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# Effects of a 14-Week Functional Training Program Using Inflatable Equipment on Postural Balance and General Coordination among Medical Students

**Andreea-Maria Tacsa [1,2] and Dana Badau [2,*]**

1 University of Medicine, Pharmacy, Sciences and Technology G.E. Palade of Targu-Mures, 540142 Targu Mures, Romania;
2 Transilvania University of Brasov, 500036 Brasov, Romania

* Correspondence: dana.badau@unitbv.ro

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**Abstract:** Balance and coordination are essential motor skills vital for daily activities, posture, and academic performance. While functional training is gaining interest, the use of inflatable equipment remains underexplored. Aim: This study evaluated a 14-week inflatable equipment-based training program for non-PE university students. An experimental group (n=40; 20 male, 20 female; age 20.7 ± 1.4 years; weight 67.3 ± 8.2 kg; height 173.8 ± 8.4 cm; BMI 22.0 ± 1.6 kg/m²) trained twice weekly, focusing on balance and coordination exercises using inflatable equipment. The control group (n=45; 22 female, 23 male; age 20.4 ± 1.6 years; weight 66.1 ± 7.9 kg; height 172.5 ± 7.8 cm; BMI 22.2 ± 1.8 kg/m²) attended only standard physical education classes and received no additional intervention. Balance was tested using a static balance board (bilateral and unilateral stance), and coordination was tested using a 360° rotational jump test (Matorin Test). Significant improvements were observed in the experimental group for all balance conditions: bilateral stance ($\Delta = 3.125$ s, $d = 1.76$, $p < 0.001$), right unilateral stance ($\Delta = 2.447$ s, $d = 1.79$, $p < 0.001$), and left unilateral stance ($\Delta = 2.300$ s, $d = 1.40$, $p < 0.001$). For coordination, the left-side jump improved most ($\Delta = 139.38°$, $d = 2.96$, $p < 0.001$), followed by the right-side jump ($\Delta = 112.25°$, $d = 2.75$, $p < 0.001$). All effect sizes exceeded 0.8, indicating very large effects. The control group showed no significant change in any parameter (all $p > 0.05$). A 14-week inflatable equipment training program significantly improved balance and coordination in medical university students, supporting its integration into university physical education curricula.

**Keywords:** bilateral balance; unilateral balance; general coordination; functional training; inflatable bag

## 1. Introduction

Balance is the ability to maintain the center of gravity over a base of support through static or dynamic postural control, involving the continuous adjustment of body segments in response to internal and external perturbations [1,2,3]. For university students, balance is essential for everyday activities such as walking, running, and transporting objects, as well as for recreational activities that require movement on unstable surfaces [4,5,6]. From a neuroscientific perspective, balance maintenance during exercise depends on the central nervous system's integration of vestibular, visual, and kinaesthetic inputs to regulate postural stability. This process engages cortical structures associated with working memory, selective attention, and concentration, thereby establishing a meaningful link between physical balance training and cognitive performance [7,8]. Balance is typically classified into two components: static balance, defined as the ability to maintain a fixed body position, and dynamic balance, which refers to postural stability during movement or positional transitions [3,9,10]. Static balance can be improved through exercises that require maintaining body position on unstable surfaces, such as balance boards or BOSU balls [11,12]. Dynamic balance benefits from exercises such as walking on narrow surfaces or balance beams [11,13].

General coordination is the capacity to efficiently synchronize the entire body or its segments during motor actions [11,14]. General coordination encompasses global body movements essential for daily activities, whereas specific coordination involves the precise control of limb segments required in sport and recreational contexts. Balance and coordination are intrinsically linked: adequate postural stability is a prerequisite for coordinated movement, and coordinated inter-segmental control, in turn, contributes to maintaining balance.

Functional training is an exercise modality designed to improve physical fitness through multi-planar, dynamic, multi-joint movements that replicate the demands of everyday life [15,16]. Its foundational components include coordination, balance, muscular strength, and flexibility [17,18,19]. The versatile structure of functional training allows for the integration of a wide range of motor components and equipment, including both traditional and novel devices [20,21,22].

Inflatable equipment comprising inflatable bags, balls, kettlebells, and dumbbells is an innovative addition to functional training. These tools create variable levels of instability through internal water displacement, which can be adjusted to participants' fitness levels. Smaller inflatable dumbbells are particularly well-suited to coordination-focused exercises, while larger devices, such as bags and balls, are more appropriate for balance training [23]. The use of inflatable equipment in functional training programs for university students has not been systematically investigated, representing a relevant gap in the literature.

