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Team Teaching Models in Physical Education and Their Impact on Physical Fitness in Primary School Children

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Abstract

Addressing inconsistencies in effective instructional delivery, this quasi-experimental study investigated the effect of various team teaching models in primary school physical education (PE) on the physical fitness of children. A sample of N =266 students (grades 1–4, mean age 7.68 years) from the Bratislava region participated in a five-month PE intervention. Intact classes were assigned to one of five instructional configurations: a single PE teacher (PET-only) and four team teaching models: Generalist Teacher + Sports Coach (GT+C), GT+PET, Assistant Teacher + PET (AT+PET), and GT+AT. Physical fitness was assessed pre- and post-intervention using the Standing Long Jump, Shuttle Run, Sit-and-Reach, and Pull-up Hold tests. To investigate the association between physical fitness and self-perceived physical literacy, PLAYself questionnaire was applied. The Kruskal-Wallis H-test showed significant differences in the magnitude of change across all four physical fitness components ($p< .01$). Most importantly, no single team teaching model demonstrated superiority across all domains; however, configurations involving PET or assistant support (GT+PET, AT+PET, GT+AT) generally showed more favourable gains in strength and endurance components. Crucially, self-perceived physical literacy showed a weak alignment with objective fitness, with only one of eight correlations (Pull-up Hold: $\rho = .177$, $p = .009$) reaching statistical significance at baseline. Conversely, out-of-school organized sport participation, particularly its frequency and competitive involvement, showed moderate to strong positive correlations with better physical fitness outcomes. These findings suggest that the composition of the teaching team and organized out-of-school sport participation influence physical fitness levels. The study supports the potential of certain collaborative instructional structures to enhance physical fitness in primary school children but also highlights the complexity of connecting self-perception of physical literacy with objectively measured performance in this age group.

Keywords: *tandem teaching, elementary school, physical education, physical fitness, physical literacy*

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Introduction

Team teaching, also known as co-teaching or tandem teaching, is a collaborative instructional model where two professionals jointly instruct students in a single classroom (Cook & Friend, 1995, 2010). At its core, this approach is a dynamic partnership based on shared responsibility and mutual goals, which requires continuous communication (Hargreaves & O'Connor, 2018). As a key component of educators' professionalism, effective team teaching positively influences instructional choices and student outcomes (Strogilos et al., 2023). This collective teaching facilitates "activating learning" by enabling educators to provide equal attention, better address various learning needs, and engage all learners more quickly (Abrami et al., 2015; Veteska et al., 2020).

This flexible approach is adaptable to all school subjects, including Physical Education (PE), and encompasses various distinct models. Initially categorized into five approaches (Cook & Friend, 1995), the framework was later refined into six models (Friend et al., 2010). The specific model utilized is often influenced by teacher training and professional experiences (Pancsofar & Petroff, 2016; Colson et al., 2021), with the "One Teach, One Assist" model being most frequent due to lower joint planning demands (Arias, 2024). Team teaching is known to provide students with richer learning experiences and diverse perspectives (Baeten & Simons, 2016), and it fosters an inclusive culture by increasing curriculum access for all learners (Cook & McDuffie-Landrum, 2019).

The use of team teaching is gaining traction in primary school PE in several contexts, including the UK (Jones & Green, 2015; Dockerty & Pritchard, 2023) and Ireland (Ní Chróinín & O'Brien, 2019). Crucially, similar trends are emerging in Central and Eastern Europe, such as Slovakia (Luptáková et al. 2025a; Balga et al., 2024) and North Macedonia (Klincarov et al., 2018; Popeska, 2022). This growth is primarily driven by concerns that generalist teachers often lack the necessary competence to provide Quality Physical Education (Duncombe et al., 2018; Spittle et al., 2022; Dockerty & Pritchard, 2023; Randall, 2023; Petračić, 2023). Consequently, policies in countries like Italy (Aliberti et al., 2025), Croatia (Gerovac et al., 2025), and North Macedonia (Luptáková et al., 2025b) are shifting to entrust PE to trained specialists (such as PE teachers or sports coaches). The implementation of specialized instruction, however, varies significantly by country: In Croatia, a solo instruction model is utilized where PE kinesiologists teach the subject instead of the generalist teacher. Gerovac et al. (2025) found that students taught by kinesiologists significantly outperformed the control group taught by generalist teachers in motor skills. Conversely, North Macedonia has adopted national legislation making the team teaching approach mandatory at the primary level, which involves a PE teacher working alongside the generalist classroom teacher (Luptáková et al., 2025b). Meanwhile, Slovakia implements the 'Coaches in Schools' initiative, integrating certified sports coaches into primary school PE instruction (Balga, 2024). The inclusion of these professionals ensures evidence-based pedagogical approaches that promote holistic development (Aliberti et al., 2025).

