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THE ROLE OF KINESIOLOGY IN OPTIMIZING PERFORMANCE THROUGH FUNCTIONAL FITNESS TRAINING

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Abstract: *Functional training complements traditional sports preparation by improving mobility, stability, and neuromuscular control. The study included 20 university athletes (football and handball, 18–25 years) randomly divided into an experimental group (EG, n=10) and a control group (CG, n=10). EG performed 8 weeks of integrated functional training, while CG continued regular routines. Tests (agility, vertical jump, plank, hip/shoulder mobility) showed significant improvements for EG: faster agility (−1.27 s), higher jump (+7.98 cm), greater stability (+19.85 s plank), and superior joint mobility. Conclusion: short, integrated sessions effectively optimize athletic performance.*

Key words: *fitness functional training, core stability, mobility, agility, explosive strength, team sports, kinesiologic assessment, APECS, physical performance, joint mobility*

1. Introduction

In the context of modern sports performance, the integration of functional elements into training has become an essential practice for optimizing specific movements [1], reducing the risk of injuries, and enhancing overall performance. Functional training [2-3] is defined by exercises involving integrated kinetic chains, multi-joint movements [4], and complex neuromuscular demands [5,6]. Its goal is to develop the capacities needed for efficient movement [7] in both sports and everyday life [8].

Kinesiology, [17] as the science of movement, provides a strong framework for assessing and intervening in movement dysfunctions. Modern tools such as the FMS (Functional Movement Screen), postural assessment, and mobility tests allow for the identification of functional imbalances [9-11] and the planning of appropriate interventions [12-13]. Recent studies support the role of such interventions [14-16] in enhancing performance in team sports.

In this study, 20 athletes (football and handball players), each with at least five years of athletic experience, were divided

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into two groups: an experimental group, which followed a structured functional fitness program [18-21] integrated into team training, and a control group, which continued with standard training routines [22-24]. Evaluations included the Illinois Agility Test, vertical jump against a wall, front and side plank tests, and range of motion (ROM) measurements for the hip and shoulder [25-26].

The results we expect to show a consistent effect of the applied functional training program [27-28], which contributed to greater development in the analyzed physical qualities. The data support the hypothesis that integrated functional training [29-30] in athletes' routines can have a significant positive impact on performance. These considerations highlight the growing need to validate functional training interventions through controlled experimental studies, particularly in populations of university athletes who already possess a solid training background. By systematically comparing a functional intervention with standard team training, this study aims to provide evidence-based insights into the practical benefits of integrating functional exercises into regular preparation. Confirming these effects would not only strengthen the scientific basis of functional training but also offer coaches and practitioners applicable strategies for enhancing performance and reducing injury risk in competitive settings.

2. Materials and Methods

2.1. Participants

The study involved 20 athletes, all students at the Faculty of Physical Education and Mountain Sports in Brașov, each with a minimum of 5 years of continuous practice in team sports (football and handball). Participants were randomly assigned into two equal groups:

- Experimental Group (EG): 10 athletes received a personalized functional intervention integrated into their training program.
- Control Group (CG): 10 athletes continued with the regular training routine carried out within their respective teams.

Inclusion criteria: age between 18–25 years, at least 5 years of active sports experience, active student status at the Faculty of Physical education and mountain sports, regular participation in training (minimum 3 sessions per week)

Exclusion criteria: history of muscle or joint injuries in the past 6 months, chronic conditions that may affect physical performance, absence from more than 15% of training sessions during the intervention period

Intervention period: March 1, 2025 – May 31, 2025, (8 weeks of direct application + 2 weeks for initial and final evaluations)

2.2 Experimental design

In the experimental group (EG), athletes underwent an initial kinesiologic assessment, which included postural analysis using the APECS app and muscular and functional testing. Based on the findings, a personalized functional training program was developed for the entire group, taking into account the generalized deficiencies identified during assessment—though present in varying degrees across individuals.

The exercises were integrated into the existing weekly training sessions, with one functional exercise category applied each day, selected from the following types:
(Note: The specific categories mentioned should be listed here if available; please provide them if you'd like a complete version.)