Despite the growing body of evidence on functional training interventions, a critical review of the literature reveals several unaddressed gaps that the present study aims to fill. Most functional training research has focused on athlete populations including volleyball players, tennis players, and martial arts practitioners, with comparatively little attention to medical university students [24,25,26,27]. This population has distinct characteristics, including sedentary academic routines, high cognitive workload, and limited structured physical activity, which may produce training responses different from those observed in competitive sport contexts. The transferability of findings from athletic samples to non-physical education students therefore remains uncertain. Simultaneously assessing balance and general coordination within a single functional training intervention is uncommon in the literature. Although inflatable equipment has been examined in isolated biomechanical contexts, specifically, the aquabag and water-filled tubes have been shown to increase core muscle activation [28], and improve proprioception during squats [29], no study to date has examined the use of a full set of inflatable implements (bag, ball, kettlebell, and dumbbells) within a structured, periodized functional training program. The potential of these devices to simultaneously challenge neuromuscular control, proprioception, and inter-segmental coordination across multiple exercise modalities has therefore not been evaluated. Existing functional training interventions with student populations have rarely incorporated active control groups, relying instead on pre-post designs without comparison conditions [22,30,31]. These gaps highlight the need for controlled intervention studies that target medical university students, simultaneously assess multiple motor capacities, and evaluate the specific contribution of inflatable equipment within a comprehensive functional training framework. The present study was designed to directly address these shortcomings.

Although the existing literature acknowledges the benefits of functional training on balance and coordination across various subject populations, only a few studies has investigated the effects of a structured 14-week experimental program based exclusively on the use of inflatable equipment (bag, ball, kettlebell, and dumbbells) on these motor capacities in medical students, thus conferring the present research a novel and original contribution to the current scientific landscape.

The aim of this study was to evaluate the impact of a 14-week functional training program using inflatable equipment on the balance and overall coordination of medical university students. It was hypothesized that participants in the experimental group would show significantly greater improvements in both balance and coordination than the control group, as a result of the structured intervention.

## 2. Materials and Methods

### *2.1. Study Design*

The present study employed a quasi-experimental pre-test/post-test design with a parallel, non-randomized control group. This design was selected because it allows evaluation of intervention effects in a naturalistic educational setting, and the inclusion of a concurrent control group enables between-group comparisons that strengthen causal inference compared with single-group pre-post designs [32].

The study spanned 16 consecutive weeks during the spring academic semester. The timeline was structured as follows: Week 1 served as the initial assessment phase (IT), during which all baseline measurements were collected; Weeks 2 through 15 constituted the experimental intervention phase, comprising the 14-week functional training program for the EG and standard physical education classes for the CG; Week 16 served as the final assessment phase (FT), during which all outcome measures were repeated under identical conditions to those of the initial assessment.

All assessments and training sessions were conducted in a university sports facility equipped with standardized flooring, adequate lighting, and sufficient space for balance and coordination tests and for group-based functional training activities. Using a single, consistent venue throughout the study ensured environmental standardization across all measurement points and sessions, minimizing potential confounding attributable to venue variability. To ensure measurement consistency, all assessments were administered by the same trained evaluator at each testing phase. Testing sessions were scheduled at the same time of day for all participants to control for potential diurnal variation in motor performance. Before each assessment, participants were asked to refrain from vigorous physical activity for at least 24 hours and to arrive rested and hydrated. A standardized verbal protocol was used for test instructions to ensure uniformity across participants and assessment phases. The test sequence was kept constant (balance test followed by coordination test) to avoid order effects.

### *2.2. Participants*

All participants were enrolled in the medicine program at the University of Medicine, Pharmacy, Sciences and Technology "G.E. Palade" in Targu-Mures. Based on a medium effect size (Cohen's d = 0.50), an alpha level of 0.05, and a statistical power of 0.80 for a two-tailed independent samples t-test, the minimum required sample size was calculated at 34 participants per group. The final sample exceeded this threshold, ensuring adequate statistical power for the study. The experimental group (EG) comprised 40 students (20 male, 20 female; age: 20.7 ± 1.4 years; body mass: 67.3 ± 8.2 kg; height: 173.8 ± 8.4 cm; BMI: 22.0 ± 1.6 kg/m$^2$) who volunteered for the functional training program. The control group (CG) consisted of 45 students (23 male, 22 female; age: 20.4 ± 1.6 years; body mass: 66.1 ± 7.9 kg; height: 172.5 ± 7.8 cm; BMI: 22.2 ± 1.8 kg/m$^2$) who attended only standard physical education classes and received no additional physical training outside the standard curriculum. Participants were excluded if they had a history of musculoskeletal injury, neurological conditions, or cardiovascular contraindications to exercise.