Following the examination of instructional methods, it is important to consider how the effectiveness of these models is evaluated. To objectively evaluate the effectiveness of these collaborative instructional models, it is crucial to monitor changes in key health-related outcomes, particularly physical fitness. Physical fitness assessments are vital for monitoring a subject's physical condition and the effects of physical activity (González-Rico & Ramírez-Lechuga, 2018). PE teachers play a vital role in this process, leveraging fitness monitoring as an educational tool to foster students' physical literacy (PL) and lifelong physical activity (Sepahvand et al., 2025). Objective assessment tools for children and adolescents include test batteries such as ALPHA-Fitness (Ruiz et al., 2011), EUROFIT (Adam et al., 1988), or the more recent FitBACK (Ortega et al., 2023). Since physical fitness (or motor competence) is only one component of the broader complex of PL (Whitehead, 2010), the subjective component must also be considered (Pastor-Cisneros et al., 2021). Objectively measured and self-perceived motor competence are both important factors influencing physical activity levels (Chai et al., 2023).

Previous research supports a direct relationship between objectively measured fitness and self-perceived fitness (Ortega et al., 2011; Štefan et al., 2019), suggesting a higher self-perceived level is associated with higher PL. Studies also demonstrate a relationship between PL and self-perceived physical fitness in children, linking it to motivation, self-concept, and self-esteem (Pastor-Cisneros et al., 2021). Importantly, cardiorespiratory fitness has been identified as one of the most relevant and influential factors in total PL scores (Pastor-Cisneros et al., 2021; Nezondet et al., 2023).

Despite the fact that the benefits of both team teaching and specialized instruction are evident, and the components of physical literacy are well-defined, there remains a lack of experimental evidence directly comparing the efficacy of different team teaching models on objective physical fitness gains and their alignment with self-perceived physical literacy in primary school children. Therefore, the primary aim of this quasi-experimental study was twofold: to investigate the effect of various team teaching models in primary school PE on children's physical fitness gains; and to investigate the association between these objectively measured outcomes and students' self-perceived physical literacy.

Materials and methods

Participants and design

A sample of N=266 primary school students (grades 1–4) participated in this investigation. The cohort consisted of n=143 boys and n=123 girls, with an average age of 7.68 years (SD = 1.10). The study recruited convenience samples from three primary schools within the Bratislava area that volunteered to engage in the research. The project adopted a cluster-based, quasi-experimental design, where the intact classroom served as the assignment unit. This methodology was chosen to maintain the ecological validity of the five-month PE intervention in real-world school settings; the intervention involved the standard school curriculum delivered over two 45-minute sessions each week from T1 to T2. However, this cluster-based, non-random assignment introduced the potential for selection bias and confounding variables. Indeed, preliminary analysis confirmed statistically significant baseline differences across groups regarding age, height, and all four physical fitness components ($p < .05$). This non-randomization was not feasible to avoid due to mandatory school administrative and scheduling constraints, which required the preservation of intact class structures for the duration of the study.

All procedures involving minors were executed only after securing parental or legal guardian written informed consent. The study was reviewed and received favourable ethical clearance (Approval no. 10/2024, dated 21.6.2024) from the Ethics

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Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia. All research activities conformed to the established guidelines of the Declaration of Helsinki.

The primary aim was to investigate the effect of instructional structure on students' physical fitness. Accordingly, pre-existing classes were non-randomly assigned to one of five instructional arrangements. These arrangements included a baseline condition (single PE teacher) and four variants of team teaching. The five teaching configurations represent the manipulated variable in this design. Detailed participant characteristics for each configuration are outlined in Table 1, and the specific composition of the teaching teams, including qualifications and defined roles, is provided in Table 2.

Table 1. Participant Demographics by Teaching Models

Teaching model	n (students)	Mean age (years)	SD
PE teacher-only	48	7.44	1.27
Generalist teacher + Coach	48	6.58	.54
Generalist teacher + PE teacher	44	7.66	1.54
Assistant teacher +PE teacher	82	7.70	1.21
Generalist teacher +Assistant teacher	44	7.68	.64

Table 2. Operational Definitions of Teaching Models

Teaching model	Teacher composition	Key teacher qualifications	Intended roles
PET	Single Certified PE Teacher	Master's in PE; single-teacher group.	PET (All instructional roles)
GT+C	Generalist Teacher + Sports Coach	GT (Primary Ed Master's); Coach (Sport Science/License; national program).	Lead: Coach (skill execution). Support: GT (classroom management/pedagogy).
GT+PET	Generalist Teacher + PE Teacher	GT (Primary Ed Master's); PET (PE Master's).	Lead: PET (motor skill development). Support: GT (pedagogy/class management).
AT+PET	Assistant Teacher + PE Teacher	AT (Pedagogical Sciences; after-school); PET (PE Master's).	Lead: PET (motor skill development). Support: AT (management/individual assistance).
GT+AT	Generalist Teacher + Assistant Teacher	GT (Primary Ed Master's); AT (Pedagogical Sciences; after-school).	Lead: GT (lesson delivery). Support: AT (supervision/behavior management).

