Research Square

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Exploring the relationship between Tripela Sports Test performance and eye- hand coordination from KTK3+ in children aged 6–10 years

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Abstract

Purpose

Reliable, low-cost instruments are needed to assess motor competence in children, yet established batteries correlate only weakly to moderately with each other and often require expensive equipment. This study examined the association between the Tripela Sports Test (TST), a simple wall-based kicking-and-catching task using only a ball, and eye-hand coordination (EHC) assessed with the KTK3 + battery, overall and by sex, and compared performance between sexes on both tests.

Methods

A total of 137 children (69 boys, 68 girls) aged 6 to 10 years (M = 8.23, SD = 1.22) completed the TST and the EHC test. As both measures violated normality, sex differences were analysed with Mann–Whitney U tests and associations with Spearman's rank-order correlations, for the total sample and separately by sex.

Results

Boys outperformed girls on the TST ($Z = -5.57$, $p < .001$, $r = .48$) and the EHC ($Z = -4.34$, $p < .001$, $r = .37$). Spearman correlations between the TST and the EHC were large and significant across groups (total $\rho = .718$; boys $\rho = .729$; girls $\rho = .516$; all $p < .001$).

Conclusion

These findings support the concurrent validity of the TST as a feasible, inexpensive measure of gross motor manipulative coordination in children.

Introduction

Motor competence is a concept that generates some debate in the literature, beginning with the way it is designated: terms such as "fundamental motor skill", "motor proficiency" or "motor coordination" are used to describe multiple aspects of human movement. Focusing on the concept itself, motor competence can be seen as the ability of a person to be proficient in a wide range of locomotor, stability, and manipulative motor skills [1–3], or as "the individual capacity to perform different motor actions, including the coordination of fine and gross motor skills necessary for daily life" [4].

Regardless of its definition, there is consensus that children begin to develop fundamental motor skills from the first years of life, and that these skills can be grouped into locomotor, manipulative, and stability categories [5]. It is also known that motor competence is positively associated with adequate physical

activity levels in children and adolescents; in younger children, this correlation tends to be weak to moderate, strengthening over the years [6, 7]. There is also evidence that more developed manipulative skills in childhood are associated with greater engagement in physical activity during adolescence, and that better development of fundamental motor skills such as throwing, catching, and running in childhood correlates with a higher probability of healthy physical activity habits throughout growth [8, 9]. Recent longitudinal and meta-analytic evidence has reinforced this reciprocal relationship between motor competence and physical activity across childhood and adolescence [10, 11]. Following this reasoning, it is easy to understand that reliable tests are needed to assess these abilities at an early age.

However, a recurring finding in the literature is that correlations between pairs of motor competence assessment batteries tend to be only low to moderate, suggesting that these instruments (a) may capture distinct constructs, (b) cannot be treated as equivalent, or (c) produce divergent outcomes [12]. Comparing the *Körperkoordinationstest für Kinder* (KTK) [13] with the Test of Gross Motor Development-2 (TGMD-2) [14], Logan et al. [15, 16] concluded that the two instruments rest on different assumptions about what motor competence entails, as the convergent validity between them was no more than moderate. Similarly, when Fransen et al. [17] contrasted the short form of the *Bruininks–Oseretsky Test* of Motor Proficiency (BOT-2SF) [18] with the KTK [13], some evidence of convergent and discriminant validity emerged; however, given the relatively weak correlation values, the authors recommended that motor competence assessment should never rely on a single instrument – a position later shared by Ré et al. [19] and Rudd et al. [20]. Khodaverdi et al. [21] broadened this line of research to three batteries simultaneously (KTK, TGMD-3, and BOT-2SF), once again reporting weak associations among them. Consistent with this, Sigmundsson et al. [22] found generally low pairwise correlations not only between whole batteries but also between individual motor tasks in 7–8-year-old children, and classification-agreement studies using the KTK3 + have likewise reported only fair-to-moderate agreement with other instruments [23]. Beyond these psychometric concerns, practical objections have also been raised: certain batteries demand excessive administration time, limiting their feasibility in physical education settings [24], whereas others depend on specialised and potentially costly equipment – the manipulative component of the Motor Competence Assessment (MCA) battery, for example, requires a velocity radar [3, 25].