### *2.3. Assessment Instruments*

Balance assessment was conducted using a static balance board test. Participants stood on the board with toes pointing outward at 15° and heels 15 cm apart. Three conditions were evaluated: bilateral stance (both lower limbs), right unilateral stance, and left unilateral stance. The outcome measure was the time (in seconds) each position could be maintained without loss of balance. Three trials were performed per condition, and the mean was recorded.

General coordination was assessed using a 360° rotational jump test (Matorin Test). Participants stood within a graduated circle (diameter: 40 cm) drawn on the floor and performed maximum-effort rotational jumps around the longitudinal body axis, both clockwise (right) and counterclockwise (left). The outcome measure was the number of degrees completed. Three trials were performed per direction, and the mean was recorded.

### ***2.4. Experimental Program using inflatable equipment's***

The experimental program consisted of 28 sessions delivered over 14 weeks (two sessions per week, 60 minutes each). Each session was structured as follows: (a) general warm-up (10 min) — dynamic exercises including joint mobilization, light jogging, and coordination drills; (b) main training component (40 min) — functional exercises using inflatable equipment to target balance and coordination; (c) cool-down (10 min) — static stretching and breathing exercises.

The inflatable equipment used included an inflatable bag (adjustable water fill: 0–15 kg), an inflatable medicine ball (0–5 kg), an inflatable kettlebell (0–10 kg), and a pair of inflatable dumbbells (0–2 kg each). Water volume was progressively increased over 14 weeks to match participants' improving fitness levels, in line with the overload principle. Inflatable dumbbells were used preferentially for coordination exercises (e.g., bilateral arm swings with rotational jumps, diagonal reaching patterns), whereas the bag, ball, and kettlebell were used for balance exercises (e.g., single-leg stance with bag stabilization, dynamic step-ups with kettlebell, bilateral squat with instability ball). Exercises targeting each motor quality were systematically rotated across sessions to ensure comprehensive development.

### ***2.5. Statistical Analysis***

Data were analyzed using IBM SPSS Statistics (version 26.0). Descriptive statistics included the mean, standard deviation (SD), minimum, maximum, variance, and coefficient of variation (CV%). Within-group differences between initial and final testing were assessed using a paired-samples t-test, and effect sizes were calculated using Cohen's d (small: $d < 0.3$; medium: $0.3 \le d < 0.5$; large: $0.5 \le d < 0.8$; very large: $d \ge 0.8$). Between-group differences at initial and final testing were assessed using an independent-samples t-test, preceded by Levene's test for homogeneity of variance. Statistical significance was set at $p < 0.05$. An a priori power analysis was conducted using G*Power (version 3.1.9.7) [33], to determine the minimum sample size required to detect a statistically significant intervention effect. Based on a conservative assumption of a medium effect size (Cohen's $d = 0.50$), a two-tailed alpha level of 0.05, and a target statistical power of 0.80, the minimum required sample size for the paired-samples t-test was calculated as $n = 32$ per group. The enrolled experimental group ($n = 40$) and control group ($n = 45$) both exceeded this threshold, confirming adequate statistical power prior to data collection. Post hoc power analyses confirmed that, given the observed effect sizes (d = 1.40–2.96 for the experimental group across all outcome variables), statistical power exceeded 0.999 for all primary comparisons, indicating that the sample size was more than sufficient to detect the effects of the intervention.

## 3. Results

### *3.1. Balance Test*

Descriptive statistics for the balance test are presented in Table 1. In the EG, mean values increased substantially across all three balance conditions, with relative gains of approximately 59% for bilateral stance (5.826 s to 9.265 s), 63% for right unilateral stance (3.882 s to 6.329 s), and 65% for left unilateral stance (3.293 s to 5.423 s). CV% decreased for bilateral and right unilateral stance at final testing (32.51% to 21.57%; 31.25% to 23.80%), reflecting increased group homogeneity, whereas a slight CV% increase for left unilateral stance (29.76% to 35.17%) suggests greater inter-individual variability in this condition, likely related to limb dominance differences. In the CG, mean values remained virtually unchanged across all parameters, confirming the absence of spontaneous improvement without structured intervention.

