Motor development in school-aged children: A comparison of structured and unstructured physical activity environments

Enrico Serra. *Department Neuroscience, Biomedicine and Movement Sciences. University of Verona. Italy. Department of Human, Philosophical and Educational Sciences. University of Salerno. Italy.*
Silvia Coppola ✉ **.** *Department of Human, Philosophical and Educational Sciences. University of Salerno. Italy.*
Daniele Albano. *Department of Human, Philosophical and Educational Sciences. University of Salerno. Italy.*
Maria Teresa Benincasa. *Department Neuroscience, Biomedicine and Movement Sciences. University of Verona. Italy. Department of Political and Social Studies. University of Salerno. Italy.*
Claudia Costa. *Department Neuroscience, Biomedicine and Movement Sciences. University of Verona. Italy. Department of Political and Social Studies. University of Salerno. Italy.*
Francesco Coiro. *Department Neuroscience, Biomedicine and Movement Sciences. University of Verona. Italy. Department of Translational Biomedicine and Neuroscience "DiBraiN". University of Bari Aldo Moro. Italy.*
Ester Celentano. *Department of Human, Philosophical and Educational Sciences. University of Salerno. Italy. Department of Political and Social Studies. University of Salerno. Italy.*
Rodolfo Vastola. *Department of Political and Social Studies. University of Salerno. Italy.*

ABSTRACT

The present study aims to investigate the influence of structured physical activity (SPA) and unstructured physical activity (UPA) environments on the development of locomotor skills in primary school children. The sample consisted of 148 pupils (mean age = 8.7 ± 0.7 years; 77 girls and 71 boys) attending the third and fourth grades of a primary school located in a rural municipality in southern Italy. Motor skills were assessed by means of the locomotion subtest of the Test of Gross Motor Development – Third Edition (TGMD-3). The results show that 86.5 % of the participants (n = 128) engage in UPA during their leisure time. The mean scaled score for the entire sample was 8.23 points (± 2.68), with 64.2 % of the pupils falling within the "*Average*" level. Children who participate in SPA obtained significantly higher scores than their peers who do not practise structured activity: 8.64 (± 2.74) vs 7.73 (± 2.53) points; p = .038; Cohen's d = 0.34. Multifactorial analysis confirmed a positive main effect of SPA but did not reveal significant interactions between SPA and UPA. Although the data confirm the influence of structured activity on locomotion test outcomes, the non-significance of UPA may be attributable to the characteristics of the subtest items, as these tasks are widespread in sporting practice. The findings highlight the role of rural contexts in promoting unstructured physical activity among school-age children and the contribution of structured physical activity to the development of motor skills. Future research should consider enlarging the sample, including the object-control subtest of the TGMD-3, and further exploring the qualitative relationships between SPA, UPA, and motor development.

Keywords: Physical education, Fundamental movement skills, Locomotor competence, TGMD-3, Rural context, Open- and closed-skill sports, Free play.

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✉ **Corresponding author.** *Via delle Stelle, n.3. Fisciano, Salerno, Italy.*
E-mail: sicoppola@unisa.it

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INTRODUCTION

Physical activity (PA) can be understood as a set of actions and performances shaped by cultural, emotional, ideational and relational factors: "*physical activity involves people moving, acting and performing within culturally specific spaces and contexts, and influenced by a unique array of interests, emotions, ideas, instructions and relationships*" (Piggin, 2020).

A large body of research highlights the crucial role of PA in youth development, documenting its beneficial effects on multiple dimensions of physical and mental health (Coppola et al., 2024a; Biddle & Asare, 2011; Janssen & LeBlanc, 2010) as well as on socio-emotional and cognitive outcomes (D'Anna et al., 2025; Coppola, D'Anna, et al., 2024; McNeill, Howard, Vella, Santos & Cliff, 2018; Ahn, Sera, Cummins & Flouri, 2018; Carson et al., 2017; Donnelly et al., 2016; Rasberry et al., 2011; Best, 2010). In childhood, PA decisively fosters the acquisition and consolidation of motor skills (Coppola et al., 2024b; D'Anna et al., 2022; Iivonen & Sääkslahti, 2014; Timmons et al., 2007).

A childhood marked by regular PA reduces the early onset of risk factors for chronic diseases in adulthood (Strong et al., 2005). Nevertheless, most children (both in high-income and in middle- and low-income countries) do not attain adequate PA levels (Bouchard et al., 2012). Globally, 81 % of young people do not meet international recommendations for daily movement, exposing their present and future health to significant risks (Guthold et al., 2020). Evidence indicates that sedentary behaviour and inactivity, rather than energy intake (which tends to remain stable), explain the decline in physical performance (Tomkinson et al., 2003). At the same time, the amount of time spent in front of television or digital screens is increasing (Twenge & Campbell, 2018; Ten Velde et al., 2021).

This dynamic, characterised by insufficient motor practice and a predominantly sedentary lifestyle, reduces the individual motor repertoire and weakens the protective effects of PA. Such a condition gradually favours childhood overweight and obesity (Mazur et al., 2018, cited in Colella & Vera, 2020). In addition, a sedentary lifestyle during development is associated with negative outcomes for cognitive and brain health, with repercussions for school performance and executive functions (Pontifex et al., 2011; Chaddock et al., 2011; Chaddock et al., 2010a, 2010b; Hillman et al., 2009; Hillman et al., 2008; Castelli et al., 2007).