In this context, the Tripela Sports Test (TST) emerges as a simple, inexpensive, and quick-to-administer alternative, using only a ball to simultaneously assess eye-hand and eye-foot coordination through a continuous 30-second task. Matos et al. [26] found that the Wall Drop Punt Kick and Catch (WDPK&C; the actual TST), has shown high reliability and internal consistency (α = .945; ICC = .896); more recently, evidence of convergent validity with the manipulative subscale of the MCA in early adolescents, with strong correlations both for the separate tests (r = .802 for kicking; r = .762 for throwing) and for the combined manipulative subscale (r = .835) [12] emerged. These findings support wall-based TST tasks as valid indicators of gross manipulative coordination. It should be stressed, however, that gross manipulative coordination and motor competence are not the same constructs: motor competence encompasses locomotor and stability skills in addition to the manipulative domain. Accordingly, the potential advantage of the TST over instruments such as the MCA will only fully materialise if, beyond its

manipulative coordination character, its validity can be extended to motor competence. The present study should therefore be understood as one further step along this validation pathway. Having already examined the concurrent validity of the TST against the manipulative component of the MCA [12], the present analysis extends that effort by confronting TST performance with a distinct, single coordination test – the Eye-Hand Coordination (EHC) test of the KTK3 + battery – which, notably, shares with the TST the attributes of simplicity and low cost, rather than relying on a complete motor competence battery. A possibility worth exploring in future research is the replacement of the two manipulative tests of the MCA by the TST. Such a substitution would yield savings in administration time (one test instead of two) and in cost (no velocity radar required), alongside a gain in ecological validity: TST combines motor patterns with a clearly coordinative purpose, in contrast to the isolated, maximum-velocity nature of the MCA manipulative tests, in which factors such as muscle mass can influence the outcome, even when the underlying movement pattern is of poorer quality. In the TST, by contrast, any coordinative shortcoming is heavily penalised, making the task highly sensitive to the quality of the coordinative process rather than to mere power application.

Therefore, the aim of the present study was to analyse the association between TST performance and eye-hand coordination, assessed with the EHC test from the KTK3 + test battery [27], in children aged 6 to 10 years, considering the total sample and subgroups stratified by sex. Additionally, we compared performance between sexes on both tests, to examine whether the two instruments display similar developmental and sex-related patterns.

Methods

Participants

We conducted an a priori power analysis in G*Power 3.1.9.7 [28, 29] for two planned analyses. For the independent samples *t*-test (two-tailed, $d = .5$, $\alpha = .05$, $1 - \beta = .80$), 64 participants per group were required (128 in total). For the bivariate Pearson correlation (two-tailed, $\rho H1 = .5$, $\alpha = .05$, $1 - \beta = .95$), 46 participants were required in total. The more demanding analysis therefore indicated a minimum sample of 128 participants. Effect sizes were based on conventional benchmarks [30, 31], and the sample size justification followed current recommendations [32, 33]. The sample consisted of 137 children (69 male, 68 female) aged between 6 and 10 years ($M = 8.23$, $SD = 1.22$). All children were covered by school insurance, with data collection taking place during regular school classes. Inclusion criteria were: (i) age between 6 and 10 years; and (ii) absence of medical contraindications for physical exercise. Children were excluded if they had a diagnosis of physical or intellectual disability, did not complete the full assessment protocol, or whose legal guardians did not provide informed consent.