**Table 1.** Descriptive statistics for the balance test

| Parameters | Group | Test | Mean | SD | Min | Max | Variance | CV (%) |
|---|---|---|---|---|---|---|---|---|
| Both lower limbs | EG | IT | 5.826 | 1.894 | 3.00 | 9.00 | 3.590 | 32.51 |
| | EG | FT | 9.265 | 1.998 | 6.00 | 12.67 | 3.992 | 21.57 |
| | CG | IT | 5.411 | 1.576 | 2.56 | 8.00 | 2.487 | 29.13 |
| | CG | FT | 5.415 | 1.574 | 2.56 | 8.00 | 2.478 | 29.07 |
| Right lower limb | EG | IT | 3.882 | 1.213 | 2.00 | 6.22 | 1.472 | 31.25 |
| | EG | FT | 6.329 | 1.506 | 3.91 | 8.91 | 2.268 | 23.80 |
| | CG | IT | 3.618 | 1.037 | 1.50 | 6.12 | 1.076 | 28.66 |
| | CG | FT | 3.638 | 1.035 | 1.50 | 6.12 | 1.071 | 28.45 |
| Left lower limb | EG | IT | 3.293 | 0.980 | 1.80 | 5.12 | 0.961 | 29.76 |
| | EG | FT | 5.423 | 1.907 | 2.34 | 8.80 | 3.637 | 35.17 |
| | CG | IT | 2.904 | 0.824 | 1.50 | 4.12 | 0.681 | 28.38 |
| | CG | FT | 2.917 | 0.815 | 1.66 | 4.12 | 0.665 | 27.94 |

EG = experimental group; CG = control group; IT = initial test; FT = final test; SD = standard deviation; CV% = coefficient of variation.

Results of the paired-samples t-test and effect size analysis are presented in Table 2. All within-group differences in the EG were statistically significant ($p < 0.001$). The largest absolute improvement was observed for bilateral stance ($\Delta = 3.125$ s; d = 1.76), whereas the right unilateral stance produced the highest effect size ($\Delta = 2.447$ s; d = 1.79), suggesting more consistent neuromuscular adaptation in the dominant limb. Left unilateral stance also improved significantly ($\Delta = 2.300$ s; d = 1.40), with the smallest — though still very large — effect size, likely reflecting greater inter-individual variability in non-dominant limb balance control. A marginally significant change was detected for the left unilateral stance in the CG ($p = 0.029$; d = 0.016); however, the effect size is trivially small, and the mean difference ($\Delta = 0.013$ s) has no practical significance, suggesting test-retest habituation rather than genuine motor improvement.

**Table 2.** Paired-samples t-test and Cohen's d for the balance test

| Parameters | Group | Diff (XFT−XIT) | SD | SEM | 95% CI Lower | 95% CI Upper | t | p | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|
| Both lower limbs | EG | 3.125 | 1.284 | 0.203 | 2.714 | 3.535 | 15.38 | <0.001 | 1.76 |
| | CG | 0.004 | 0.020 | 0.003 | 0.001 | 0.010 | 1.431 | 0.160 | 0.003 |
| Right lower limb | EG | 2.447 | 0.571 | 0.090 | 2.264 | 2.630 | 27.083 | <0.001 | 1.79 |
| | CG | 0.019 | 0.085 | 0.012 | 0.006 | 0.044 | 1.523 | 0.135 | 0.02 |
| Left lower limb | EG | 2.300 | 1.080 | 0.170 | 1.784 | 2.475 | 12.466 | <0.001 | 1.40 |
| | CG | 0.013 | 0.038 | 0.005 | 0.001 | 0.024 | 2.258 | 0.029 | 0.016 |

EG = experimental group; CG = control group; Diff = mean difference (FT − IT); SD = standard deviation; SEM = standard error of the mean; CI = confidence interval; p = level of statistical significance.

Between-group comparisons are shown in Table 3. At baseline, no significant differences were observed between EG and CG for bilateral or right unilateral stance ($p > 0.05$; d = 0.24), confirming baseline equivalence for these parameters. A borderline difference was noted for left unilateral stance (p = 0.050; d = 0.43), which should be considered when interpreting between-group comparisons for this condition. At final testing, the EG demonstrated significantly superior performance across all three balance parameters (all $p < 0.001$), with very large effect sizes (bilateral: d = 2.15; right: d = 2.11; left: d = 1.74), confirming the substantial practical impact of the intervention relative to standard physical education.

