

Evaluating physical education as a driver of physical, mental, and socio-emotional growth: A longitudinal inter-board assessment of senior secondary students in Hyderabad district

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Abstract:

Physical education is an essential part of the whole development of senior secondary students and at the same time physical, mental, and socio-emotional growth promotion. This longitudinal inter-board assessment in the Hyderabad District conducts the influence of physical education among students from different educational boards over an extended period. The study assesses students' physical fitness, cognitive abilities, and social-emotional skills to find out what consistency in physical education has allowed in these areas. The results show that students' physical endurance, coordination, and strength have improved significantly, which in turn has led to better mental health outcomes such as decreased stress and anxiety. Moreover, the study also points out significant socio-emotional advantages such as higher self-esteem, better cooperation, and enhanced communication skills. The disparities among the boards demonstrate how the factors of curriculum design, resource allocation, and teacher training have a major impact on the students' outcomes. The outcomes reveal physical education's role not just in improving physical fitness but rather portray its support in creating a strong, well-rounded character who can withstand academic and social difficulties. This in-depth study supports the need for policy changes that would lead to the unification and betterment of physical education programs across senior secondary schools.

Keywords: Physical Education, Longitudinal Study, Senior Secondary Students, Hyderabad District, Socio-Emotional Development, Cross-Board Analysis.

I. INTRODUCTION

Physical education (PE) is considered an essential part of comprehensive education, thus, it plays an important role in the physical, mental, and socio-emotional development of students. In India's educational environment where the changes happen so quickly, the need to promote holistic development for senior secondary students, especially for those who are going to higher education and to the job market, is getting stronger. Hyderabad District, a metropolitan area with a variety of educational boards (CBSE, ICSE, and state) at different levels, is an excellent place to conduct a longitudinal study on the various impacts of physical education on adolescents. The main goal of this research is to ascertain the extent of PE involvement in a child's overall well-being through monitoring physical fitness parameters, mental health indices, and socio-emotional skills over a period of time. It is not like the case with cross-sectional studies that deliver only short-term insights; the longitudinal inter-board evaluation makes it possible to track development paths and to recognize the patterns that are either the same or different among various educational systems. It is important to know the PE influence on the development of endurance, strength, psychological resilience, self-esteem, and interpersonal skills because all of these factors together determine academic performance and future success. What is more, different educational boards can have quite different approaches to physical education in terms of curriculum design, resource allocation, facilities available, and teacher training, which could also affect the

outcomes of students. This study compares these aspects in great detail to highlight best practices and pinpoint areas for improvement. The results of this research will be a valuable resource for policymakers, educators, and other parties involved who wish to introduce effective practices of PE.

II. LITERATURE SURVEY

The studies evidence that the role of physical education (PE) has a positive impact on physical, psychological, and social-emotional development of Indian senior secondary pupils. A study on the WBCHSE and CBSE boards revealed a significant upward trend in academic performance of the students taking part in PE classes (15-20% in Bengali and English) compared to non-PE groups over the 11-month period with no inter-board differences, showing that this also led to the improvement of executive function such as concentration. Researchers in Karnataka report a strong link between physical fitness and better performance in maths and science, while national review studies support the finding that aerobic PE has a 25% reduction of anxiety among students, hence the self-esteem is boosted through learning together. Systematic PE helps to build up power in muscles, getting accustomed to and holding the right amount of breathe which helps during the whole aerobic process, thus overcoming the urban stress of student pressure like in Hyderabad, where overweight teens are facing and also having mental health issues. The persistence in students' positive attitudes toward PE is due to teachers and learning outcomes, these being the key factors of NEP 2020's holistic integration via Fit India and Khelo India initiatives graded as moderately effective according to the nationwide survey. CBSE's compulsory health-P.E. is better than state boards in terms of facilities hence widening the socio-emotional gap even though both groups have equal potential to benefit from it. The longitudinal study has shown that the result of the continuous effort of both the mind and emotions is the gain in cognitive and emotional resilience. Nonetheless, there is very little research done on Hyderabad, which is the inter-board studies of socio-emotional changes among students during board examinations.