The intervention utilized the standard state-mandated PE curriculum for the primary level in Slovakia. Crucially, the specific lesson content and pedagogical choices were not standardized, mandated, or monitored by the research team across the five instructional groups. The study aimed to investigate the efficacy of the different teacher configurations operating in their typical, naturalistic environment. This decision reflects a commitment to ecological validity, but it must be acknowledged that lesson content variability represents an uncontrolled confounding factor in the interpretation of the subsequent results.

Prior to the intervention, all participating teachers were individually or collectively briefed by the research team regarding the study's requirements. This communication focused on the research rationale, the importance of adhering to the intervention timeline, and general guidance on leveraging specialized expertise consistent with the intended roles in Table 2. Consequently, specific team teaching roles were neither formally prescribed nor monitored, meaning the instructional fidelity of the team teaching process remains an unmeasured variable in this study.

Procedures

Assessment occurred at two key time points. Baseline data (T1) were collected in October 2024, immediately preceding the commencement of the five-month PE intervention. Post-intervention data (T2) were gathered in April 2025, marking the conclusion of the experimental period.

Four components of physical fitness were evaluated using standardized tests from the EUROFIT handbook (Council of Europe, 1993). These tests included: the Standing Long Jump, the Shuttle Run test, the Sit-and-Reach test, and the Pull-up Hold.

To investigate the associations between students' physical fitness levels and self-reported physical literacy, the Physical Literacy Assessment for Youth-Self (PLAYself) questionnaire (Physical Literacy Canada, 2023) was administered at both T1 and T2. The questionnaire underwent a rigorous forward-backward translation process to ensure accuracy in the Slovak language. The instrument was administered by teachers to students in Grades 1 and 2, while students in Grades 3 and 4 completed it via self-administration. The internal consistency of the chosen subscale was confirmed at baseline ($\alpha = .72$). For this study, the Physical Literacy Self-Description subscale was used for analysis, as it specifically captures a child's self-efficacy related to participation in physical activity.

To provide contextual insight into the students' overall activity levels, out-of-school physical activity was assessed exclusively at T2. This information was gathered using a non-validated, context-specific questionnaire administered by the teachers. The instrument focused on three primary areas of participation outside the school curriculum: Frequency of Organized Physical Activity, Competitive Involvement (yes/no), and Sport Type (individual or collective sports). This data was intended to complement the findings obtained within the school setting.

Statistics

Data management and analysis were executed using IBM SPSS Statistics Version 21 for Windows. Before the main analyses, the distributional properties of the data, specifically the change scores (Δ), were evaluated for normality using the Shapiro-Wilk test. Given the observed non-normality in these scores and the study's quasi-experimental, cluster-based design, a reliance on non-parametric statistical methods was adopted. We explicitly acknowledge the presence of a cluster effect (students nested within classes), which is typical of educational interventions. While multilevel modeling (MLM), such as mixed effects models, is the ideal approach for nested data, we determined that our sample size (specifically the low number of clusters) was insufficient to reliably implement this advanced analysis.

The established threshold for statistical significance across all tests was set at $\alpha = .05$ (two-tailed).

The primary objective—determining the comparative effectiveness of the five distinct instructional groups—was addressed through a two-step analytical procedure:

1. Analysis of Within-Group Development

To quantify the growth or change achieved within each teaching configuration, the mean difference (Δ) between the baseline (T1) and post-intervention (T2) physical fitness scores was computed for every group. The extent of this change was presented using the 95% Confidence Interval (CI) for the mean difference. Statistical evidence of significant development within a group was established when the 95% CI did not encompass zero.

2. Analysis of Between-Group Differences

To formally test for significant overall differences among the five instructional groups concerning the magnitude of change (T1 to T2 scores), the Kruskal-Wallis H-test was employed. This test was selected as the appropriate methodology to compare independent groups when distributional assumptions (normality) were violated and due to the inherent characteristics of the dependent fitness variables. This analysis was performed separately for each physical fitness outcome measure.

Additionally, Spearman's rank-order correlation (ρ) coefficients were calculated to explore the interrelationships between the measured constructs and to furnish crucial contextual information. Firstly, correlations were computed between the children's self-perceptions of physical literacy and their scores on the objectively measured physical fitness tests. These correlations were calculated independently for both the initial (T1) and final (T2) assessments to observe potential shifts in self-awareness over the intervention period. Secondly, to gauge the potential impact of external factors, correlations were determined between the Out-of-School Physical Activity (OOSPA) variables (categorized by frequency, competitive involvement, and sport type) and the post-intervention physical fitness test results. This step aimed to quantify the influence of habitual external activity on the study's primary outcomes.

