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THE EFFECT OF A TEN-WEEK FUNCTIONAL TRAINING PROGRAM ON BALANCE PERFORMANCE IN NON-ATHLETE UNIVERSITY STUDENTS

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Abstract: This study aimed to evaluate the effects of a ten-week functional training program on static and dynamic balance in non-athlete university students. Thirty-six students (14 males, 22 females; aged 19–25) without prior sport experience participated in the study. A pre-test/post-test design was employed, with balance assessed using the Single-Leg Stance Test (SLST) for static balance and the Functional Reach Test (FRT) for dynamic balance. Participants engaged in a once-weekly, 50-minute functional training session as part of their regular physical education curriculum. The program included exercises targeting postural control, core stability, and neuromuscular coordination. Paired-samples t-tests and effect sizes (Cohen's *d*) were used to analyze pre- and post-intervention results. Statistically significant improvements were observed in both SLST and FRT scores following the intervention ($p < 0.001$). SLST performance increased from a mean of 19.51 ± 2.81 s to 22.44 ± 3.09 s, and FRT reach distance improved from 27.61 ± 3.68 cm to 31.58 ± 4.48 cm. Very large effect sizes were found for both SLST ($d = 2.183$) and FRT ($d = 1.878$), indicating strong practical relevance. A low-frequency, equipment-free functional training program effectively enhanced static and dynamic balance in non-athletic university students. These findings support the integration of functional movement exercises into physical education settings as a practical strategy to improve postural control and movement competence.

Key words: balance, functional training, university students, postural control, physical education, neuromuscular training

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INTRODUCTION

Balance is a fundamental component of physical fitness, closely linked to postural control, movement efficiency, and injury prevention (Behm et al., 2010). It relies on the integration of sensory input from the visual, vestibular, and proprioceptive systems, along with adequate neuromuscular responses (Gruber & Gollhofer, 2004). Poor balance has been associated with an increased risk of falls, musculoskeletal injury, and impaired functional performance in both athletic and non-athletic populations (Lesinski et al., 2015; Granacher et al., 2013). As such,

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improving balance is not only relevant for athletes, but also crucial for the general population, including university students who often engage in sedentary behaviors and lack exposure to structured physical training.

Functional training, defined as exercise that mimics real-life movement patterns and enhances neuromuscular control, has gained popularity for its applicability across populations (Boyle, 2016). It emphasizes multi-joint, multi-planar exercises that require coordination (Sandu, E. R. et al., (2019), core stability, and balance (Faigenbaum et al., 2009). Research indicates that functional training is effective in improving postural stability, proprioception, and muscular coordination, particularly when it includes balance-challenging components such as single-leg stances, unstable surfaces, and dynamic movements (Behm & Colado, 2012; Prieske et al., 2020).

Several studies have demonstrated the positive effects of functional or neuromuscular training on balance performance in both clinical and athletic populations (Myer et al., 2006; Hübscher et al., 2010). However, there is limited research on its impact within general university settings, where students may have varying fitness levels and no formal sport background. Moreover, most balance-focused interventions in the literature involve high-frequency or equipment-dependent programs, which may not be feasible in standard physical education (PE) classes (Granacher et al., 2011).

The inclusion of structured functional training within university PE curricula could offer a low-cost, scalable approach to improving neuromuscular function and physical literacy. A once-weekly, equipment-free program could be especially beneficial for non-athlete students by enhancing their balance capacity without requiring significant time or resource investment (Behm et al., 2010; Lounsbery et al., 2013).

Therefore, the aim of this study was to examine the effects of a ten-week, once-per-week functional training program on both static and dynamic balance in non-athlete university students. We hypothesized that participants would demonstrate significant improvements in balance performance after completing a 10-Week Functional Training Program.

MATERIALS AND METHODS

Participants

A total of 36 university students (14 males and 22 females), aged between 19 and 25 years, voluntarily participated in this study. All participants were enrolled at the same university and regularly attended mandatory physical education (PE) classes. Eligibility criteria included the absence of prior formal sport experience and the lack of injuries or medical conditions that could restrict physical activity. Prior to participation, all individuals received detailed information regarding the study's aims and procedures and provided informed consent. This sampling approach was intended to reflect the general population of non-athlete university students.