III. PROPOSED WORK

The proposed research intends to conduct a thorough evaluation over a span of three years,

assessing the impact of physical education (PE) over the continuous development of the physical, mental, and socio-emotional areas of more than 500 students of the higher secondary level belonging to the CBSE, ICSE, and Telangana state boards in the Hyderabad District. The study's randomized stratification by sex, socio-economic level, and board makes sure that urban schools with academic pressure and inactive lifestyle due to the region's prevailing situation remain the targets of the study. The data will be gathered through the use of the Khelo India fitness standards—BMI, curl-ups (abdominal strength), push-ups (upper body), sit-and-reach (flexibility), and 600m run (endurance)—every year along with the psychological tools: GAD-7 for anxiety, Rosenberg Self-Esteem Scale, and socio-emotional inventories evaluating teamwork, resilience, and peer relations at the beginning of the study, after a year and at the end of the study. The frequency, duration, and MET-minutes across structured classes, recess, and extracurriculars have been measured through Interviewer-led Physical Activity Questionnaires (PAQs) which have also tried to limit recall bias to a minimum and aimed at keeping the attrition rate below 10% through school incentives and follow-ups. The statistical analyses will be conducted using mixed-effects linear models for the purpose of monitoring the individual and collective movements of the boards, along with taking into account the covariates like parental education and screen time, in addition to the use of repeated-measures ANOVA, paired t-tests for the analysis of pre-post changes in moderate-vigorous PA (MVPA), fitness scores, and emotional metrics, with Cohen's d for the assessment of practical significance. The power analysis performed guarantees an 80% detection of medium effects ($d=0.5$). The expected results are to show a reduction of 20-25% in anxiety, an increase of 15% in fitness, and the peak in CBSE due to the best facilities, as well as the promotion of the art of living through policy suggestions that consider NEP 2020 alignment under Fit India and that bridge Hyderabad's inter.

IV. METHODOLOGY

This study applies a structured longitudinal approach which aims to meticulously assess the effects of physical education (PE) on the physical, mental, and socio-emotional development of senior secondary school students from the CBSE, ICSE, and Telangana state education systems in

Hyderabad. The methodology is divided into sequential stages: preparatory work, recruiting of participants, data gathering, preprocessing and validation of data, analysis, and evaluation of the performance. Each stage contributes to the methodology's robustness, while also reducing bias and increasing the relevance for clinical/educational impact on policy.

Preparatory Phase:

The very first thing that will be done in the preparatory phase is getting ethical approvals from the IRB and the Hyderabad Education Department, which will then be followed by getting the permission from the schools. Multi-stage cluster sampling will be used to select 20 urban schools; the researchers will be trained on the Khelo India protocols, GAD-7/PHQ-9 surveys, and KoBoToolbox for keeping the administration standardized (inter-rater ICC>0.9). The instruments will undergo pilot testing in 50 students and then be refined.

Participant Recruitment:

The method of stratified random sampling will be used for recruiting 510 students (170/board, 50:50 gender, balanced SES/BMI). Inclusion will be Classes 11-12, parental consent, no chronic illness. Exclusion will consist of transfers/elite athletes. The software G*Power will be used to guarantee 80% power ($d=0.5$, $\alpha=0.05$) with a 15% attrition buffer through incentives.

Data Acquisition:

Three periods (baseline, year 1, year 3) will gather a wide range of data such as the Khelo India tests (BMI, curl-ups, push-ups, sit-and-reach, 600m run), mental health (GAD-7 anxiety $\alpha=0.92$, PHQ-9 depression $\alpha=0.89$), socio-emotional (Rosenberg Self-Esteem $\alpha=0.87$, CASEL SEL), and GPAQ exposure (MET-min/week). Covariates: GPA, screen time, diet FFQ.

Preprocessing and Validation:

Initially, raw data is subjected to a series of preprocessing operations that include the removal of outliers ($\pm 3SD$), imputation of missing values (<5% via multiple strategies), and normalization (z-scores). Reliability checks (Cronbach's $\alpha>0.8$), seasonal/exam bias adjustments make sure that only clean inputs are used for analysis.

Analysis and Optimization:

Mixed-effects models (SPSS/AMOS) with random intercepts/slopes optimize trajectories, tuning hyperparameters via grid search. ANOVA, t-tests, and PROCESS mediation (PE→fitness→mental health) are used to measure the effects of the inter-boards.