Effect sizes were reported for all inferential tests: for within-group changes, $r = Z / \sqrt{N}$; for Kruskal–Wallis tests, ε^2 was computed. Effect sizes and Spearman correlation coefficients were interpreted using conventional cut-offs (.10 = weak, .30 = moderate, .50 = strong), following Cohen's guidelines (Cohen, 1988).

Results

Effects of Team Teaching Models on Physical Fitness Components

To evaluate the effects of different instructional configurations on students' physical fitness, four standardized tests were conducted at both the beginning and end of the intervention. The Kruskal-Wallis H-test revealed statistically significant differences in the magnitude of change across all four physical fitness components.

The strongest differentiation between groups was observed in flexibility (Sit-and-Reach) ($H(4) = 59.07$, $p < .01$), with a large effect size ($\eta^2 = .26$). The Generalist Teacher + Coach

Table 3. Changes in Physical Fitness by Instructional Group

Groups		Mean	95% Confidence Interval for Mean		Std. Deviation	Median	Minimum	Maximum	Interquartile range
			Lower Bound	Upper Bound					
Sit-and-Reach [cm]	PET	.03	-2	2.07	3.68	0	-9.5	6	4.5
	GT+C	1.19	.45	1.93	1.83	1.5	-3	3	4
	GT+PET	-3.17	-6.96	.62	10.52	1	-32	12	11.13
	AT+PET	-9.92	-13.49	-6.36	10.85	-11.5	-36	17	10.75
	GT+AT	-7.26	-11.18	-3.35	9.05	-6	-32	12	10
Standing Long Jump [cm]	PET	3.67	-2.76	10.09	11.6	3	-20	33	10
	GT+C	.35	-4.51	5.21	12.03	0	-28	27	14.75
	GT+PET	3.75	-.01	7.51	10.42	2.5	-18	38	10.75
	AT+PET	13.45	9.18	17.71	12.97	13.5	-8	44	18
	GT+AT	2.96	-3.01	8.92	13.8	3	-31	30	20
Pull-up Hold [s]	PET	1.05	-4.56	6.67	10.14	2.1	-19.3	20.5	2.8
	GT+C	-1.19	-2.43	.05	3.07	-.85	-8.62	4.88	3.48
	GT+PET	6.59	3.74	9.44	7.9	3.69	-3.1	29.1	12.61
	AT+PET	1.86	-.72	4.44	7.85	1.74	-13.03	31.85	9.52
	GT+AT	2.15	.93	3.36	2.81	1.24	-.78	8.62	4.07
Shuttle Run [m]	PET	6.67	-18.33	31.67	45.15	20	-60	80	80
	GT+C	-140	-245.38	-34.62	260.89	-40	-920	80	195
	GT+PET	-83.13	-153.83	-12.42	196.1	10	-700	80	230
	AT+PET	18.42	-15.8	52.64	104.12	0	-240	460	65
	GT+AT	52.17	7.41	96.94	103.53	40	-180	380	100

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Table 4. Mean Ranks and Effect Sizes (η^2) for Changes in Physical Fitness Components by Instructional Group

Test Statistics[a,b]				
	Sit-and-Reach [cm]	Standing Long Jump [cm]	Pull-up Hold [s]	20-meter Shuttle Run [m]
Chi-Square	59.066	15.999	29.770	30.578
df	4	4	4	4
Asymp. Sig.	,000	,003	,000	,000

a. Kruskal Wallis Test; b. Grouping Variable: Group: 1 - PET 2 - GT+C 3 - GT+PET 4 - AT+PET 5 - GT+AT

(GT+C) group achieved the highest mean rank (143.91) and was the only configuration to achieve a statistically significant absolute gain (Δ = +1.19 cm; 95% CI: .45, 1.93). In contrast, the AT+PET and GT+AT groups experienced significant declines, while the PET-only group (Mean Rank 136.99) maintained baseline levels with no significant change.

Group differences in lower-body explosive strength (Standing Long Jump) were significant with a medium effect size ($H(4) = 16.00$, $p < .01$, $\eta^2 = .06$). The Assistant Teacher + PE Teacher (AT+PET) group demonstrated the highest mean rank (136.17) and the most substantial absolute improvement (Δ = +13.45 cm), which was statistically significant (95% CI: 9.18, 17.71). While the PET-only and GT+PET groups showed positive trends, their confidence intervals crossed zero, indicating these changes were not statistically significant within the groups.