Article 31 of the United Nations Convention on the Rights of the Child (1989, ratified in Italy by Law 176/1991) recognises every child's right to play and to recreational activities appropriate to age (Yogman et al., 2018). Nevertheless, the meta-analysis by Tomkinson et al. (2003) shows a rapid secular decline in 20 m shuttle-run performance among 6- to 19-year-olds over the past twenty years; similarly, Dordel (2000) reports a regression in coordinative abilities among primary-school children compared with peers from the 1970s. To clarify the link between PA and bio-psycho-social well-being, the systematic review by Poitras et al. (2016) documents favourable associations of PA with adiposity, cardiometabolic biomarkers, fitness, bone health, quality of life, motor-skill development and reduced psychological distress.

World Health Organization guidelines (WHO, 2020) recommend that children and adolescents (5–17 years) engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day, predominantly aerobic throughout the week, together with muscle- and bone-strengthening exercises at least three times per week and systematic reduction of screen time. Yet the majority of children and adolescents do not achieve these levels (Tremblay et al., 2016), and more recent studies indicate further growth in non-compliance (Faigenbaum et al., 2018). The result is a generation of young people with lower strength and speed and higher body weight than in the past, a trend increasingly discussed in specialist paediatrics in relation to rising physical, psychosocial and cognitive disorders (Poitras et al., 2016).

In this context, the concept of physical literacy (PL) assumes particular importance; it represents an educated state of an individual's capacities and the ability to integrate and enhance them. Whitehead contributed substantially to defining this concept and, in 2001, described it as "*the ability to use one's body with skill, effectiveness and pleasure in a variety of contexts. It is the ability to move efficiently, safely and in control, and to utilise one's physical capacities to achieve goals, enjoy oneself and participate actively in life*" (Whitehead, 2001). She subsequently elaborated a five-component model of PL that includes knowledge of one's body and its capacities, competence understood as the safe and effective execution of movements, motivation to engage in PA and remain active, social skills aimed at interacting and collaborating with others and cultural skills, which involve understanding the historical, philosophical and artistic aspects of physical practice (Whitehead, 2010).

Consistent with these principles, the International Physical Literacy Association (IPLA, 2017) points out that motivation, confidence, physical competence, knowledge and understanding are fundamental to promoting a physically active lifestyle across the life course. From this perspective, PL is decisive in young people's holistic development, as it not only provides the foundations for active participation in a variety of physical activities but also fosters understanding of key concepts related to movement and health. According to Lander et al. (2015), PL encompasses motor competence, knowledge of the principles and practices of physical activity and the capacity to integrate these aspects in order to lead an active and healthy life.

A relevant aspect concerns the complex nature of PL, in which motor learning and development unfold through continuous processes of organising and reorganising movements aimed at achieving functional performance (Davids et al., 2023). Such dynamics are not always understood or exploited in teaching-learning contexts, especially in physical-education programmes and extracurricular activities. In many cases, attention focuses only on the development of simple movement capacities such as balance, basic coordination, core stability, flexibility or proprioception, neglecting to combine these skills into more complex and integrated forms such as bilateral coordination, inter-limb coordination, eye–hand coordination, control of accelerations and decelerations or rhythmic movements (Whitehead, 2010).

Understanding these constructs and related variables can inspire more effective intervention strategies aimed at promoting physical competence in young people. It is indeed possible to design appropriate practice opportunities and an environment conducive to PA (Minghelli et al., 2023; O'Brien et al., 2013), as well as assessment tools for physical competence that enable practitioners to monitor and evaluate the effectiveness of interventions (Castelli et al., 2014), thus going beyond the mere quantification of motor skills (Romano et al., 2023).

The *Test of Gross Motor Development* (TGMD-3) is a standardised instrument for assessing the level of development of gross-motor skills in children aged 3 to 11 years, highlighting strengths and weaknesses in view of potential educational or personalised actions (Ulrich et al., 2023). The first version of the test (TGMD) was published in 1985 (Ulrich & Sanford, 1985) to fill an evident gap in assessing motor development in childhood, offering examiners a rapid method for collecting data relevant to key educational decisions. In 2000 a new edition (TGMD-2) was released, introducing important changes following the revisions by Bunker and Edwards. Although recognising the TGMD's exceptional utility in identifying children with gross-motor weaknesses, they pointed out some sampling issues and the need for finer differentiation between boys and girls. Finally, Dale Ulrich published the third version (TGMD-3) in 2019, incorporating further user feedback (Ulrich et al., 2023).

The TGMD-3 can be used to identify children who are significantly delayed relative to their peers, to plan instructional programmes targeting gross-motor development, to monitor individual progress, to evaluate the success of specific interventions and to support research into motor development. The instrument includes two subtests: one for locomotor skills (run, forward gallop, one-leg hops, skip, standing long jump, slide) and one for ball-control skills. Comparisons of raw scores with normative values yield scaled scores, percentile ranks and additional descriptors (ranging from "*poor or delayed*" to "*very advanced*"), while the sum of the two subtests' scaled scores provides the Gross Motor Index, which reflects the child's overall level of gross-motor development. It should be noted that the Italian manual of the TGMD-3 (Ulrich, 2023), unlike the U.S. version, provides gender-specific norms for the locomotor subtest, thereby improving the accuracy of comparisons with the Italian reference population.

The present study sets out to evaluate quantitatively how different forms of motor participation influence the locomotor skills of primary-school children, addressing three main questions. The first concerns the main effect of Structured Physical Activity (SPA): the aim is to verify whether regular participation in organised sports (irrespective of discipline) is associated with higher TGMD-3 locomotor subtest scores than non-participation. The second question pertains to the contribution of Unstructured Physical Activity (UPA) and the possible interaction between SPA and UPA, in order to determine whether spontaneous motor activity during free time further increases locomotor scores and whether a joint effect exists between these variables. Finally, the third question examines the impact of the type of sport practised, analysing whether the open-skill (variable environment) or closed-skill (stable environment) nature of a sport modifies locomotor-skill levels. In summary, the study aims to quantify the main and combined effects of SPA, UPA and sport type on the TGMD-3 locomotor score, providing evidence of their importance for motor development in school-age children.