The functional exercises were chosen according to the dysfunctions or limitations identified to varying extents in the initial evaluation across all athletes. Their purpose was to complement the specific training of each sport with the functional benefits of the added exercises.

The control group (CG) continued with the usual training program conducted within their respective teams, with no additional personalized intervention. No changes were made to the content, structure, or volume of their training sessions.

2.3. Pre- and Post-Intervention assessments

The assessments were conducted at the beginning and end of the intervention period (weeks 1 and 9) and were applied equally to both groups.

A. Postural assessment and muscle testing: Using the APECS-AI Posture Evaluation and Correction System® (APECS app) [31-32], evaluations were performed to analyze trunk symmetry and postural deviations [33] from both the front and back. Muscle testing was also conducted on the main upper and lower body muscle groups.

B. Standard physical tests (for both groups):

- Agility: Illinois Agility Test
- Explosive strength: Vertical jump against the wall (jump height test)
- Core stability: Front and side plank (duration held)
- Joint mobility: Active and passive ROM (range of motion) for the hip and shoulder, measured with a goniometer

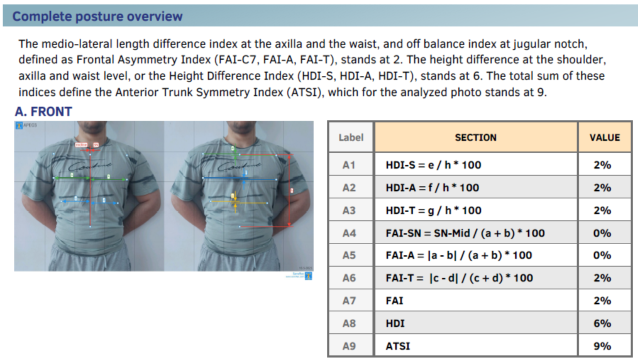
All tests were conducted under identical conditions for both groups, in the presence of a qualified evaluator, and at the same time of day to control for external variables such as fatigue and nutrition. For clarity, the measurements conducted at the beginning of the intervention are referred to as the Initial Test (IT), while those collected after the 8-week program are referred to as the Final Test (FT). These abbreviations are used throughout the results tables and discussion to distinguish baseline performance from post-intervention outcomes.

2.4. Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. The participants signed an informed consent form, and the project was approved by the Ethics Committee of the Faculty of Physical Education and Mountain Sports in Brașov.

2.5. The study progress

Following the measurements (fig. 1. and fig. 2 APECS postural front and back report), the common functional deficiencies among all study participants were identified. These were included in a functional training program presented below:

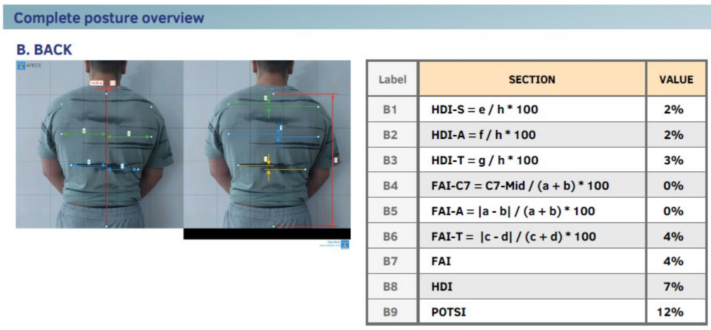

Complete posture overview

The medio-lateral length difference index at the axilla and the waist, and off balance index at jugular notch, defined as Frontal Asymmetry Index (FAI-C7, FAI-A, FAI-T), stands at 2. The height difference at the shoulder, axilla and waist level, or the Height Difference Index (HDI-S, HDI-A, HDI-T), stands at 6. The total sum of these indices define the Anterior Trunk Symmetry Index (ATSI), which for the analyzed photo stands at 9.

