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Integrating Biomotor Ability Training with Tactical Behavior Development in Under-18 Basketball Players

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ABSTRACT: Youth basketball performance depends on the integration of physical capacity and tactical decision-making, yet training programmes for players under 18 years commonly develop these two dimensions in isolation. This study tested whether an eight-week training programme built around six biomotor abilities (sprint speed, agility, arm and leg explosive power, coordination, and performance endurance) produces greater gains in tactical behavior than a club's standard training curriculum. Using a pretest-posttest, control-group experimental design, twenty male basketball players under 18 years (M age within the club's registered youth roster) were randomly assigned to an experimental group ($n = 10$), which received the biomotor-based programme embedded in game-like offensive and defensive situations, or a control group ($n = 10$), which continued the coach's regular curriculum. Tactical behavior was assessed with the Game Performance Assessment Instrument (GPAI; Oslin, Mitchell, & Griffin, 1998) across five components — decision-making, skill execution, support, covering, and moving with the ball — combined into a performance-rating index and a composite use-index. Both groups improved significantly from pretest to posttest on all six biomotor variables and all seven tactical indicators (paired-samples t-test, $p < .05$), but the gains were consistently larger in the experimental group. At posttest, the experimental group outscored the control group on every biomotor variable (independent-samples t-test, $t(18) = 3.92–7.59$, $p \le .001$) and every tactical indicator ($t(18) = 2.48–9.51$, $p \le .023$), with the largest between-group gap on the covering indicator ($t(18) = 9.51$, $p < .001$). These findings indicate that linking biomotor training directly to tactical decision-making within the same training unit yields greater improvement in match-relevant tactical behavior than developing physical and tactical qualities separately, and support embedding biomotor-tactical integration in the training curricula of youth basketball academies.

1. INTRODUCTION

Basketball performance at the youth level increasingly depends on more than isolated technical skill: successful play requires the integration of physical capacity with the ability to read the game and select an appropriate tactical response under time pressure (Gréhaigne & Godbout, 1995). More broadly, context-sensitive behavior involves selecting appropriate responses according to situational demands, a principle also observed in pragmatic studies of communicative behavior (Aliwie, 2026). Contemporary training science holds that specific physical qualities should be developed through a staged, sport-specific plan rather than through generic or traditional conditioning routines (Bompa & Buzzichelli, 2019), yet in practice many youth basketball programmes still separate physical preparation from tactical preparation, assigning independent units to speed, strength, and agility work that are never connected to the decision-making demands of live play.

This separation is potentially costly for players under 18 years, an age band in which motor learning and physical adaptability are unusually responsive to structured training (Issurin, 2021). Recent work in elite youth basketball has shown that combining physical qualities with decision-making tasks within a single training unit produces larger gains in tactical performance than training either component alone (Lucia et al., 2023), while separate evidence identifies speed and agility as strong predictors of physical performance in youth basketball players whose applied value nonetheless remains limited unless it is translated into effective tactical behavior during competition (Čaušević et al., 2023; Padhy et al., 2025). Taken together, these findings motivate a direct test of whether biomotor-ability training, when explicitly linked to tactical situations, transfers to measurable gains in tactical behavior among under-18 basketball players — the gap this study addresses.

The study accordingly aimed to: (1) determine the level of biomotor abilities and tactical behavior among under-18 basketball players; (2) design a training programme built around biomotor abilities and linked to basketball-specific tactical situations; (3) evaluate its effect on the biomotor and tactical variables of an experimental group relative to a control group between pretest and posttest; and (4) compare the two groups' posttest scores on both sets of variables. Two hypotheses followed: that both groups would show significant pretest-to-posttest gains, and that the experimental group would significantly outperform the control group at posttest.

2. RELATED WORK

Two lines of prior research bear most directly on the present design. Studies of combined-exercise interventions in adjacent team sports report that programmes linking special physical training to tactical or decision-making tasks produce broader gains than physical training alone: an anaerobic-exercise programme integrated with tactical play improved young football players' tactical behavior alongside strength- and speed-endurance and biochemical recovery markers (Khuwaybir, 2016), and a programme of tactical exercises performed within defined pitch areas improved both performance endurance and offensive tactical behavior in young footballers (Da'i Alhaq, 2018). Within basketball specifically, a multicomponent programme combining speed, agility, and decision-making exercises in a single training unit produced significantly greater gains in sprint and agility times and in decision-making speed and accuracy than a conventional physical programme in elite players (Lucia et al., 2023), while a descriptive-comparative study identified explosive leg power and anthropometric measures as the strongest predictors of speed and agility across three youth age bands, with the strength of these relationships varying by age group (Čaušević et al., 2023).