Study Design

A quasi-experimental, single-group pre-test/post-test design was employed to evaluate the effects of a structured ten-week functional training program on balance performance. The intervention was integrated into the participants' regular PE classes, which were conducted once weekly for 50 minutes per session. Standardization was maintained across all sessions to ensure procedural consistency. Baseline assessment was conducted during the first week using two validated balance tests, one assessing static balance and the other dynamic balance. Identical testing procedures were repeated following the completion of the ten-week program to facilitate accurate pre–post comparisons. This study was conducted in accordance with the ethical standards set forth in the Declaration of Helsinki and approved by the Institutional Ethics Committee of Transilvania University of Brașov, Approval No. 156 from March 23rd, 2025. Prior to participation, all individuals were informed about the study's objectives, procedures, potential risks, and benefits. Written informed consent was obtained from all participants.

Training Program

The intervention consisted of a ten-week functional training program designed to enhance balance, postural control, and neuromuscular coordination. Each session included five targeted exercises selected based on their capacity to challenge balance under various stability conditions. The exercise program detailed in Table 1 comprised: Single-leg stance variations, aimed at developing unilateral weight control; Lateral lunges with controlled return, to improve mediolateral stability; Plank with contralateral limb lift, targeting core engagement under reduced support; Step-ups with knee drive, enhancing dynamic lower-limb control; Hip hinge balance drills, promoting posterior chain activation and control.

Each session began with an instructor-led demonstration of all exercises, followed by supervised execution. Technique corrections and individualized modifications were provided as necessary to ensure both proper form and participant comfort. The exercises remained consistent throughout the program to support motor learning through repetition and progressive adaptation.

Table 1. Overview of the 10-Week Functional Training Program

Exercise	Targeted Function	Repetitions / Duration	Frequency
Single-Leg Stance Variations	Unilateral balance and weight control	3 × 20–30 sec (each leg)	Once per week, 10 weeks
Lateral Lunges with Return	Lateral stability and lower limb control	3 × 10 reps (each side)	Once per week, 10 weeks
Plank with Contralateral Limb Lift	Core engagement under instability	3 × 20–30 sec holds	Once per week, 10 weeks
Step-Up with Knee Drive	Dynamic balance and coordination	3 × 10 reps (each leg)	Once per week, 10 weeks
Hip Hinge Balance Drill	Posterior chain activation and stability	3 × 10 controlled reps (each side)	Once per week, 10 weeks

Procedure

Each weekly session adhered to a standardized 50-minute format, consisting of three phases:

1. Warm-up (10 minutes): Included dynamic mobility drills for the hips, ankles, and shoulders to prepare for the balance-focused exercises.
2. Main session (30 minutes): Participants performed the five functional exercises with an emphasis on controlled execution and postural stability. The instructor provided real-time feedback and encouraged technical improvements throughout.
3. Cool-down (10 minutes): Comprised light static stretching to support recovery and mitigate muscle tension.

Evaluation Measures

Balance performance was assessed using two widely recognized standardized tests: the Single-Leg Stance Test (SLST) for static balance, and the Functional Reach Test (FRT) for dynamic balance. These assessments were selected based on their simplicity, reliability, and relevance to evaluating balance improvements in non-athletic populations within educational settings.

1. Single-Leg Stance Test (SLST) – Static Balance

The Single-Leg Stance Test is a widely used clinical assessment of static postural control. It evaluates an individual’s ability to maintain balance on one leg without external support. The test is performed barefoot on a firm surface, with participants standing upright and hands placed on their hips.

Procedure: Participants begin in a neutral bipedal stance and lift one leg, bending the knee at approximately 90 degrees. They are instructed to hold the position as long as possible without touching the raised foot to the ground or shifting the supporting foot. The test is terminated when balance is lost, the hands are removed from the hips, or the raised foot touches the floor. Each leg is tested three times, and the longest duration (in seconds) for each side is recorded for analysis.

The SLST has demonstrated high test–retest and inter-rater reliability in healthy young adults and is responsive to balance training interventions (Springer et al., 2007).

2. Functional Reach Test (FRT) – Dynamic Balance

The Functional Reach Test evaluates dynamic balance by measuring the maximal distance an individual can reach forward beyond arm's length while maintaining a fixed base of support. It reflects the ability to shift the center of gravity safely without losing stability.