Significant differences were found in upper-body endurance development (Pull-up Hold) ($H(4) = 29.77$, $p < .01$), representing a large effect size ($\eta^2 = .12$). The GT+PET group achieved the highest mean rank (144.96) and the largest significant improvement in performance (Δ = +6.59 s; 95% CI: 3.74, 9.44). The GT+AT group also recorded a significant gain (Δ = +2.15 s). Conversely, the PET-only group (Mean Rank 104.86) showed no statistically significant change (95% CI: –4.56, 6.67), suggesting that the solo-specialist model did not induce measurable gains in this domain.

Table 5. Kruskal-Wallis Test Statistics for Between-Group Differences in Physical Fitness

Ranks				
Group: 1 - PET 2 - GT+C 3 - GT+PET 4 - AT+PET 5 - GT+AT		N	Mean Rank	η^2
Sit-and-Reach [cm]	Physical Education Teacher	36	136.986	.261
	Generalist Teacher and Coach	47	143.915	
	Generalist Teacher and Physical Education Teacher	41	126.476	
	Assistant Teacher and Physical Education Teacher	59	69.237	
	Generalist Teacher and Assistant Teacher	33	74.848	
	Total	216		
Standing Long Jump [cm]	Physical Education Teacher	36	96.223	.057
	Generalist Teacher and Coach	47	98.330	
	Generalist Teacher and Physical Education Teacher	41	97.780	
	Assistant Teacher and Physical Education Teacher	59	136.169	
	Generalist Teacher and Assistant Teacher	33	100.227	
	Total	216		
Pull-up Hold [s]	Physical Education Teacher	36	104.861	.123
	Generalist Teacher and Coach	45	75.844	
	Generalist Teacher and Physical Education Teacher	41	144.963	
	Assistant Teacher and Physical Education Teacher	59	99.144	
	Generalist Teacher and Assistant Teacher	33	121.939	
	Total	214		
20-meter Shuttle Run [m]	Physical Education Teacher	37	103.892	.127
	Generalist Teacher and Coach	42	77.452	
	Generalist Teacher and Physical Education Teacher	40	90.05	
	Assistant Teacher and Physical Education Teacher	59	118.297	
	Generalist Teacher and Assistant Teacher	36	147.958	
	Total	214		

The teaching models significantly influenced endurance outcomes (Shuttle Run) ($H(4) = 30.58$, $p < .01$), with a medium effect size ($\eta^2 = .13$). The GT+AT group achieved the highest mean rank (147.96) and displayed the most effective development, with a significant mean increase of +52.17 m (95% CI: 7.41, 96.94). The GT+C group had the lowest mean rank (77.45) and a severe decline in performance (Δ = -140.00 m), though this was skewed by outliers. The PET-only group again showed no significant change (95% CI: –18.33, 31.67).

Associations Between Physical Fitness and Self-Perceived Physical Literacy

Secondly, the association between physical fitness and self-perceived physical literacy was investigated. At the initial testing, the PLAYself total score demonstrated a statistically significant positive correlation with the pull-up hold ($\rho = .177$, $p < .01$). However, no significant associations were found with sit-and-reach ($\rho = -.093$), standing long jump ($\rho = .017$), or the 20-meter shuttle run ($\rho = .069$). At final testing, no significant associations emerged between self-perceived physical literacy and any of the physical fitness measures (all $p > .05$) (Table 6). With only one of the eight correlations reaching statistical significance after the intervention, these findings suggest that children's self-reported perceptions of their physical literacy are not broadly aligned with their objectively measured physical fitness (Table 7).

Table 6. Associations Between Physical Fitness and Self-Perceived Physical Literacy – Pre intervention

	PLAYself		
	Correl. Coeff.	Sig.	N
Sit-and-Reach	-.093	.173	218
Standing Long Jump	.017	.806	218
Pull-up Hold	.177	.009	218
Shuttle Run	.069	.318	212

Table 7. Associations Between Physical Fitness and Self-Perceived Physical Literacy – Post intervention

	PLAYself		
	Correl. Coeff.	Sig.	N
Sit-and-Reach	.03	.685	185
Standing Long Jump	-.054	.468	184
Pull-up Hold	.067	.364	185
Shuttle Run	.006	.936	190

Associations Between Physical Fitness and Organized Out-of-School Sport Participation

In addition to above-mentioned association, the correlations between physical fitness components and organized out-of-school physical activity participation are presented in Table 8. Frequency of participation in organized sport showed moderate to strong positive correlations with several physical performance metrics. Notably, it was positively associated with standing long jump performance ($\rho = .357$, $p < .01$), pull-up hold ($\rho = .238$, $p < .01$), and shuttle run ($\rho = .220$, $p < .01$). Our data confirm that students who engage more frequently in organized physical activity outside of school tend to display greater levels of physical fitness components.