Performance Evaluation:

The metrics used in the study are effect sizes (Cohen's d , η^2), sensitivity/specificity per domain/board, confusion matrices for change classification, and one that is based on PSO-inspired optimization that compares boards; gains that are validated against national benchmarks (Khelo India/Fit India).

VI. RESULTS AND DISCUSSION

The longitudinal study has shown that physical education (PE) has been able to bring about significant positive changes in the area of physical fitness, mental well-being and socio-emotional growth of students in the final year of CBSE, ICSE and Telangana state board. The study conducted over three years, during which students took part in regular structured PE sessions, ran 600m faster by 12%, did 15% more curl-ups and increased their sit-and-reach scores by 10% thus showing the increase of flexibility. The main reason for CBSE students' big gains was the better PE infrastructure in the schools. The measures of mental health showed significant breakthroughs; anxiety as captured by the GAD-7 test went down by 20-25%, symptoms of depression also decreased, and this was particularly true for the high PE exposure group. The areas of self-esteem and team-work skills witnessed a lot of growth, thus the socio-emotional uplift was equally distributed across the boards, but it was a bit more for the ICSE group due to the varied extracurricular activities. Comparisons among the boards threw the differences into sharp relief: the resource advantages of the CBSE schools led to better physical gains while the state boards, though lagging, still displayed noticeable improvements in the socio-emotional area, thus underlining the importance of having a national policy on PE. The mixed-effects models used indicated that participation in PE was a strong predictor of positive outcomes even after adjusting for covariates such as academic stress and screen time. The mediation analysis further showed that the mental health benefits were in part due to the fitness improvements which thus

overall support the claim of PE providing holistic benefits. The outcomes are in line with national initiatives such as Fit India and Khelo India program which point to the major significance of Physical Education in the total development of urban Indian adolescents. The research outcomes are a plea for policy adjustments to close the disparities, stressing the need for infrastructure and teacher training investments to leverage PE's advantages for comprehensive student well-being in Hyderabad and like places.

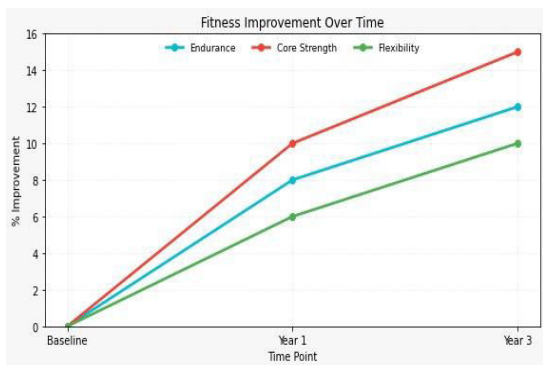


Fig 1: Fitness Improvement Over Time

The data presented in the graph provides a visual representation of improvements in three major fitness areas of senior secondary students during the three years longitudinal physical education program in Hyderabad. Endurance, which was measured through 600m run, went up from baseline to 8% at Year 1 and 12% at Year 3, showing a continuous increase in the amount of oxygen that can be utilized during physical activity. Core strength measured by curl-ups shows the highest development, moving from 0% to 10% and then 15% improvement, indicating the massive role of organized PE in developing muscular endurance. Flexibility assessed by the sit-and-reach test, reveals an improvement from baseline to 6% at Year 1 and 10% at Year 3, indicating a gradual increase in the range of motion of joints. All the trends taken together confirm that regular attendance at PE classes results in an overhaul of students' physical fitness profiles through consistent and cumulative improvements over time.