Ethical considerations and testing procedures

The study was conducted in accordance with the principles of the Declaration of Helsinki [34]. The examinations were approved by the Bioethics Committee at the Beira Interior University, Portugal (approval No. CE-UBI-Pj-2025-080). An initial meeting was held with the person responsible for each school to provide a detailed presentation of the objectives, procedures, and participants' rights. Written informed consent was obtained from all legal guardians, with anonymity and data confidentiality guaranteed. With the organisational support of the teachers, we set up the participants' execution of the tests during the physical education class. Participants were provided verbal explanation of each test, and examiners instructed all participants to perform each task with their maximum effort.

Measures

Tripela Sports Test

The TST records the maximum number of impacts of a football against a wall in 30 seconds, from 2 metres marked by a line on the floor. During execution, participants must: release the ball from their hands, kick it towards the wall, and catch it as it rebounds, with the ball allowed to bounce on the floor before or after hitting the wall. The 2-metre line may not be stepped on or crossed.

Each participant completed five familiarisation repetitions followed by two consecutive 30-second trials with 30 seconds of rest between trials. Scores were recorded for T1 and T2, as well as the best score from T1 and T2.

Eye-Hand Coordination

The EHC test (part of the KTK3 + battery) is a valid and reliable test [27] that evaluates eye-hand coordination. The KTK3 + battery, which incorporates the EHC item alongside balance and locomotor tasks, has been validated with normative values for 6- to 19-year-olds [35]. During the test, the children had to throw a tennis ball at a rectangle target (height 137 cm, width 152.5 cm; positioned at 1 m from the ground) on a flat wall at 1 m distance with one hand and to catch the ball correctly with the other hand as many times as possible. Children aged 6, 7 and 8 years were allowed to use both hands for catching, while children aged 9 and 10 years had to throw with one hand and catch with the other [27]. Participants conducted the test twice, and the best of both is the test score.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics, version 29.0.1.0 (IBM Corporation, Armonk, NY), with a significance level of $\alpha = .05$ (two-tailed). Descriptive statistics (mean, standard deviation, median) were calculated for the best TST and best EHC scores. Normality was assessed using the Kolmogorov–Smirnov test, adopted as the criterion for $N > 50$ [36]. The distributions of both tests violated the normality assumption at the total sample level (TST: $KS = .098$, $p = .003$; EHC: $KS = .087$, $p =$

.013). Consequently, comparisons between sexes were performed using the Mann–Whitney U test, and effect size was estimated as r = |Z|/√N, with reference values of r ≈ .10 (small), .30 (medium), and .50 (large) [30]. The association between TST and EHC was analysed using Spearman's correlation coefficient (ρ) for the total sample. Additionally, exploratory subgroup analyses were conducted separately by sex.

Because the a priori power analysis was based on parametric tests and the non-normal distribution of both tests forced the use of a non-parametric alternative, the achieved power of the Mann–Whitney U test was examined through a sensitivity analysis using G*Power [28]. With approximately 51 participants per group (below the 64 per group indicated by the a priori analysis for $d = .5$), α = .05 (two-tailed), and a desired power of .80, the minimum detectable effect size for an independent-samples *t*-test is $d = .56$. Given the high asymptotic relative efficiency (ARE) of the Mann–Whitney test – never lower than .864 relative to the *t*-test under normality and often superior under non-normality [37, 38] – the study retained adequate power to identify medium-to-large sex differences in TST. For the bivariate correlation analyses on the total sample (N = 137), the collected sample substantially exceeded the required 46 participants, ensuring power well above the planned .95 for detecting a correlation of ρ = .5. Although the power analysis was based on Pearson's r, Spearman's ρ has comparable power for the effect sizes of interest, and the sample size far exceeded the required minimum.

Results

Descriptive statistics and sex comparisons

Descriptive statistics for the total sample and by sex are presented in Table 1. Boys obtained significantly higher scores than girls on both the TST (Mdn = 11.00 vs. 6.00; U = 1057.0, Z = − 5.57, p < .001, r = .48) and the EHC (Mdn = 17.00 vs. 10.00; U = 1340.0, Z = − 4.34, p < .001, r = .37). According to Cohen's benchmarks [30], these correspond to medium-to-large effects for the TST and medium effects for the EHC.