MATERIALS AND METHODS

Participants

The sample comprised 148 pupils (mean age = 8.7 ± 0.7 years), of whom 77 were girls and 71 boys. They were drawn from the third (n = 73) and fourth (n = 75) grades of a primary school located in a predominantly rural municipality in southern Italy (<10 000 inhabitants). All pupils were involved in a school-year physical-activity project. Inclusion criteria were regular school attendance and voluntary participation in the project; a history of traumatic events with potential impact on motor performance constituted an exclusion criterion.

The study protocol received formal authorisation from the school leadership and approval from the University Department Ethics Committee (Protocol no. 0125702). The research was designed and coordinated by the Laboratory for Innovative Teaching and Sports Performance Analysis at the University of Salerno (UNISA) and was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and relevant national regulations. Parents or legal guardians of every participant provided written informed consent, and data anonymity was guaranteed. All assessments were carried out in the school building, during school hours, under standardised environmental and organisational conditions.

Each pupil was told in simple terms the purpose of the activities (presented as "*movement games to see how you move*"), and the examiner spent a few minutes establishing a positive, reassuring rapport to reduce evaluation anxiety. Before testing, a supervised warm-up of ten minutes of light running and guided joint-mobility exercises was performed to lessen muscle stiffness and injury risk.

The locomotion subtest of the Test of Gross Motor Development – Third Edition (TGMD-3, Italian version) was administered; it requires six fundamental skills (run, forward gallop, one-leg hops, skip, standing long jump and slide). The standardised TGMD-3 instructions were read verbatim, and only neutral encouragement ("*keep going*", "*try again*") was offered, without technical hints. After a practical demonstration by the examiner, each pupil completed one unscored practice trial to confirm understanding; when necessary, a second demonstration was provided before starting the test proper (Ulrich et al., 2023). Each pupil then performed two scored trials per skill, all video-recorded for later scoring. Testing was organised in two separate sessions, with the sample divided and video-recording used to speed execution and facilitate later analysis. The videos were subsequently analysed to score performance criteria, minimising observation errors.

In this study, limited to the locomotion subtest, raw scores were converted into age- and sex-normalised scaled scores. The TGMD-3 manual recommends this equal-interval metric because it allows locomotor abilities to be assessed separately from the normative sample and highlights individual strengths and weaknesses (Ulrich et al., 2023). These properties made the scaled score the most appropriate measure for the planned analyses. Using standardised scores is also consistent with applied literature on motor development (Barnett et al., 2009). For communicative clarity, each scaled score was additionally translated into the seven official descriptive levels, providing results in an immediately understandable format without sacrificing statistical rigour (Ulrich et al., 2023).

After the motor tests, pupils completed a paper questionnaire documenting their physical and sports habits and distinguishing between:

1. Structured Physical Activity (SPA): organised sport, that is, exercise directed by a coach or responsible adult, governed by formal rules and structured training sessions, often including competition (Marques et al., 2016; Chen et al., 2020). To be classified as SPA, the activity had to be practised at least four times per week (each session ≥ 60 minutes) for a minimum of four consecutive months. Children indicated the discipline (e.g., football, basketball, dance, swimming, martial arts), the number of weekly training sessions, regularity and overall duration of participation.
2. Unstructured Physical Activity (UPA): non-structured physical activity carried out outdoors during free time (Brockman et al., 2011) at least four times per week. This category included outdoor games (e.g., free running, ball games), walking or cycling, and other forms of movement not guided by an instructor. Children also reported the average duration of these activities and the consistency with which they were practised.

Analysis

All TGMD-3 data (raw scores and subsequent scaled scores) and the information obtained from the questionnaire (SPA and UPA) were merged into a single digital file (Excel). This integration made it possible to correlate locomotor-skill level with the different forms of motor participation, in line with the objectives of the present study.

All analyses were conducted in Python 3.11 (Pandas 2.2.0, SciPy 1.11.4, Statsmodels 0.14); the significance threshold was set at $\alpha = .05$, and all tests were two-tailed. First, to describe the full sample of 148 children, the mean, standard deviation, median and range of the TGMD-3 locomotor scaled score were calculated; these values were then re-classified into the seven international descriptive categories, and absolute and percentage frequencies were reported. To explore the distribution of categorical variables, contingency tables were produced crossing participation in Structured Physical Activity (SPA: organised sport yes/no), type of sport practised (open-skill vs closed-skill) and the presence of Unstructured Physical Activity (UPA). The category "*absence of UPA*" also includes the eight totally inactive subjects.

Before proceeding with inferential tests, normality of the scaled-score distribution was assessed with the Shapiro–Wilk test, and homogeneity of variances with Levene's test. Because moderate violations of these assumptions appeared in some sub-groups, the Welch version of parametric tests was adopted, as it is suitable when variances and sample sizes are unequal. The main effect of SPA was estimated with a Welch t-test, reporting the t value, p value, 95 % confidence interval of the mean difference and effect size (Cohen's d). The same approach was used to compare the scores of open-skill versus closed-skill athletes; in that case the point-biserial coefficient r_{pb} was also calculated. The same coefficient was estimated for the SPA versus non-SPA comparison (UPA-only + inactive) in order to quantify the association between the respective binary variables and locomotor performance.