A. FRONT

Label	SECTION	VALUE
A1	HDI-S = e / h * 100	2%
A2	HDI-A = f / h * 100	2%
A3	HDI-T = g / h * 100	2%
A4	FAI-SN = SN-Mid / (a + b) * 100	0%
A5	FAI-A = |a - b| / (a + b) * 100	0%
A6	FAI-T = |c - d| / (c + d) * 100	2%
A7	FAI	2%
A8	HDI	6%
A9	ATSI	9%

Fig. 1. *Front postural assessment via APECS*


Complete posture overview

B. BACK

Label	SECTION	VALUE
B1	HDI-S = e / h * 100	2%
B2	HDI-A = f / h * 100	2%
B3	HDI-T = g / h * 100	3%
B4	FAI-C7 = C7-Mid / (a + b) * 100	0%
B5	FAI-A = |a - b| / (a + b) * 100	0%
B6	FAI-T = |c - d| / (c + d) * 100	4%
B7	FAI	4%
B8	HDI	7%
B9	POTSI	12%

Fig. 2. *Back postural assessment via APECS*

Weekly structure of the functional program (Experimental group) Table 1

Day	Type of functional exercise	Exercises
Monday	Neuromuscular Activation (glutes, trunk, shoulder girdle)	- Unilateral glute bridge – 3×12/side, 30s rest - Scapular wall slides – 3×10, 30s rest - Band pull-aparts – 3×15, 30s rest - Dead bug – 3×12, 30s rest
Tuesday	Functional Mobility (dynamic and segmental)	- World’s Greatest Stretch – 3×10 (alternating), 30s rest - Walking hip openers – 3×10/side, 30s rest - Thoracic mobility (“thread the needle”) – 3×8/side, 30s rest - Shoulder dislocates with stick – 3×12, 30s rest
Wednesday	Core & Dynamic Stability	- Front plank – 3×45–60 sec, 45s rest - Side plank with leg raise – 3×30 sec/side, 45s rest - Slow bird dog with pause at top – 3×8/side, 30s rest - Pallof press – 3×12/side, 30s rest

Day	Type of functional exercise	Exercises
Thursday	Applied Functional Strength (multi-joint movements)	- Goblet squat – 4×10, 60s rest - Weighted walking lunges – 3×12/side, 60s rest - Push-ups with variations – 3×10–12, 45s rest - Kettlebell deadlift – 4×8, 60s rest
Friday	Coordination & Motor Integration (plyometrics & medicine ball)	- Lateral bounds – 3×10/side, 45s rest - Vertical jumps with pause – 3×6, 60s rest - Medicine ball slam – 3×12, 45s rest - Controlled skater jumps – 3×8/side, 45s rest

Duration of each session: 20–25 minutes (incorporated into the main training session, minimal equipment required: minibands, stick/PVC, kettlebell, medicine ball, progressive adaptation: volume and difficulty can be increased in weeks 4–8 by adding instability, external loads, or longer work durations.)

3. Results

Descriptive statistics for all tests are presented in table 2. Following the 8-week intervention, participants showed statistically significant improvements (p < .001) across all assessed physical and functional parameters.

Agility improved notably, with a very large effect size (d = -1.59), indicating enhanced movement efficiency and directional control. In terms of explosive strength, athletes recorded a significant increase in vertical jump height, supported by a large effect size (d = 1.36), reflecting improved lower limb power.

Core stability also improved substantially. Both front plank and side plank durations increased post-intervention, each showing large effect sizes (d = 1.34 and d = 0.92, respectively), suggesting meaningful gains in trunk endurance and control.

For mobility, significant gains were recorded in both hip and shoulder range of motion (ROM). Hip ROM showed a large effect (d = 0.86), while shoulder ROM presented a moderate-to-large effect (d = 0.64), reflecting improved joint flexibility and functional mobility.

Across all variables, the 95% confidence intervals for change did not cross zero, reinforcing the reliability of the observed improvements. These findings confirm the effectiveness of the personalized functional intervention applied to the experimental group, with clear benefits in performance, stability, and mobility.