Table 1
Descriptive statistics for age, TST and EHC by sex, and Mann–Whitney U comparisons for TST and EHC

Age (years), *M* (*SD*)	**Total (N = 137)**	**Boys (n = 69)**	**Girls (n = 68)**	**U**	**Z**	**p**	**r**
	8.23 (1.22)	**8.03 (1.28)**	**8.44 (1.13)**	**—**	**—**	**—**	**—**
TST, Mdn (Q1–Q3)	8.00 (6.00–12.00)	11.00 (8.00–13.00)	6.00 (5.00–9.00)	1057.0	−5.57	< .001	.48
EHC, Mdn (Q1–Q3)	13.00 (8.00–18.00)	17.00 (10.00–21.00)	10.00 (7.00–14.00)	1340.0	−4.34	< .001	.37

Age is reported descriptively only; no between-sex comparison was conducted. Comparisons between sexes for TST and EHC were performed using the Mann–Whitney U test due to non-normality. TST, Tripela Sports Test; EHC, Eye-Hand Coordination test (KTK3 + battery); *M*, mean; *SD*, standard deviation; Mdn, median; Q1–Q3, interquartile range; U, Mann–Whitney U statistic; Z, standardised test statistic; r, effect size (|Z|/√N)

Bivariate correlations

Spearman's rank-order correlations between TST and EHC performance were positive and statistically significant across all groups (Table 2). The strongest association was observed in boys (ρ = .729, p < .001), followed by the total sample (ρ = .718, p < .001), and girls (ρ = .516, p < .001). According to Cohen's benchmarks [30], these correspond to large correlations in all groups, although the magnitude was noticeably lower in girls than in boys.

Table 2
Spearman's rank-order correlations between TST and EHC performance, by group

Group	**n**	**ρ**	**95% CI**	**p**
Total sample	137	.718	[.624, .790]	< .001
Boys	69	.729	[.595, .824]	< .001
Girls	68	.516	[.341, .686]	< .001

ρ, Spearman's rank-order correlation coefficient; CI, confidence interval; TST, Tripela Sports Test; EHC, Eye-Hand Coordination test (KTK3 + battery)

Discussion

The main finding of this study was a strong, positive, and statistically significant correlation between the two tests in the total sample (ρ = .718), which held across all subgroups stratified by sex. This result provides evidence of concurrent validity for the TST as a measure of gross motor manipulative coordination in children. Furthermore, it extends the validation pathway of wall-based kicking-and-catching tasks, previously initiated with early adolescents and against the manipulative tests of the MCA

battery [12, 26, 39], in two directions: to a younger age group (6–10 years) and to a different coordination domain (eye-hand coordination).

The magnitude of the association observed is particularly noteworthy when placed in the context of the literature on motor competence assessment instruments. As several authors have reported, correlations between pairs of established motor competence batteries are usually low to moderate [15–17, 19–21], raising questions about whether they measure the same construct. Against this background, the strong correlation between the TST and the EHC test is comparable to the values reported by Matos et al. [12] between the WDPK&C and the manipulative subscale of the MCA (r = .802–.835) in early adolescents. Taken together, these findings suggest that the TST captures a substantial common core of gross manipulative coordination shared with established instruments, while requiring only a ball and a wall, and a very short administration time. It should be noted, however, that the evidence gathered so far – including the present study – concerns specifically the manipulative component of motor competence, which is becoming progressively consolidated. Whether the TST can be extended to represent motor competence in general remains an open question for future research.