To investigate the joint action of SPA and the group "*UPA-only* + *inactive*", a 2 × 2 factorial ANOVA was run via OLS regression, including SPA, the UPA-only + inactive indicator and their interaction term as predictors. Coefficients were tested with Type-II F tests and, for each effect, partial η^2 was reported. As no significant interaction emerged, a Tukey HSD post hoc on the four resulting combinations was nonetheless applied, controlling familywise error; all contrasts returned $p > .35$. For exploratory purposes, the means of the four mutually exclusive sub-groups resulting from the full SPA × UPA cross (SPA + UPA, SPA-only, UPA-only, inactive) were compared via a one-way Welch ANOVA; the global test was not significant ($p = .124$), but, for completeness, the planned contrast between SPA-only and UPA-only is reported with the corresponding Welch t, confidence interval and Cohen's d. Relationships between continuous variables were examined with Pearson correlations, whereas continuous-binary pairings were assessed with point-biserial correlations, both accompanied by 95 % confidence intervals. Missing data, amounting to less than 5 % of the total, were handled by list-wise deletion; multivariate outliers were checked using Mahalanobis distance (χ^2 cut-off, $p < .001$), with no further exclusions required.

This combination of precise descriptive statistics, robust tests and multifactorial models provides a reliable assessment of the effects of SPA, UPA and sport type on TGMD-3 locomotor scores in the sample under investigation.

RESULTS

Sample distribution

In the descriptive analysis, the mean scaled score on the TGMD-3 locomotor sub-test was 8.23 ± 2.68 (median = 9; range = 1–14) for the whole sample. The TGMD-3 locomotor scores were reclassified into seven descriptive categories: Impaired or Delayed, Borderline Impaired or Delayed, Below Average, Average, Above Average, Superior, and Gifted or Very Advanced. Table 1 summarises the distribution of these categories in the third-grade group (n = 73; Fig. 1), the fourth-grade group (n = 75; Fig. 2), and in the total sample. In both grades the most frequent category was Average, and no participant reached the highest categories (Superior or Gifted or Very Advanced). Considering all 148 participants, 95 children (64.2 %) were classified as Average, 25 (16.9 %) as Borderline Impaired or Delayed, 17 (11.5 %) as Below Average, 8 (5.4 %) as Impaired or Delayed, and 3 (2.0 %) as Above Average.

Table 1. Distribution of Grade 3 and Grade 4 children across the seven TGMD-3 locomotor descriptive categories. Columns list absolute counts for each grade, overall totals, and the percentage that each level represents within the entire sample (n = 148).

Descriptive category	Grade 3	Grade 4	Total	Percentage of the sample (n = 148)
Impaired or Delayed	2	6	8	5.4 %
Borderline Impaired or Delayed	14	11	25	16.9 %
Below average	10	7	17	11.5 %
Average	46	49	95	64.2 %
Above average	1	2	3	2.0 %
Superior	0	0	0	0 %
Gifted or Very Advanced	0	0	0	0 %
Total	73	75	148	—

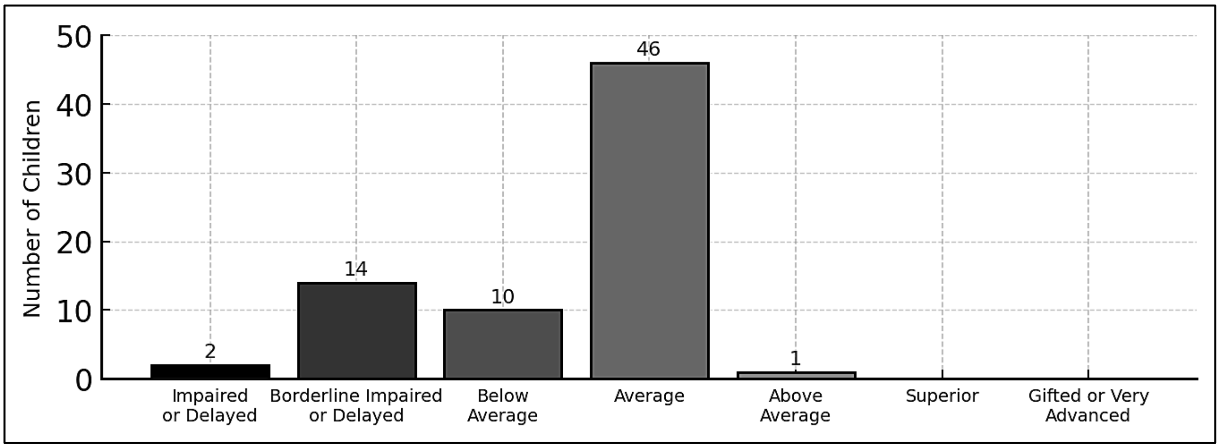

Figure 1. Absolute frequency distribution of third-grade children (N = 73) across the seven TGMD-3 locomotor descriptive categories, ordered from Impaired or Delayed to Gifted or Very Advanced. The y-axis ranges from 0 to 50; most children fell in the Average category (n = 46), while none reached the Superior or Gifted or Very Advanced categories.