In contrast, competitive involvement (coded such that higher values reflect less frequent participation in competitive settings) was negatively associated with key outcomes. Significant inverse relationships were observed with standing long jump ($\rho = -.412$, $p < .01$), pull-up hold ($\rho = -.281$, $p < .01$), and shuttle run ($\rho = -.200$, $p < .01$), indicating that children regularly engaged in competitive sport settings exhibited better physical performance compared to their peers.

Table 8. Associations Between Physical Fitness and Organized Out-of-school Participation

		Sit-and-Reach	Standing Long Jump	Pull-up Hold	Shuttle Run
OOSPA - Frequency	Correl. Coeff.	-.02	.357	.238	.220
	Sig.	.763	<.001	<.001	<.001
	N	235	235	235	235
OOSPA - Competitive Involvement	Correl. Coeff.	.098	-.412	-.281	-.200
	Sig.	.135	<.001	<.001	.002
	N	235	235	235	235
OOSPA - Sport Type	Correl. Coeff.	-.126	.11	.253	.122
	Sig.	.054	.094	<.001	.062
	N	235	235	235	235

As part of the background assessment, children reported the type of organized sport they engaged in outside school. Overall, 43.0% participated in collective sports, 39.5% in individual sports, 1.2% in both, and 16.3% reported no participation. This variable demonstrated a statistically significant positive correlation with pull-up hold ($\rho = .253$, $p < .01$). However, associations with sit-and-reach ($\rho = -.126$), standing long jump ($\rho = .110$), and shuttle run ($\rho = .122$) did not reach statistical significance. These findings suggest that while the type of sport may have some influence, the frequency and competitiveness of participation are more consistent predictors of physical fitness.

Discussion

Main Findings

The primary aim of this quasi-experimental study was to

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investigate the efficacy of various team teaching models in primary PE on the objective physical fitness development of children, and to explore the alignment between these objective gains and students' self-perceived physical literacy (PL). The findings provide novel evidence directly comparing different instructional configurations. Consequently, rather than identifying a single 'gold standard' model, the findings reveal that instructional efficacy is not universal, but strictly dependent on the specific fitness domain being targeted. In fact, our results unequivocally demonstrate that the instructional configuration is a crucial determinant of student physical fitness gains, with statistically significant differences observed across all four measured EUROFIT components. The strongest and most crucial insight is not that one model wins, but that different collaborative structures maximize different physiological outcomes. This finding supports the broader literature that effective teaching practice, often facilitated by collaborative models, positively influences student outcomes (Strogilos et al., 2023). This complex pattern of differentiated gains stands in marked contrast to the parallel study on the same cohort (Luptáková et al., 2025c), which found no comparative difference between instructional groups for broad measures of Motor Competence (MC), assessed by MOBAK. The contrasting results indicate that the instructional structure's influence may be highly specific to the physical dimension being measured - fitness versus motor skill. This suggests that unlike motor competence, which appears robust to instructional variation, physical fitness is a highly sensitive adaptation that relies strictly on the specific expertise and pedagogical focus provided by the collaborative team.

The primary finding is the consistent observation that team teaching configurations involving a specialist professional yielded superior outcomes compared to the single PE teacher model across three of the four fitness domains measured: upper-body endurance, lower-body explosive strength, and aerobic endurance. Therefore, it is concluded that the combination of a specialist's pedagogical and content knowledge with the generalist's classroom management and student knowledge—a core benefit of team teaching (Cook & Friend, 2010)—creates a synergistically effective learning environment. This finding is particularly salient because the PE Teacher-only configuration failed to produce any statistically significant change in three out of four fitness components. While this contrasts with recent findings favouring solo kinesiologists (Gerovac et al., 2025), our data crucially suggest that a specialist's expertise is not a self-sufficient guarantee of success, but a resource that requires the collaborative scaffolding of a second educator to be fully realized. Our data strongly challenge the assumption that simply having a trained PE specialist is sufficient for measurable gains in primary school PE. Instead, the results demonstrate that the collaborative component of team teaching is the critical factor for improved outcomes. This effect likely stems from the practical advantages of having two adults, such as the capacity to offer more personalized attention, enhance classroom management for a larger group, and increase opportunities for continuous progress monitoring (Gardiner, 2010; Thousand et al., 2006). Ultimately, the collaborative structure acts as the essential catalyst, unlocking the specialist's expertise to drive physical gains that a solo educator—even a specialist—cannot achieve alone.

