas, and test classroom active breaks, coordinative physical education or yoga against usual practice.
2. **Validated outcome measures.** Use performance-based attention tests (d2-R) alongside validated self-report measures of academic stress (for example the Educational Stress Scale for Adolescents; Sun et al., 2011) and aggression (for example the Buss–Perry Aggression Questionnaire; Buss & Perry, 1992). Check reliability within each group studied.
3. **Mediators.** Measure self-control, sleep and loneliness to test the mechanisms described in Section 3.
4. **Examination-cycle studies.** Follow pupils through the Class X and XII examinations to describe changes in activity, stress and concentration.
5. **Reporting.** Report effect sizes with confidence intervals and analyse clustering by school.
6. **Implementation research.** Study how far board requirements for daily physical education are delivered in practice.

8. Limitations of this Review

This is a narrative review. The search was targeted rather than exhaustive, and studies were not independently screened or appraised by two reviewers. Selection may reflect the authors' judgement. Most included evidence comes from high- and middle-income countries outside India, so its transfer to Indian schools is uncertain. Meta-analyses on attention, executive function and aggression all reported high heterogeneity. The pooled effect on aggression was not robust to the removal of individual studies.

9. Conclusion

Physical activity is a plausible, inexpensive and scalable lever for adolescents' psychological functioning at school. The case is strongest for concentration: fitness, exercise training and short classroom active breaks all improve attention. Physical activity also reduces depressive symptoms modestly, especially in older and more distressed adolescents. It may reduce

aggression when delivered through structured, non-contact activities, though this evidence is weaker. For Indian secondary schools, where academic stress and aggression are common and most pupils are insufficiently active, the practical message is to protect and improve physical education rather than cut it in examination years. Physical educators are well placed to lead the cluster-randomised trials needed to confirm these benefits in Indian state-board and national-board schools.

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Use of artificial intelligence: State honestly how AI tools were used, as required by the target journal. For example: "An AI assistant (Claude, Anthropic) was used to search for and summarise literature and to draft and edit the manuscript. The authors reviewed and verified all content and take full responsibility for it."

Related work: If the companion review on academic stress, aggression and concentration across school boards is submitted or published, cite it here, and tell the editor that both reviews draw on the same doctoral literature review but address different questions.

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