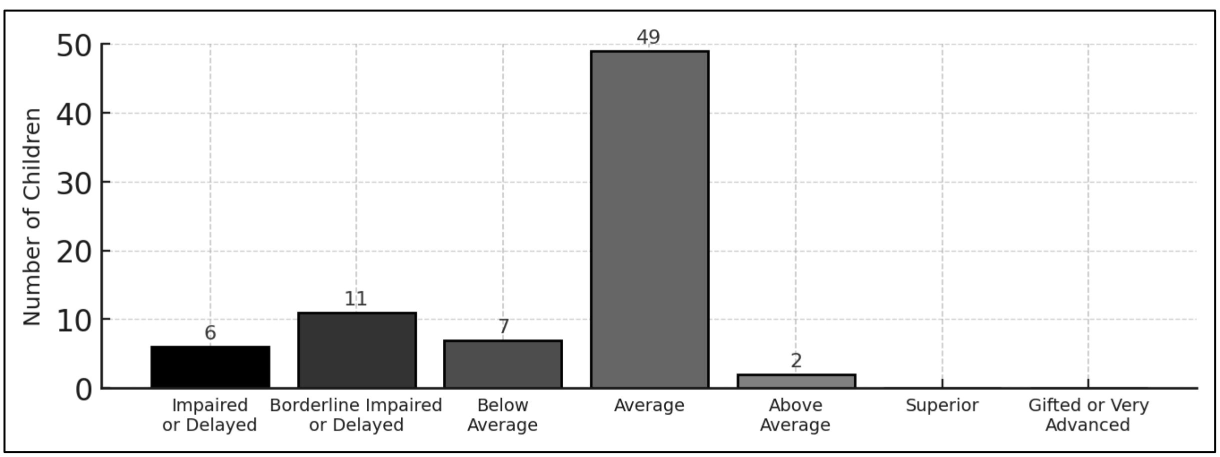

Figure 2. Absolute frequency distribution of fourth-grade children (N = 75) across the seven TGMD-3 locomotor descriptive categories, ordered from Impaired or Delayed to Gifted or Very Advanced. The y-axis ranges from 0 to 50; the predominant category was Average (n = 49), and, as in Grade 3, no child reached the Superior or Gifted or Very Advanced categories.

With regard to motor practice, 54.7 % of the sample (n = 81) took part in Structured Physical Activity (SPA): forty-seven children engaged in open-skill sports (31.8 % of the total) and thirty-four in closed-skill sports (23.0 %). The remaining 45.3 % (n = 67) did not practise any organised sport. Regardless of SPA participation, 86.5 % of the pupils (n = 128) reported performing Unstructured Physical Activity (UPA) in their leisure time. In the remaining 13.5 % (n = 20) no UPA was reported: twelve of these children nevertheless engaged in a structured sport, whereas eight were inactive (neither SPA nor UPA) outside school hours (Fig. 3). Table 2 summarises, for these four subgroups, the sample size together with the mean and the standard deviation of the TGMD-3 locomotor scaled score.

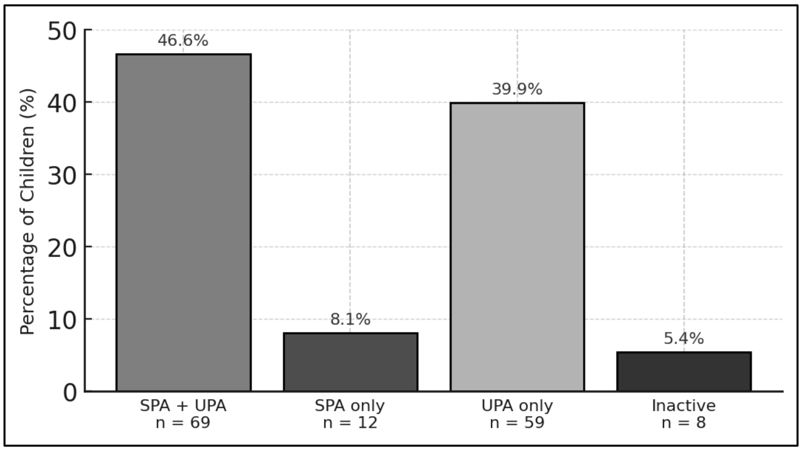

Figure 3. The whole sample (N = 148) is split into four mutually-exclusive physical-activity categories: Structured Physical Activity (SPA) + Unstructured Physical Activity (UPA), SPA only, UPA only, and Inactive (neither SPA nor UPA).

Table 2. Distribution of mean (± SD) TGMD-3 locomotor scaled scores across the four mutually exclusive subgroups obtained by cross-classifying Structured Physical Activity (SPA) with Unstructured Physical Activity (UPA).

Group (SPA / UPA)	Numbers	Mean ± SD (points)
No-SPA / No-UPA (Inactive)	8	7.38 ± 2.07
UPA-only	59	7.78 ± 2.59
SPA-only	12	9.17 ± 1.99
SPA / UPA	69	8.55 ± 2.86

Table 3. Distribution of the 81 children engaged in Structured Physical Activity (SPA) across the five TGMD-3 locomotor categories, split by open-skill and closed-skill sports. Values are counts with row percentages in parentheses; the last row presents the overall totals for each category.

SPA	Impaired or delayed n (%)	Borderline impaired or delayed n (%)	Below average n (%)	Average n (%)	Above average n (%)	Total n
Open-skill	2 (4.3)	4 (8.5)	9 (19.1)	29 (61.7)	3 (6.4)	47
Closed-skill	2 (5.9)	5 (14.7)	3 (8.8)	24 (70.6)	0 (0.0)	34
Total	4 (4.9)	9 (11.1)	12 (14.8)	53 (65.4)	3 (3.7)	81

Restricting the observation to athletes only (n = 81), Table 3 shows that open- and closed-skill sports display similar profiles: in the former, 29 of 47 participants (61.7 %) fell into the Average category and 3 (6.4 %) into the Above Average category; in the latter, 24 of 34 participants (70.6 %) were classified as Average and none as Above Average. Overall, the athlete group included 4 children in the Impaired or Delayed category (4.9 %), 9 in the Borderline Impaired or Delayed category (11.1 %), 12 in the Below Average category (14.8 %), 53 in the Average category (65.4 %), and 3 in the Above Average category (3.7 %).