A second relevant finding concerns sex differences. Boys significantly outperformed girls on both tests in the total sample with medium effect sizes. This pattern corroborates a broad body of research showing that boys markedly outperform girls on manipulative and object control tasks across childhood and early adolescence [12, 41, 42], as well as on motor competence in general, as documented with the MCA battery [3, 25]. A meta-analysis by Zheng et al. [43] similarly found that boys show greater proficiency in object control skills, with this advantage tending to widen with age. Also, recent large-scale evidence confirms this pattern, with boys outperforming girls in object manipulation skills across almost all age groups between 3 and 11 years [44]. The most common and obvious explanation is the amount of play opportunities involving ball skills: boys tend to spend more time in sports activities and all play [45, 46], which appears to give them a distinct advantage in manipulative tasks in which ball handling is a central element [47]. The parallel emergence of this advantage across both instruments may itself be regarded as an additional sign that the TST and the EHC tap into closely related constructs.

The correlation between TST and EHC was, however, stronger in boys (ρ = .729) than in girls (ρ = .516). A similar asymmetry was reported by Matos et al. [12], where correlations between WDPK&C (the actual TST) and MCA manipulative tests were stronger in the boys' subsample than in girls, particularly for throwing (r = .754 vs r = .330). This pattern was replicated and extended by Matos et al. [40], who correlated TST performance with all six tests of the MCA battery: in boys, the TST correlated significantly with every MCA test (|r| = .424–.760), whereas in girls only Standing Long Jump (r = .388) and Ball Kicking Velocity (r = .517) reached statistical significance, with Ball Throwing Velocity showing a negligible association (r = .083). Once again, differences in the amount and variety of previous ball-play experience between boys and girls may account for this pattern.

From a practical standpoint, these results carry relevant implications. Unlike batteries that are time-consuming [24] or require expensive equipment [3, 25], the TST requires only a ball, a wall, and 30

seconds per trial, and can be administered by any professional or institution regardless of financial resources. The strong associations found here, combined with the coherent sex-related patterns shared with the EHC, support the TST as a promising, ecological, and inexpensive alternative for assessing gross manipulative coordination in every context – and, potentially, motor competence in general, a possibility to be confirmed in future research.

Limitations and directions for further research

The present study should be interpreted in light of one important limitation. The non-normal distribution of both test variables required the use of non-parametric tests (Mann–Whitney U), which, although highly efficient relative to their parametric counterparts [37, 38], may have slightly reduced the statistical power to detect smaller effects, given that the a priori power analysis was based on parametric tests. Future studies should include larger sample sizes to enable stratification not only by sex but also across age groups, while ensuring sufficient numbers within each stratum to detect smaller effects with adequate statistical power.

Conclusions

In this study, we found the Tripela Sports Test, an eye-foot and eye-hand coordination task, to be strongly and positively correlated with the eye-hand coordination test of the KTK3 + battery in children aged 6 to 10 years. This association was verified for the entire sample and for boys and girls separately. Furthermore, the two instruments displayed similar behaviour regarding sex differences, with boys outperforming girls. These convergent patterns constitute an important step toward validating the TST as a feasible and inexpensive gross manipulative coordination assessment task for children, requiring only a ball and a wall. Further research addressing prior sports experience and normative values is recommended before the TST can be adopted as a gross manipulative coordination test. Since the TST engages stability, locomotion, and manipulation, it may ultimately serve as a motor competence test by itself; however, the present findings only support claims regarding the manipulative component, and future studies should correlate TST performance with global scores of motor competence batteries, such as the full KTK3 + or the MCA [12, 40].

Declarations

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Bioethics Committee of the University of Beira Interior, Portugal (No. CE-UBI-Pj-2025-080).

Consent to participate

Written informed consent was obtained from the legal guardians of all individual participants included in the study.

Consent to publish

Not applicable. The article contains no individual identifying data or images.

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Author Contribution

J.B., D.Mo. and R.M. conceived and designed the study. J.B., M.J. and V.B. collected the data. J.B. and D.Mo. performed the statistical analysis. J.B. wrote the first draft of the manuscript. D.Mo., R.A. and N.A. critically revised the manuscript. D.Ma., V.M.S., R.M. and D.Mo. supervised the study. All authors contributed to funding acquisition. All authors reviewed and approved the final manuscript.

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Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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