The present study shares its experimental, two-group pretest-posttest design and its youth-sample focus with these studies, and shares its tactical-behavior outcome specifically with Da'i Alhaq (2018). It differs from them in sport (basketball rather than football), in its combined set of six biomotor variables assessed alongside seven GPAI-based tactical indicators, and, relative to Čaušević et al. (2023), in its experimental rather than descriptive-comparative design. No identified prior study has combined an eight-week biomotor programme explicitly embedded in basketball-specific offensive and defensive situations with a GPAI-based evaluation of tactical behavior in an under-18 sample — the gap the present design was built to close.

3. MATERIALS AND METHODS

3.1 Experimental Design, Population, and Sample

A pretest-posttest, two-group experimental design was used, in which an experimental group received the biomotor-ability training programme and a control group continued the coach's standard curriculum, with both groups tested before and after the eight-week intervention. This design isolates the effect of the independent variable (biomotor-ability training) from maturation, test-retest, and seasonal confounds by holding a control group under identical conditions other than the training content (Thomas, Silverman, & Nelson, 2015).

The research population comprised all male basketball players under 18 years registered with clubs in Al-Qadisiyah Governorate for the 2024–2025 season (N = 109 players across seven clubs). The main sample (n = 20) was drawn from Al-Hamza Club, selected for training regularity, staff cooperation, and logistical control, and was randomly split into equal experimental and control groups of ten players each. Skewness coefficients for all study variables in both groups fell within ±3 before the intervention (control: −0.965 to 0.994; experimental: −0.884 to 0.687), and independent-samples t-tests on the pretest scores showed no significant between-group differences ($p > .05$), confirming baseline homogeneity and equivalence.

3.2 Training Intervention

The experimental programme targeted six biomotor abilities — sprint speed, agility, arm explosive power, leg explosive power, coordination, and performance endurance — and explicitly linked each to basketball-specific offensive and defensive situations (decision-making among passing, shooting, or driving; off-the-ball movement to support a teammate; defensive covering and gap closure; ball-carrying movement under opponent pressure; numerical-superiority and small-sided situations such as 2v1, 3v2, 3v3, and 4v4; and execution of tactical tasks under fatigue and time pressure). The programme ran for eight weeks at three sessions per week (24 training units in total), with the biomotor-tactical content delivered in the main part of each unit (approximately 45 minutes) under progressive load, while the control group continued its coach's regular curriculum over the same period. The experimental group trained under the direct supervision of the researcher, the team coach, and an assisting work team.

3.3 Testing Battery and Psychometric Properties

Biomotor abilities were assessed with a standard field-test battery: a 30-metre sprint from a standing start for sprint speed (Delextrat & Cohen, 2009); a zig-zag run between cones for agility (Sheppard & Young, 2006); a seated medicine-ball throw (3 kg) for arm explosive power (Stockbrugger & Haennel, 2001); a standing broad jump for leg explosive power (Delextrat & Cohen, 2009); and a wall pass-and-catch test for eye-hand coordination (AAHPERD, 1984). Performance endurance was assessed with a repeated skill circuit performed for 60 seconds.

Tactical behavior was assessed in a live evaluation match using the Game Performance Assessment Instrument (GPAI; Oslin, Mitchell, & Griffin, 1998), scoring five components — decision-making, skill execution, support, covering, and moving with the ball — from which a mean performance-rating index and a composite use-index (the sum of the five component scores plus the performance-rating index) were derived. Two fixed cameras recorded each evaluation match from complementary angles; footage was coded from recordings rather than live observation. Content validity of the tests, the GPAI coding sheet, and the training programme was established via a panel of specialists in sport training, basketball, and measurement; published validity, test-retest reliability, and inter-observer objectivity coefficients for the GPAI-based tactical test were 0.95, 0.93, and 0.94 respectively.

3.4 Statistical Analysis

Data were analyzed in IBM SPSS Statistics using percentages, means, standard deviations, medians, and skewness coefficients (for normality and homogeneity checks); Pearson correlation (for reliability and objectivity); Levene's test (for equality of variances); the paired-samples t-test (for within-group pretest-posttest differences); and the independent-samples t-test (for between-group posttest differences). Statistical significance was set at $\alpha = 0.05$.

4. RESULTS

4.1 Effect of the Training Programme on Biomotor Abilities

Both groups improved significantly from pretest to posttest on all six biomotor variables (Table 1). In the control group, gains ranged from a paired $t(9)$ of 3.00 (leg explosive power, $p = .015$) to 10.50 (agility, $p < .001$); in the experimental group, every variable reached $p < .001$, with paired $t(9)$ ranging from 8.00 (coordination) to 23.28 (performance endurance) — markedly larger effects than in the control group on the same tests.