Table 4 cross-tabulates sport type with UPA. Almost half of the athletic subsample comprised children who engaged in Open + UPA activities (n = 40; 49.4 %); they were followed by those involved in Closed + UPA (n = 29; 35.8 %), whereas groups with no UPA were numerically small (Open + No-UPA: 7 children, 8.6 %; Closed + No-UPA: 5 children, 6.2 %). Within these four combinations, the Average category remained the most frequent: among the Open + UPA group, 24 children (29.6 % of the athletic subsample) fell into this category; similarly, 19 children in the Closed + UPA group (23.5 %) reached the same level. Extreme categories were rare: in total, only 4 participants (4.9 %) were classified as Impaired or Delayed and 3 (3.7 %) as Above Average.

Table 4. Distribution of the 81 children who practise organised sport across the five TGMD-3 locomotor descriptive categories, cross-classified by sport type (open-skill vs closed-skill) and by whether they also engage in Unstructured Physical Activity (UPA). Values are counts with row percentages in parentheses; the final row presents the overall totals for each category.

SPA	UPA	Impaired or delayed n (%)	Borderline impaired or delayed n (%)	Below average n (%)	Average n (%)	Above average n (%)	Total n (%)
Open-skill	Yes	2 (2.5)	3 (3.7)	8 (9.9)	24 (29.6)	3 (3.7)	40 (49.4)
Open-skill	No	0 (0.0)	1 (1.2)	1 (1.2)	5 (6.2)	0 (0.0)	7 (8.6)
Closed-skill	Yes	2 (2.5)	5 (6.2)	3 (3.7)	19 (23.5)	0 (0.0)	29 (35.8)
Closed-skill	No	0 (0.0)	0 (0.0)	0 (0.0)	5 (6.2)	0 (0.0)	5 (6.2)
Total	—	4 (4.9)	9 (11.1)	12 (14.8)	53 (65.4)	3 (3.7)	81 (100)

Comparison between SPA and UPA-only + inactive in TGMD-3 locomotor scores

When children who engaged in SPA were compared with peers who did not take part in structured sport (UPA-only + inactive), a mean advantage of 0.91 scaled points emerged in favour of the SPA group (Table 5). The SPA group, comprising 81 children involved in both open- and closed-skill disciplines, included every participant who performed at least one structured activity, regardless of any Unstructured Physical Activity (UPA), and showed a mean score of 8.64 ± 2.74. The UPA-only + inactive group (n = 67) consisted of 59 pupils who participated solely in UPA and eight who were inactive (neither SPA nor UPA); their combined mean was 7.73 ± 2.53. Welch's t-test confirmed that this difference was significant ($t \approx 2.10$; $p = .038$); the 95 % confidence interval for the mean difference (0.05 – 1.77) did not include zero.

The effect size, calculated as Cohen's d = 0.34, fell within the small-to-medium range. The point-biserial correlation between SPA membership (1 = yes, 0 = no) and the TGMD-3 score was r_{pb} = 0.17 ($p = .039$), accounting for roughly 3 % of the explained variance.

Table 5. Comparison of TGMD-3 locomotor scaled scores between children engaged in Structured Physical Activity (SPA) and age-matched peers who do not practise structured sport (UPA-only + inactive). The n column gives group size; Mean ± SD shows the mean with standard deviation; Cohen's d is the effect size; r_{pb} is the point-biserial correlation with its corrected p value; Mean difference reports the SPA–control difference with a 95 % confidence interval; p (t-test) is the Welch t-test *p*-value.

Group	n	Mean ± SD	Cohen's d	rpb	*p* (corr.)	Mean difference (95% CI)	*p* (t-test)
SPA	81	8.64 ± 2.74	—	—	—	—	—
UPA-only + inactive	67	7.73 ± 2.53	—	—	—	—	—
Total / test	148	—	0.34	0.170	.039	+0.91 pt (0.05 – 1.77)	.038

Factorial analysis of SPA and UPA in TGMD-3 locomotor scores

To examine the combined effect of Structured Physical Activity (SPA) and the UPA-only + inactive condition on the TGMD-3 locomotor score, a 2 × 2 factorial analysis was performed. Structured Physical Activity was defined as every child who engaged in at least one structured motor activity (SPA-only or SPA + UPA); the second factor identified children who either practised only Unstructured Physical Activity (UPA) or were inactive.

The analysis revealed a single significant effect: the presence of SPA. The SPA factor accounted for roughly 3 % of the variance in the TGMD-3 locomotor score (SS = 31.61; F = 4.47; p = .036; partial η^2 = 0.030). By contrast, the comparison between children who performed only UPA and/or were inactive and those who did not yielded no significant differences (SS = 0.86; F = 0.12; p = .728; partial $\eta^2 \approx 0.001$); nor did any SPA × (UPA-only + inactive) interaction emerge (SS = 2.81; F = 0.40; p = .530; partial $\eta^2 \approx 0.003$).

Because the SPA × UPA interaction was not significant (p = .53), the UPA levels were collapsed into a single category. Children who practised any Structured Physical Activity (n = 81) were compared with peers without SPA (n = 67), revealing an average advantage of 0.9 scaled points (d = 0.34) in favour of the former.

The group UPA-only + inactive therefore represented both children who engaged solely in spontaneous motor activity and those who were completely inactive. As shown in Table 2, subgroups without SPA (whether with or without UPA) scored around 7.4–7.8 scaled points, whereas children with SPA scored 8.6–9.2, regardless of their unstructured-activity level. The absence of interaction and the non-significant post-hoc tests (Tukey HSD, all p > .35) confirmed the lack of differential effects among groups not involved in structured activities.