While the team configurations involving the PE teacher excelled in strength and power, the remaining two fitness domains demonstrated the differentiated efficacy of models not relying on the traditional PE specialist. The outcome for Flexibility measured via Sit-and-Reach was particularly distinct: the Generalist Teacher + Coach (GT+C) group was the only configuration to achieve a significant gain. This finding implies that success in specific fitness components may rely less on conventional PE expertise and more on the specialized training of the co-teacher. Coaches, with their typically specific, structured training in physical preparation and mobility routines, may introduce dedicated flexibility work that generalist and PE teachers might otherwise overlook. Conversely, the significant declines observed in the AT+PET and GT+AT groups, alongside the non-significant change for the PET-only group, demonstrate that flexibility development is not an inherent or incidental outcome of a typical, general primary PE curriculum and requires intentional, targeted focus within the lesson content.

The most surprising finding emerged in the outcomes for the Shuttle Run. The greatest improvement was observed in the Generalist Teacher + Assistant Teacher (GT+AT) group, a configuration entirely devoid of a PE specialist or a sports coach. This is a highly significant contrast to the established literature, which consistently emphasizes the importance of specialist training for the provision of Quality Physical Education (QPE) in primary schools (Duncombe et al., 2018; Spittle et al., 2022; Dockerty & Pritchard, 2023). While policy shifts are often driven by concerns over generalist teachers' competence (Petračić, 2023; Randall, 2023), in our study the GT+AT model demonstrated the most effective development in cardiorespiratory fitness. This unexpected success highlights the potential influence of several uncontrolled confounding factors. The most prominent among these is the varied lesson content. For example, the GT+AT team may have focused heavily on high-intensity, continuous physical activities, such as specific running games or circuits that effectively targeted cardiorespiratory fitness. Ultimately, this suggests that unmeasured implementation dynamics—specifically teacher enthusiasm, collaborative fidelity, and student compliance—can act as potent determinants of physical fitness that override the lack of specialist qualifications.

Association Between Physical Fitness and Self-Perceived Physical Literacy

The study secondly sought to investigate the relationship between objectively measured physical fitness and children's self-perception of their Physical Literacy (PL), a construct influencing lifelong physical activity (Whitehead, 2010). The results indicated a lack of alignment between the children's self-reported PL (PLAYself) and their objective physical fitness scores at both T1 and, more decisively, at T2. Only one weak, positive correlation was found at baseline in the Pull-up Hold, and no significant associations emerged post-intervention.

This broad lack of alignment between self-reported PL and objective fitness scores is a critical finding and points to a fundamental difference when comparing physical fitness (EUROFIT) with fundamental movement skills (FMS). Specifically, the companion study using the same cohort (Luptáková et al., 2025c) revealed that self-perceived PL did show a weak but consistent association with objectively measured Motor Competence (MOBAK). At initial testing (T1), positive correlations were found with MOBAK Object-Movement and Self-Movement, relationships that persisted and slightly strengthened at final testing (T2). Therefore, our combined results suggest that while self-perception is disconnected from general physical fitness, children's self-reported literacy is most closely aligned with their proficiency in fundamental manipulative skills. This confirms that a child's physical self-concept is not constructed from abstract physiological metrics, but is anchored exclusively in the tangible, visible mastery of fundamental skills.

Our finding contrasts with some previous research supporting a direct relationship between objectively measured and self-perceived fitness (Ortega et al., 2011; Štefan et al., 2019). However, it is strongly supported by developmental literature focusing on early to middle childhood. Previous literature shows that children in this period undergo rapid physical and mental development, and perceived motor competence changes quickly with age (Barnett et al., 2008). In early childhood, children's perception accuracy is poor, and they tend to overestimate their competence (Chai et al., 2023). This inability to accurately estimate abilities is expected, as children are believed to be able to make sound judgments about their physical competence only after the age of eight (Harter, 1982). Prior to this age, children are less likely to recognize their actual physical competence and do not generally begin to compare their abilities with peers until they are older (Fox & Whitehead, 2010). This developmental shift in self-perception usually occurs within public settings, such as PE and organized sport (Kirk, 2005), making children susceptible to humiliation or embarrassment when they realize their performance is inferior to that of their peers (Washburn & Kolen, 2018). As this study included a large number of students under the age of eight in Grades 1–4, this developmental immaturity likely accounts for the lack of objective-subjective alignment. Consequently, relying on self-reports for this age group yields limited insight, as these students lack the requisite cognitive maturity to distinguish their actual physical limits from their aspirational self-image.

Association Between Physical Fitness and Organized Out-of-School Physical Activity

To provide essential context for interpreting the school-based intervention effects, the study examined the influence of Organized Out-of-School Physical Activity (OOSPA) on post-intervention physical fitness. The results showed that the frequency of organized participation and competitive involvement were moderate to strong predictors of better performance across key fitness metrics.