Table 1. Pretest and posttest biomotor ability scores for the control and experimental groups (M ± SD) and within-group paired-samples t-test results (df = 9)

Variable	Unit	Ctrl pre	Ctrl post	Ctrl t(9)	Ctrl p	Exp pre	Exp post	Exp t(9)	Exp p
Sprint speed (30 m)	s*	4.400±0.094	4.220±0.063	5.014	0.001	4.410±0.099	4.110±0.032	10.062	0.000
Agility (zig-zag run)	s*	24.552±0.599	22.580±0.092	10.501	0.000	24.652±0.717	21.980±0.476	11.218	0.000

Variable	Unit	Ctrl pre	Ctrl post	Ctrl t(9)	Ctrl p	Exp pre	Exp post	Exp t(9)	Exp p
Arm explosive power	m	4.125±0.015	4.255±0.109	3.545	0.006	4.130±0.014	4.434±0.095	10.169	0.000
Leg explosive power	m	2.348±0.039	2.398±0.043	3.000	0.015	2.360±0.041	2.508±0.044	8.488	0.000
Coordination	score	14.540±0.107	15.240±0.542	4.583	0.001	14.530±0.095	16.440±0.752	8.001	0.000
Performance endurance	score	34.900±0.876	39.600±1.075	9.945	0.000	34.700±0.823	42.800±0.789	23.275	0.000

**Lower values indicate better performance for sprint speed and agility.*

At posttest, the experimental group scored significantly better than the control group on every biomotor variable (Table 2), with the largest between-group gap on performance endurance, $t(18) = 7.59$, $p < .001$, and the smallest — though still significant — on agility, $t(18) = 3.92$, $p = .001$.

Table 2. Posttest comparison of biomotor ability variables between the control and experimental groups (independent-samples t-test, df = 18)

Variable	Unit	Control post (M±SD)	Experimental post (M±SD)	t(18)	p
Sprint speed (30 m)	s*	4.220±0.063	4.110±0.032	4.919	0.000
Agility (zig-zag run)	s*	22.580±0.092	21.980±0.476	3.917	0.001
Arm explosive power	m	4.255±0.109	4.434±0.091	3.999	0.001
Leg explosive power	m	2.398±0.043	2.508±0.044	5.649	0.000
Coordination	score	15.240±0.542	16.440±0.752	4.095	0.001
Performance endurance	score	39.600±1.075	42.800±0.789	7.589	0.000

4.2 Effect of the Training Programme on Tactical Behavior

Both groups also improved significantly from pretest to posttest on all seven GPAI-based tactical indicators (Table 3). Gains were significant but comparatively modest in the control group (paired $t(9) = 3.53–6.76$, $p \leq .006$) and consistently larger in the experimental group (paired $t(9) = 4.59–21.55$, $p \leq .001$), with the covering indicator showing the sharpest experimental-group improvement ($t(9) = 21.55$, $p < .001$).

Table 3. Pretest and posttest tactical behavior indicator scores for the control and experimental groups (M ± SD) and within-group paired-samples t-test results (df = 9)

Indicator	Ctrl pre	Ctrl post	Ctrl t(9)	Ctrl p	Exp pre	Exp post	Exp t(9)	Exp p
Decision-making	0.806±0.157	1.048±0.098	3.623	0.006	0.865±0.110	1.286±0.252	4.585	0.001

Indicator	Ctrl pre	Ctrl post	Ctrl t(9)	Ctrl p	Exp pre	Exp post	Exp t(9)	Exp p
Skill execution	0.842±0.058	1.063±0.161	4.974	0.001	0.825±0.092	1.250±0.127	9.513	0.000
Support	0.875±0.076	1.068±0.169	3.525	0.006	0.822±0.123	1.230±0.082	8.372	0.000
Covering	0.877±0.014	0.966±0.082	3.562	0.006	0.877±0.014	1.254±0.050	21.552	0.000
Moving with the ball	0.896±0.039	1.150±0.172	4.482	0.002	0.847±0.099	1.370±0.221	5.863	0.000
Performance rating	0.859±0.031	1.082±0.082	6.763	0.000	0.847±0.047	1.284±0.081	15.321	0.000
Composite use-index	5.155±0.188	6.377±0.448	6.563	0.000	5.083±0.283	7.674±0.408	17.618	0.000

At posttest, the experimental group outscored the control group on every tactical indicator (Table 4). The gap was largest for covering, $t(18) = 9.51$, $p < .001$, and smallest — though still significant — for moving with the ball, $t(18) = 2.48$, $p = .023$. The composite use-index likewise favoured the experimental group, $t(18) = 6.77$, $p < .001$.