Table 6. 2 × 2 ANOVA for the TGMD-3 locomotor scaled score with the factors Structured Physical Activity (SPA) and UPA-only + inactive (children who perform only Unstructured Physical Activity or are inactive, i.e., neither SPA nor UPA). Partial η² = SS / (SS + SS_{Residual}).

Effect	SS	df	F	*p*-value	Partial η²
SPA	31.61	1	4.47	.036	0.030
UPA-only + INACTIVE	0.86	1	0.12	.728	0.001
SPA × (UPA-only + INACTIVE)	2.81	1	0.40	.530	0.003
Residual	1 018.65	144	—	—	—

To assess differences among the four subgroups created by crossing Structured Physical Activity (SPA: yes / no) and Unstructured Physical Activity (UPA: yes / no) on the TGMD-3 scaled score, a four-level Welch ANOVA was conducted. This test, chosen because of unequal variances and sample sizes, revealed no overall significant differences (F(3, 25.08) = 2.11, p = .124; see Table 7).

The planned comparison between SPA-only (n = 12) and UPA-only (n = 59) showed a mean advantage of 1.39 points for the SPA-only group; Welch's t-test (t(19.45) = 2.08, p = .051) and the 95 % confidence interval (–0.01 – 2.78) indicated that this difference did not reach statistical significance. The effect size was moderate (Cohen's d = 0.55).

Preliminary checks showed slight non-normality in the No-SPA / No-UPA group (Shapiro–Wilk W = 0.83, p = .065) and in the SPA + UPA group (W = 0.95, p = .012), whereas variances were homogeneous (Levene F = 1.35, p = .260), supporting the use of Welch versions of ANOVA and t-tests.

Table 7. Comparison of the TGMD-3 scaled score across the four subgroups obtained by crossing Structured Physical Activity (SPA) and Unstructured Physical Activity (UPA). The "*Comparison*" column presents the results of the four-level Welch ANOVA and, at the bottom, the planned SPA-only vs UPA-only contrast (mean difference, Welch t, *p*-value and effect size).

Statistic	No-SPA / No-UPA (Inactive, n = 8)	UPA-only (n = 59)	SPA-only (n = 12)	SPA + UPA (n = 69)	Comparison
Mean ± SD (points)	7.38 ± 2.07	7.78 ± 2.59	9.17 ± 1.99	8.55 ± 2.86	—
Welch ANOVA					F(3, 25.08) = 2.11, *p* = .124
Mean difference (SPA-only – UPA-only)					+1.39 pt (95% CI = -0.01 – 2.78)
t (Welch, df ≈ 19.45)	—	—	—	—	2.08
p (t-test)	—	—	—	—	.051
Cohen's d	—	—	—	—	0.55

Comparison between open- and closed-skill sports in TGMD-3 locomotor scores

The comparison between participants engaged in open-skill disciplines (n = 47) and those in closed-skill disciplines (n = 34) revealed no significant differences in the TGMD-3 locomotor scaled score (Table 8). The open-skill group averaged 8.83 ± 2.85 points, whereas the closed-skill group averaged 8.38 ± 2.61 points; the mean gap of 0.45 points was not significant (Welch's t(≈ 75) = 0.733, *p* = .466; 95 % CI = –0.77 to 1.66). The effect size was small (Cohen's d = 0.16), and the point-biserial correlation between sport type and score was modest and non-significant (r_{pb} = 0.08, *p* = .472).

Preliminary tests confirmed the appropriateness of the procedure: Shapiro–Wilk indicated slight non-normality in the closed-skill group (W = 0.89, *p* = .002) but not in the open-skill group (W = 0.96, *p* = .108), while Levene's test showed equal variances (F = 0.52, *p* = .472). Under these conditions, the Welch t-test yielded a robust estimate of the mean difference.

Table 8. Comparison of TGMD-3 locomotor scaled scores between open-skill sports (n = 47) and closed-skill sports (n = 34). Shown are the group means ± SD, the mean difference with its 95 % confidence interval, Welch's t (df ≈ 75), the associated *p*-value, effect size (Cohen's d) and point-biserial correlation (r_{pb}).

Statistic	Open-skill (n = 47)	Closed-skill (n = 34)	Comparison
Mean ± SD (points)	8.83 ± 2.85	8.38 ± 2.61	—
Mean difference (Open – Closed)	—	—	+0.45 pt (95% CI = –0.77 – 1.66)
t (Welch, df ≈ 75)	—	—	0.733
p (t-test)	—	—	.466
Cohen's d	—	—	0.16
rpb	—	—	0.08 (*p* = .472)

DISCUSSION

The mean score on the TGMD-3 locomotor subtest (8.23 ± 2.68) and the strong concentration at the Average level (64.2 %) indicate that most of the sample exhibits average locomotor competence. The rather wide range (1–14) nonetheless reveals substantial inter-individual variability. In the rural context examined, the limited availability of sports facilities and structured programmes (Gallotta et al., 2022) may hinder motor development and favour weight gain. At the same time, the low population density provides ample green spaces and lightly trafficked roads that encourage free play: Stojiljković et al. (2025) show that, in similar settings, spontaneous outdoor activity is more widespread and partly offsets the lack of organised opportunities. In the present sample, 54.7 % of children take part in Structured Physical Activity (SPA) and 86.5 % report Unstructured Physical Activity (UPA); only 5.4 % are completely inactive. These data reiterate the importance of promoting SPA participation from early childhood to counteract sedentary behaviour and obesity (Bouchard et al., 2012; Mazur et al., 2018, cited in Colella & Vera, 2020).