Participants stand barefoot next to a wall with one arm extended forward at 90 degrees, parallel to the floor. A yardstick or measuring tape is mounted at shoulder height to record reach distance. From the initial arm position, participants reach forward as far as possible without stepping, lifting the heels, or losing balance. The distance between the starting and ending position of the third metacarpal (middle finger knuckle) is recorded in centimeters. Three trials are performed, and the average of the two best attempts is used for analysis.

The FRT has been shown to be a valid and reliable tool for assessing dynamic balance in both clinical and general populations, including healthy young adults (Duncan et al., 1990). It is particularly suitable for environments without access to specialized equipment.

Testing Conditions

All balance assessments were conducted in a controlled environment to ensure consistency, including identical lighting, flooring, and supervision by the same instructor. Participants were tested at baseline (Week 1) and post-intervention (Week 10), following standardized instructions. Comfortable athletic attire was required, and a familiarization trial was provided to reduce the impact of learning effects on performance.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics, version 26.0. Descriptive statistics, including the mean, standard deviation (SD), minimum, maximum, coefficient of variation (CV%), and kurtosis, were calculated for each variable. The 95% confidence intervals (CI) for the mean were also reported to indicate the precision of the estimates.

To evaluate the effect of the functional training program, paired-samples t-tests were conducted to compare pre-intervention (initial test, IT) and post-intervention (final test, FT) scores for both the Single-Leg Stance Test (SLST) and Functional Reach Test (FRT). Statistical significance was set at $p < 0.05$, with results considered highly significant at $p < 0.001$. Effect sizes were not calculated in this analysis, but changes in means and consistency indicators (CV%) were interpreted to assess the magnitude and variability of improvements.

All data were screened for normality and outliers prior to analysis. No missing data were reported.

RESULTS

This section presents the outcomes of the balance assessments conducted before and after the ten-week functional training program. Descriptive statistics and inferential analyses were used to evaluate changes in static and dynamic balance performance. Comparisons between initial and final test scores were conducted using paired t-tests to determine the statistical significance of the observed improvements.

Table 2. Descriptive Statistics for Balance Tests

Test	Min	Max	X	SD	CV%	Kurtosis	95% CI		p
							Lower	Upper	
SLST_IT (s)	14.3	25.6	19.51	2.81	14.40	-0.40	18.56	20.46	< 0.001
SLST_FT (s)	14.6	30.1	22.44	3.09	13.78	0.39	21.40	23.49	< 0.001
FRT_IT (cm)	17.5	35.5	27.61	3.68	13.33	0.85	26.36	28.85	< 0.001
FRT_FT (cm)	17.7	40.2	31.58	4.48	14.18	1.16	30.06	33.10	< 0.001

Note: Min – Minimum; Max – Maximum; X – Mean; SD – Standard Deviation; CV% - Coefficient of Variation; 95% CI – 95% Confidence Interval; p – Significance Threshold.

The results presented in Table 2 indicate statistically significant improvements in both static and dynamic balance performance following the ten-week functional training program. Specifically, the Single-Leg Stance Test (SLST) showed a significant increase in mean balance time from 19.51 ± 2.81 seconds at baseline to 22.44 ± 3.09 seconds post-intervention ($p < 0.001$), reflecting enhanced postural stability. Similarly, the Functional Reach Test (FRT) demonstrated a notable improvement in dynamic balance, with mean reach distance increasing from 27.61 ± 3.68 cm to 31.58 ± 4.48 cm ($p < 0.001$). The reductions in coefficient of variation (CV%) and narrow confidence intervals further support the consistency of performance gains across participants.

These findings confirm that even low-frequency, structured balance training integrated into weekly physical education classes can elicit meaningful improvements in neuromuscular control among non-athlete university students.

Table 3. Paired Samples T-Test for Balance Tests

Test	t	p	d
SLST (s)	-13.097	< 0.001	2.183
FRT (cm)	-11.268	< 0.001	1.878

Note: t – Paired Samples t-test; p – Significance Threshold; d – Cohen's d.