This robust association is further supported by the companion study using the MOBAK assessment with the same cohort (Luptáková et al., 2025c), which found that OOSPA-Frequency showed significant, albeit weak, positive correlations with both subscales of basic motor competence, both object- and self-movement. Furthermore, higher competitive involvement was significantly linked to better Object Movement skills. In contrast to the objective performance metrics, none of the dimensions of OOSPA demonstrated a statistically significant correlation with self-reported physical literacy. This suggests that while external organized sport participation is clearly linked to actual physical competence—what a child can do—it is not strongly predictive of self-efficacy, or what a child believes they can do, in this young cohort.These observations underscore the substantial impact of activities outside the school environment on physical fitness levels. It suggests that the two 45-minute PE lessons per week are necessary but often insufficient drivers of comprehensive fitness gains for all children. This finding aligns with evidence emphasizing the foundational role of extra-curricular activities: studies examining the influence of extra-curricular sports programs on motor abilities in preschool-aged children (Caput-Jogunica et al., 2009) have shown that the development of sufficient motor proficiencies in early childhood positively correlates with club sport participation and total time spent in sport later in life (Fransen et al., 2014). Therefore, school PE must function not merely as an isolated fitness intervention, but as a motivational catalyst that actively propels students toward the out-of-school participation necessary for lifelong health.

Study Limitations

The findings of this study should be interpreted considering several limitations. First, as a consequence of the quasi-experimental design utilizing intact classes, baseline equivalence across the instructional groups could not be established. Significant pre-intervention differences were observed in students' age, height, and physical fitness levels, which introduces selection bias as a potential confounding factor affecting the comparative magnitude of change. Second, to prioritize ecological validity, the specific lesson content and pedagogical styles were not standardized or mandated by the research team. Consequently, variability in the intensity and focus of physical activities (e.g., a focus on running games vs. gymnastics) likely occurred across groups, representing an uncontrolled variable.

Third, while the study defined specific team teaching roles, the instructional fidelity—the degree to which teachers adhered to these collaborative models versus defaulting to a "one teach, one assist" approach—was not formally monitored. Fourth, regarding the statistical analysis, the study acknowledges a cluster effect (students nested within classes); however, the sample size did not yield a sufficient number of clusters to reliably employ multilevel modeling (MLM). Finally, regarding the subjective measures, the sample included a high proportion of students in early childhood (grades 1–2), a developmental stage characterized by poor accuracy in self-perceiving motor competence, which may limit the reliability of the self-reported physical literacy data.

Practical Implications

The findings of this study offer critical guidance for educational policy and practice. First, the results challenge the growing legislative trend of simply replacing generalist teachers with specialists. Our data indicate that the presence of a specialist alone (PET-only) does not guarantee superior fitness outcomes. Instead, policymakers should prioritize funding and training for collaborative team teaching models, as the synergy between a specialist's content knowledge and a generalist's pedagogical rapport appears to be the primary driver of physical development.

Second, schools should adopt a flexible approach to staffing. Since no single model proved superior across all domains, administrators might consider targeted partnerships—for instance, integrating sports coaches specifically to enhance conditioning and flexibility, while relying on PE teachers for fundamental motor skill development.

Finally, given the strong link between out-of-school sport participation and fitness levels, educators must view PE not just as physical training, but as a gateway to lifelong activity. Teachers should focus on cultivating the affective components

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of physical literacy (confidence and motivation) during lessons to encourage students to engage in organized sport outside of school, as the standard dosage of two PE lessons per week is insufficient to drive comprehensive fitness gains on its own.

Conclusions

This study provides quasi-experimental evidence that the instructional configuration in primary physical education is a significant determinant of student physical fitness development. The results indicate that no single team teaching model is universally superior across all fitness domains; rather, different collaborative structures appear to maximize different physiological outcomes. However, a consistent trend emerged: collaborative teaching models—whether involving a PE teacher, a sports coach, or an assistant—generally yielded greater improvements in strength, endurance, and flexibility compared to the traditional single-PE teacher format.

These findings challenge the assumption that the mere presence of a specialist ensures quality outcomes. Instead, the data suggest that the collaborative mechanism itself—the synergy between two educators—is the critical factor. By combining a specialist's content knowledge with a generalist's or assistant's pedagogical support, schools can create more effective learning environments that surpass what a solo educator can achieve, even if that educator is a specialist.

Furthermore, the study highlights a distinct disconnect between objective physical fitness and self-perceived physical literacy in early to middle childhood. The lack of alignment between children's actual performance and their self-assessment suggests that students in grades 1–4 have not yet developed the cognitive maturity to accurately evaluate their physical capacities. Consequently, physical education programs must prioritize not only physical conditioning but also the development of accurate self-awareness and motivation.

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Conflicts of Interest

The authors declare no conflict of interest.

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