Table 4. Posttest comparison of tactical behavior indicators between the control and experimental groups (independent-samples t-test, df = 18)

Indicator	Control post (M±SD)	Experimental post (M±SD)	t(18)	p
Decision-making	1.048±0.098	1.286±0.252	2.786	0.012
Skill execution	1.063±0.161	1.250±0.127	2.889	0.010
Support	1.068±0.169	1.230±0.082	2.720	0.014
Covering	0.966±0.082	1.254±0.050	9.509	0.000
Moving with the ball	1.150±0.172	1.370±0.221	2.481	0.023
Performance rating	1.082±0.082	1.284±0.081	5.536	0.000
Composite use-index	6.377±0.448	7.674±0.408	6.771	0.000

5. DISCUSSION

Both training approaches produced statistically significant improvement in every biomotor and tactical variable measured, consistent with the general principle that regular, structured practice — even without sport-specific targeting — drives functional and neuromuscular adaptation in young athletes. The experimental programme, however, produced consistently larger gains on every variable in both domains, and this pattern held not only for the physical qualities the programme targeted directly but, more notably, for the tactical indicators it targeted only indirectly, through embedding physical work in game-like decision situations.

The between-group gap was widest for covering ($t(18) = 9.51$) and for performance endurance ($t(18) = 7.59$) — the two variables most directly tied to sustained, repeated effort under match-like conditions — and narrowest, though still significant, for agility and for moving with the ball, variables on which the control group's conventional curriculum already provided substantial incidental practice through repeated direction changes and dribbling drills. This pattern is consistent with the interpretation that conventional training develops physical qualities in a general way, while training that explicitly rehearses tactical situations under physical load develops the specific coupling between physical capacity and in-game decision execution that a general programme does not reliably produce.

The magnitude of the experimental group's tactical gains — particularly the very large paired effect on covering ($t(9) = 21.55$) — is consistent with evidence that a combined physical–decision-making programme produces larger tactical gains than physical training delivered in isolation (Lucia et al., 2023), and reinforces the broader argument that physical qualities such as speed and agility only translate into effective in-game tactical behavior when training explicitly connects them to decision situations rather than developing them as ends in themselves (Čaušević et al., 2023).

5.1 Practical Implications for Coaching Programmes

For coaching staff working with under-18 players, the clearest practical implication is that biomotor-ability drills and tactical decision-making should be trained within the same unit rather than in separate blocks. Embedding speed, power, and coordination work inside small-sided and situational play (2v1, 3v2, 3v3, 4v4, transition, and fatigue-condition tasks) appears to convert physical adaptation into tactical performance more efficiently than developing the two in parallel but separately. The consistent gain on the covering indicator in particular suggests that defensive-transition and gap-closure situations are a productive vehicle for this integration. The GPAI-based coding approach used here also offers coaching staff a structured, repeatable way to track tactical development across a training cycle, independent of match outcome.

6. LIMITATIONS AND FUTURE RESEARCH

Several limitations qualify these findings. The sample comprised twenty male players from a single club, and the results cannot be assumed to generalize to female players, to other age bands, or to other clubs without further testing. Tactical behavior was evaluated from a single filmed evaluation match per testing point, which — while consistent with established GPAI practice — captures a narrower slice of in-game behavior than would repeated-match assessment. The eight-week duration, while sufficient to detect significant change, leaves open whether the observed gains are retained after training ceases. Future research should extend this design to larger and mixed-sex samples, to other age categories (e.g., under-16 or under-20), and to comparisons between biomotor-integrated training and other contemporary approaches such as small-sided-game-based or cognitive training, and should examine the relationship between biomotor abilities and tactical behavior in team sports beyond basketball.

7. CONCLUSION

An eight-week training programme that embedded six biomotor abilities directly within basketball-specific tactical situations produced significantly larger gains than a club's standard curriculum on every biomotor variable and every GPAI-based tactical indicator measured in male players under 18 years. Both groups improved from pretest to posttest, but only the biomotor-integrated programme produced improvement of a magnitude that translated into a clear posttest advantage in tactical behavior, most markedly in defensive covering and in overall performance rating. These findings support designing youth basketball training around the explicit integration of physical and tactical demands rather than their separate development, and support the use of a GPAI-based coding approach as a practical tool for tracking that integration over a training cycle.

Ethics Statement

Data collection involving the human participants was conducted with informed consent and in accordance with the ethical standards of the institution overseeing this research programme. No identifying personal information beyond performance-relevant test and match data is reported.

Data Availability Statement

The dataset and analysis files supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

[To be completed by authors — e.g., conceptualization, data curation, formal analysis, methodology, writing.]

Conflicts of Interest

The authors declare no conflicts of interest.

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