The results demonstrate statistically significant improvements in both static and dynamic balance following the ten-week functional training program. For the SLST, balance time increased significantly ($t(35) = –13.097$, $p < 0.001$), with a very large effect size (Cohen's $d = 2.183$), indicating a substantial enhancement in static postural control. Similarly, the FRT showed a significant improvement in reach distance ($t(35) = –11.268$, $p < 0.001$), also accompanied by a very large effect size (Cohen's $d = 1.878$). This suggests a strong training effect on dynamic balance and functional stability.

The magnitude of these effect sizes confirms that the intervention not only produced statistically significant changes but also yielded practically meaningful improvements in balance performance among non-athlete university students.

DISCUSSION

This study examined the impact of a structured ten-week functional training program on balance performance among university students without formal athletic backgrounds. The results demonstrated statistically significant improvements in both static balance, as measured by the SLST, and dynamic balance, as measured by the FRT. Notably, both tests showed very large effect sizes (Cohen's $d > 1.8$), indicating strong practical relevance and suggesting that even low-frequency interventions can yield meaningful neuromuscular adaptations.

The observed improvement in SLST scores confirms the role of unilateral and static postural exercises in enhancing proprioception, ankle stability, and motor control (Behm & Colado, 2012). Static balance is highly dependent on the integration of sensory information and neuromuscular responses, which can be effectively stimulated through task-specific exercises involving single-leg stance, joint loading, and postural feedback (Gruber & Gollhofer, 2004). Similar improvements in static balance following neuromuscular training have been documented in both athletic and general populations (Lesinski et al., 2015), underscoring the universal efficacy of these protocols.

Dynamic balance, evaluated using the FRT, also improved significantly post-intervention. FRT is sensitive to changes in forward postural control, trunk mobility, and anticipatory muscle activation. Enhancements in this area are particularly meaningful in everyday functional tasks such as reaching, walking, and transitioning between postures (Duncan et al., 1990). The observed gains support previous findings that functional training emphasizing core stability and multiplanar movement patterns can lead to superior dynamic balance performance (Granacher et al., 2013). Moreover, the exercises included in this study such as step-ups with knee drive and plank with limb lifts are consistent with established practices for enhancing center-of-mass control and dynamic stability (Prieske et al., 2020).

An important feature of this intervention was its low frequency (once per week) and integration into regular physical education (PE) classes, which enhances its feasibility in academic settings. Despite this minimal dosage, the program produced substantial improvements, suggesting that exercise quality and movement specificity may be more important than volume alone in balance training outcomes (Faigenbaum et al., 2009). Additionally, the instructional supervision and consistency across sessions likely contributed to motor learning and improved execution, as reported in previous neuromuscular training literature (Myer et al., 2006).

From a pedagogical perspective, these findings advocate for the inclusion of functional movement training within PE curricula, especially for non-athletic students who may lack exposure to balance-challenging activities. Incorporating simple, progressive exercises into weekly lessons may provide a non-intimidating entry point for neuromuscular development and injury prevention strategies (Behm et al., 2010). Furthermore, improved balance has been associated with better academic engagement and physical literacy in youth and young adults, reinforcing its educational value (Lounsbery et al., 2013).

Limitations and Future Directions

While the outcomes are promising, several limitations must be acknowledged. The study did not include a control group, limiting causal interpretation. The sample was drawn from a single university, and all participants were healthy young adults, which restricts generalizability to other age groups or clinical populations. Additionally, long-term retention of balance improvements was not assessed, nor were potential gender-based differences analyzed.

Future studies should explore dose-response relationships, include control or comparison groups, and consider follow-up assessments to examine the durability of training effects. Investigating the neuromechanical mechanisms underlying balance improvements, such as joint proprioception or muscle activation patterns, could also enhance the understanding of functional training outcomes.

CONCLUSION

This study provides strong evidence that a structured, once-weekly functional training program can significantly improve both static and dynamic balance in non-athlete university students. Despite the low frequency, the intervention led to highly significant changes with large effect sizes, indicating meaningful neuromuscular adaptations (Onea, GA et al., 2018). The findings support the incorporation of functional exercises, emphasizing balance, core control, and multi-planar movement, into physical education curricula as an effective, low-cost strategy for enhancing postural stability and overall physical competency. Functional training, when applied consistently and with proper technique, can serve not only as a tool for performance improvement but also for injury prevention and physical literacy development in general student populations.

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