The main effect of SPA is clear: children involved in organised sports score on average 0.91 scaled points higher than peers without SPA (Cohen's d = 0.34; $p \approx .038$). Consistent with numerous studies (McNeill et al., 2018; Iivonen & Sääkslahti, 2014; Strong et al., 2005), the finding confirms the role of structured programmes in enhancing fundamental skills. Multifactorial analysis shows that the SPA × (UPA-only + inactive) combination produces no significant interaction: spontaneous activity alone does not raise the TGMD-3 score, nor does it amplify the positive effect of organised sport (Donnelly et al., 2016; Poitras et al., 2016). When the goal is to develop specific motor competences, systematic training guided by qualified coaches therefore remains crucial (Iivonen & Sääkslahti, 2014).

The comparison between open-skill and closed-skill disciplines reveals no significant differences ($p \approx .466$; d = 0.16). At eight–nine years of age, it is plausible that the quality of motor activity—encompassing coordinative drills, basic patterns and adequate supervision—matters more than the open or closed nature of the sporting context (Castelli et al., 2007). Overall, the small effect size and modest point-biserial correlation (r_{pb} = 0.08) suggest that differences linked to sport type might emerge only with larger samples or at ages when specialisation is greater.

The evidence collected strengthens the call for targeted school interventions and high-quality extracurricular programmes (Piggin, 2020; Caspersen et al., 1985). This aligns with Whitehead's (2010) Physical Literacy paradigm, according to which solid motor foundations and self-awareness in movement foster an active lifestyle across the life span. Because childhood sedentariness is associated with cardiometabolic risk and overweight (Guthold et al., 2020; Mazur et al., 2018), it is essential to ensure at least 60 minutes per day of moderate-to-vigorous activity, as recommended by the WHO (2020). The results confirm that participation in organised sports, whether open-skill or closed-skill, is conducive to higher locomotor-skill levels, whereas spontaneous activity alone appears less effective in improving TGMD-3 scores. This underlines the need for physical-literacy pathways from primary school onwards to promote balanced motor development and lasting active habits.

CONCLUSION

The results obtained suggest that structured physical activity (SPA) plays a fundamental role in the development of locomotor skills during the school years. These findings align with the existing literature, which underscores the centrality of organised, systematic practice for fostering the acquisition of essential motor competences (Iivonen & Sääkslahti, 2014; Strong et al., 2005). Nevertheless, while acknowledging the efficacy of SPA, it remains important not to underestimate the value of unstructured physical activity (UPA), which nonetheless contributes to overall health and to a long-term disposition toward an active lifestyle.

In the rural context investigated, 86.5 % of the children engage in UPA; this unusually high percentage confirms that green spaces, limited traffic and strong neighbourhood ties favour spontaneous outdoor play, simultaneously offering a key opportunity for community-based physical-activity promotion policies. It is likely, however, that the UPA finding in this study was affected by the intrinsic difficulty of accurately quantifying and assessing this type of activity, whose importance is clearly supported by the literature. Because UPA is, by definition, unsupervised and variable, it eludes objective recording of frequency, intensity and quality: children's self-reports may therefore under- or overestimate the actual motor load, attenuating statistical associations with outcomes. As stated in the WHO Global Action Plan on Physical Activity (GAPPA) 2018–

2030, the goal is to guarantee everyone access to diverse movement opportunities, thereby reducing physical inactivity by 15 % by 2030 (WHO, 2019). This target relates directly to the concept of Physical Literacy (PL), which helps explain the complex factors that shape lifelong physically active individuals (Carl et al., 2023).

The practical implications of this study are numerous and significant. First, it is clear that schools constitute a privileged setting for reaching children and effectively promoting a physically active lifestyle. Consequently, teachers must receive appropriate training, acquiring specific competences to design and deliver structured motor activities that integrate the core elements of Physical Literacy. It should also be borne in mind that the TGMD-3 locomotor subtest items mirror exercises widely used in many organised sports; children engaged in SPA may therefore have enjoyed a "*familiarity advantage*" over peers who practise only UPA, contributing to the score differences observed.

Equally important is the reminder that pragmatically measuring the specific elements constituting PL should not entail imposing rigid parameters or absolute standards but rather providing researchers and practitioners with tools to design targeted, flexible physical-literacy pathways that meet children's diverse needs and promote holistic physical activity encompassing all aspects of PL itself (Britton et al., 2023).

This study has certain limitations, foremost among them the exclusive analysis of the TGMD-3 locomotor subtest. Including the object-control subtest would have offered a broader and more complete picture of children's motor development, enabling an integrated assessment of gross-motor competences. A further consideration concerns UPA: beyond the measurement challenges already discussed, future studies should integrate objective instruments capable of capturing not only the intensity and duration of activity but also its quality, modes of execution and contextual settings. Such an approach could yield deeper insight into UPA's role in children's motor development. Finally, future work should extend the analysis to larger samples that are geographically and socio-culturally diverse, incorporating non-rural contexts such as urban and peri-urban areas; moreover, the qualitative influence of structured programmes should be evaluated, and the interaction between structured and unstructured physical activity on the various dimensions of children's motor and cognitive development explored.

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The article is the result of collaborative work by all the authors. Rodolfo Vastola is the Scientific Coordinator of the entire contribution.

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No potential conflict of interest was reported by the authors.

ETHICAL APPROVAL

The present study has been approved by the University Department Ethics Committee of the University of Salerno (protocol no. 0125702).

DATA AVAILABILITY STATEMENT

Data available on request.

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