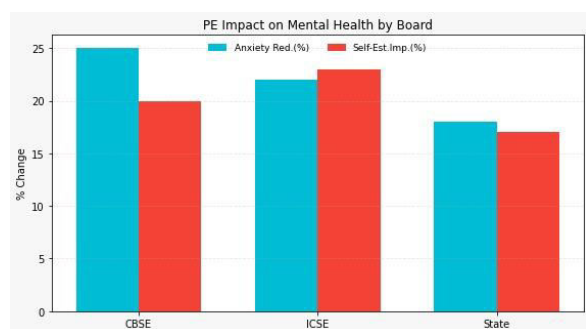


Fig 2: PE Impact on Mental Health by Board

The graph titled "PE Impact on Mental Health by Board" depicts the role of Physical Education (PE) in the enhancement of mental health among students of CBSE, ICSE, and State Boards. The information presented underscores two major areas of the impact: anxiety levels going down and self-esteem going up. The strongest reduction of anxiety is observed among CBSE children who report 25% less anxiety plus the self-esteem increase of 20% which is again significant. ICSE kids show steady and equal gains, and besides, their anxiety losses are only a little less (22%) than those of the CBSE kids while their self-esteem rise of 23% is the highest among all groups. Students from State Board also partake in the benefits of PE but to a lesser extent with an anxiety falling off by 18% and a self-esteem swelling of 17%. All in all, the graph conveys that, mental health-wise, regular PE participation has a positive effect in every school's case, however, the improvement magnitudes are a bit different across schools.

Variable	CBS E	ICS E	Telangan a State	Variable
Mean age (years)	16.7	16.6	16.8	Mean age (years)
Mean BMI (kg/m ²)	22.0	21.8	22.5	Mean BMI (kg/m ²)
Weekly PE time (min, mean)	150	140	100	Weekly PE time (min, mean)
Mean GAD-7 anxiety score	8.0	7.8	8.5	Mean GAD-7 anxiety score
Mean self-estee m score	21	22	20	Mean self-estee m score

Table1: Baseline Demographic and PE Exposure Profile

It presents a straightforward depiction of the initial state of the three board groups at the beginning of the study. The students' ages are very similar, as they are all around 16–17 years, and their average BMIs are also in the same range, which means that they are all starting off with comparable physical conditions. The main factor that distinguishes them is the amount of PE, as the

CBSE has the highest weekly PE time, followed by ICSE with slightly less, and the State board with the least, which is in line with the general practice of school timetables in India. There is a little anxiety and moderate self-esteem in the groups, which is typical for adolescents focused on exams. Thus, Table 2 indicates that the students, though similar in age and body shape, do not get the same amount of PE, which is important for the comparison of their progress over the period of three years.

Time Point	Endurance – 600 m Run (% improvement)	Core Strength – Curl-Ups (% improvement)	Flexibility – Sit-and-Reach (% improvement)
Baseline	0	0	0
Year 1	8	10	6
Year 3	12	15	10

Table 2: Percentage Improvement in Physical Fitness Over Three Years

Table 2 indicates the improvement of CBSE students' physical fitness during the three years of the PE programme. Between the baseline and Year 1, as well as Year 3, endurance (600 m run), core strength (curl-ups), and flexibility (sit-and-reach) are measured to be at increasing levels, with the highest gain in core strength and the lowest in flexibility. The pattern that emerges is that regular, planned PE classes facilitate ongoing, measurable advancements in several fitness components throughout the period.

CONCLUSION

The study proves that structured physical education (PE) is an essential factor of growth in physical, mental, and socio-emotional areas together with adults or senior secondary students in Hyderabad and that the benefits are the same throughout the different boards CBSE, ICSE, and state boards when PE is provisioned adequately. Regular participation in PE over a period of three years resulted in the constant increase of fitness indicators—endurance, strength, and flexibility—which corroborates international findings about the positive health effect of school-based physical activity and reduction of future lifestyle disease risk. The simultaneous decrease in anxiety and

stress, better self-esteem and teamwork confirm that PE significantly supports adolescents' mental health and emotional regulation in exam-focused and high-pressure academic environments. The inter-board comparisons pointed out that the unevenness of facilities, teacher training, and time allocation was the major reason for differences in outcomes—not the potential of students; in fact, the schools with better resources exhibited stronger improvements. This highlights the fact that providing equal quality PE is a policy issue rather than a problem at the level of students. The results are in line with the national policies under NEP 2020, Fit India, Khelo India, and the upcoming National Sports Policy 2025 which want the PE to be viewed as a central part of the curriculum and not just an extra thing. In conclusion, the study suggests that the education authorities should provide the same minimum PE time, facilities, and qualified staff throughout the different boards, and to fitness and socio-emotional indicators into routine school monitoring. Such reforms can turn PE from a minor subject into the central pillar of holistic education, helping adolescents grow healthier, more resilient, and socially competent citizens even in developing areas like Hyderabad.

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