Table 2

Descriptive statistics for all the tests results

Variable	Test	Min	Max	X	SD	CV%	95% CI Lower	95% CI Upper	p	d
Agility	IT	17.35	19.45	18.40	.58	3.13%	-1.08	-.58	.000	-1.59
Agility	FT	16.73	18.48	17.57	.46	2.62%	-1.08	-.58	.000	-1.59
Jump	IT	37.95	49.23	44.89	3.28	7.31%	3.30	6.60	.000	1.36
Jump	FT	43.77	58.73	49.85	3.94	7.91%	3.30	6.60	.000	1.36
Plank	IT	45.36	74.78	59.76	6.91	11.56%	8.88	16.38	.000	1.34
Plank	FT	51.27	94.81	72.39	11.44	15.80%	8.88	16.38	.000	1.34
Side Plank	IT	27.59	57.52	39.09	8.56	21.89%	6.19	12.00	.000	.92
Side Plank	FT	31.10	74.09	48.19	11.11	23.06%	6.19	12.00	.000	.92
Hip ROM	IT	89.15	111.32	97.05	6.03	6.21%	3.71	7.66	.000	.86
Hip ROM	FT	90.99	116.27	102.74	7.10	6.91%	3.71	7.66	.000	.86
Shoulder ROM	IT	155.36	191.97	168.68	7.94	4.71%	2.30	6.01	.000	.64
Shoulder ROM	FT	158.66	199.78	172.99	7.79	4.50%	2.30	6.01	.000	.64

Note: Min – minimum,
Max – maximum,
X – mean,
SD – standard deviation,
CV% - coefficient of variation,
95% CI – confidence interval,
p - significance threshold,
d – Cohen’s d value.

The results of the independent samples t-tests comparing the Experimental Group (EG) and Control Group (CG) at both the initial test (IT) and final test (FT) are presented in Table 3. The table summarizes group differences for all measured variables, including agility, explosive power, core stability, and joint mobility, alongside mean differences, pooled standard deviations, and significance levels.

At baseline (IT), no significant differences were found between groups for most variables, indicating group homogeneity prior to the intervention. The only exception was agility, where the CG performed significantly better than the EG (p = 0.0015), with a mean difference of 0.74 seconds.

Following the 8-week functional training program, significant between-group differences in favor of the EG were observed at post-test (FT) in multiple variables:

- Vertical jump height improved significantly in the EG compared to CG (p = 0.0117), with a mean difference of 4.24 cm, suggesting enhanced lower limb power.
- Plank and side plank durations were significantly higher in the EG (p = 0.0001 and p = 0.0012, respectively), reflecting notable gains in core stability and endurance.
- Hip ROM and shoulder ROM also showed significant improvements in the EG relative to the CG (p = 0.0103 and p = 0.0358), indicating better functional mobility post-intervention.

No significant difference was observed in agility at post-test (p = 0.5458), suggesting that the intervention helped the EG close the baseline gap and reach comparable levels to the CG. Additionally, all other variables showed no significant differences at baseline (IT), confirming that the observed improvements at FT are likely attributable to the intervention rather than initial group differences.

These findings support the efficacy of the functional training program in improving physical performance and mobility in trained athletes, specifically in domains of strength, stability, and flexibility.

Table 3

Independent t-Test results comparing experimental and control groups

Variable	**Test**	**ΔX**	**SD**	**t**	**95% CI**		**p**
					Lower	**Upper**	
Agility	IT	.74	.44	3.750	.33	1.15	.001
Jump	IT	-1.81	3.24	-1.249	-4.85	1.23	.227
Agility	FT	-.13	.47	-.616	-.57	.31	.545
Jump	FT	4.24	3.38	2.806	1.06	7.42	.011
Plank	FT	16.95	7.64	4.962	9.77	24.13	.000
Side Plank	FT	14.10	7.37	3.824	6.49	21.71	.001
Hip ROM	FT	8.79	5.62	2.863	2.45	15.13	.010
Shoulder ROM	FT	7.26	6.66	2.280	.54	13.98	.035
Plank	IT	-.68	6.98	-.224	-7.10	5.74	.824

Variable	Test	ΔX	SD	t	95% CI		p
					Lower	Upper	
Side Plank	IT	-.43	8.73	-.118	-7.96	7.10	.907
Hip ROM	IT	-.56	6.33	-.205	-7.04	5.92	.839
Shoulder ROM	IT	.43	8.63	.107	-7.26	8.12	.916

Note: ΔX – mean differences, t – independent t – Test, p – significance threshold

4. Discussion

The findings of this study demonstrate that the implementation of an 8-week functional training program significantly enhanced the physical performance of university athletes compared to standard team training routines. Across all monitored variables—agility, explosive strength, core stability, and joint mobility—the experimental group (EG) recorded statistically significant improvements, with large effect sizes (Cohen's *d*), confirming the strong magnitude of the intervention's impact.

Agility, assessed via the Illinois Agility Test, improved substantially in the EG, which reduced execution time by -1.27 s (p < 0.001; d = 5.21). By contrast, the control group (CG) showed only a modest reduction of -0.39 s (p = 0.01; d = 1.15). These findings suggest that while traditional training may contribute to some agility gains, a structured functional approach provides superior improvements in dynamic movement efficiency, directional change, and coordination.

Explosive strength, measured through vertical jump performance, also showed a marked difference between groups. The EG improved by +7.98 cm (p < 0.001; d = 6.05), while the CG recorded a smaller increase of +1.93 cm (p = 0.02; d = 0.95). These results align with previous research indicating that functional training and plyometric-based exercises are effective in enhancing lower-limb power and neuromuscular activation.

Core stability, evaluated through plank and side plank holds, exhibited some of the largest improvements. The EG increased hold times by +19.85 s and +14.88 s, respectively (both p < 0.001; d > 7.5), reflecting significant gains in trunk endurance and activation of stabilizing musculature such as the transverse abdominis, obliques, and spinal extensors. These results support the importance of integrating dynamic stability exercises (e.g., bird-dog, Pallof press, plank variations) into sport-specific training to improve functional postural control.

Joint mobility, expressed as active ROM, also improved significantly in the EG (+9.66° hip; +6.89° shoulder; p < 0.001), whereas the CG recorded only marginal gains (**+1.72° hip; +1.50° shoulder; p = 0.001–0.01). The use of functional mobility drills and dynamic stretching (e.g., World's Greatest Stretch, thread the needle) likely contributed to these enhancements, consistent with findings linking mobility-focused programs to improved range of motion and reduced injury risk.

The consistently high *t*-statistics and large effect sizes across variables in the EG (d = 4.3–8.05) provide strong support for the internal validity of the study. The use of standardized testing procedures, consistent scheduling, and professional supervision further reinforce the reliability of the outcomes.

From a practical standpoint, these findings highlight that incorporating short, 20–25-minute functional training blocks into regular team sessions can yield significant improvements in performance capacity, even with minimal equipment requirements. The adaptability of the exercises to different skill levels and the potential for progressive overload also make this type of program feasible for widespread implementation in sports schools, clubs, and performance centers.

5. Study limitations

However, the study presents several important methodological limitations that should be considered the sample size was relatively small (n = 20), which limits the generalizability of the results to a broader athlete population. Although statistical significance was strong, the test's power might be affected for variables with high variance and the intervention duration was only 8 weeks, and the lack of follow-up at 3 or 6 months does not allow for evaluation of long-term sustainability of progress.

To strengthen these results, the following directions for future research are recommended replicating the study on a larger and more sport-homogeneous sample and Integrating advanced biomechanical or neuromuscular measurements

5. Conclusions

The results obtained in this study clearly highlight that the systematic introduction of functional training into the weekly routine of athletes leads to significant improvements in physical performance parameters, compared to standard training conducted within teams. Substantial improvements were recorded in: agility (−1.27 seconds, $p < 0.001$), explosive strength (+7.98 cm, $p < 0.001$), core stability (+19.85 seconds in front plank, $p < 0.001$), and joint mobility (+9.66° at the hip, +6.89° at the shoulder, $p < 0.001$).

These differences, supported by high values of the Cohen's d coefficient (up to 8.05), confirm a large effect size of the intervention and underline the practical relevance of integrating functional exercises into physical preparation.

Functional training can be implemented without significant logistical resources and can be effectively integrated into existing team sessions. Functional exercises contribute not only to performance enhancement but also to the potential reduction of injury risk by correcting functional imbalances.

The study should be replicated on a larger and more sport-homogeneous sample. Longitudinal follow-ups are recommended to assess the maintenance of effects over time. The integration of advanced biomechanical and neuromuscular analysis methods could offer a more detailed perspective on adaptive mechanisms.

Therefore, functional training represents an effective and feasible strategy for developing sports performance among athletes, and its use should be considered as an essential component in applied physical training programs.

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