**Table 3.** Independent-samples t-test for balance (EG vs. CG)

| Parameters | Test | Levene F | Levene p | t | p | Mean Diff. | SED | 95% CI LL: UL | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|
| Both lower limbs | IT | 3.335 | 0.071 | 1.103 | 0.273 | 0.415 | 0.376 | −0.333; 1.164 | 0.24 |
| | FT | 6.468 | 0.013 | 9.919 | <0.001 | 3.849 | 0.388 | 3.077; 4.621 | 2.15 |
| Right lower limb | IT | 1.011 | 0.318 | 1.081 | 0.283 | 0.263 | 0.244 | −0.211; 0.749 | 0.24 |
| | FT | 16.28 | <0.001 | 9.691 | <0.001 | 2.691 | 0.277 | 2.139; 3.244 | 2.11 |
| Left lower limb | IT | 2.487 | 0.119 | 1.986 | 0.050 | 0.389 | 0.195 | 0.000; 0.778 | 0.43 |
| | FT | 56.45 | <0.001 | 8.031 | <0.001 | 2.505 | 0.312 | 1.885; 3.126 | 1.74 |

IT = initial test; FT = final test; Levene F = Levene's test statistic; SED = standard error of the difference; CI = 95% confidence interval for the difference between means, LL- lower level, UL – upper level.

### *3.2. Coordination Test*

Descriptive statistics for the Matorin test are presented in Table 4. In the EG, mean values increased markedly in both jump directions: the right-side jump improved from 224.38° to 336.63° (+50%), and the left-side jump from 169.13° to 308.50° (+82%), indicating greater relative improvement on the non-dominant side. CV% decreased substantially at final testing (right: 18.90% to 11.62%; left: 27.20% to 15.60%), reflecting convergence in performance levels across the group. A potential ceiling effect should be noted, as the maximum final value reached 360° for both directions in the EG. In the CG, mean values remained virtually unchanged, and CV% was stable, confirming the absence of meaningful spontaneous change.

**Table 4.** Descriptive statistics for the Matorin test

| Parameters | Group | Test | Mean | SD | Min | Max | Variance | CV (%) |
|---|---|---|---|---|---|---|---|---|
| Jump to the right | EG | IT | 224.38 | 42.40 | 180 | 260 | 1797.62 | 18.90 |
| | EG | FT | 336.63 | 39.12 | 250 | 360 | 1530.58 | 11.62 |
| | CG | IT | 204.00 | 20.93 | 180 | 245 | 438.18 | 10.26 |
| | CG | FT | 205.78 | 19.94 | 180 | 245 | 397.67 | 9.69 |
| Jump to the left | EG | IT | 169.13 | 46.01 | 125 | 270 | 2117.21 | 27.20 |
| | EG | FT | 308.50 | 48.12 | 225 | 360 | 2315.53 | 15.60 |
| | CG | IT | 185.56 | 23.63 | 145 | 245 | 558.21 | 12.73 |
| | CG | FT | 187.22 | 23.54 | 145 | 245 | 554.04 | 13.21 |

EG = experimental group; CG = control group; IT = initial test; FT = final test; SD = standard deviation; CV% = coefficient of variation.

Results of the paired-samples t-test and effect size analysis are presented in Table 5. All within-group improvements in the EG were statistically significant ($p < 0.001$). The greatest gain was observed for the left-side jump (Δ = 139.38°; d = 2.96), which produced the largest effect size among all outcome variables in the study, followed by the right-side jump (Δ = 112.25°; d = 2.75). The higher SD for the left-side jump (49.12° vs. 29.13°) reflects greater inter-individual variability on the non-dominant side. In the CG, changes were negligible in both directions (right: Δ = 1.78°, d = 0.021; left: Δ = 1.67°, d = 0.050), with no practical significance despite borderline statistical values.

**Table 5.** Paired-samples t-test and Cohen's d for the Matorin test

| Parameters | Group | Diff (XFT–XIT) | SD | SEM | 95% CI Lower | 95% CI Upper | t | p | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|
| Jump to the right | EG | 112.25 | 29.13 | 4.61 | 102.93 | 121.57 | 24.37 | <0.001 | 2.75 |
| | CG | 1.78 | 1.04 | 0.16 | 0.09 | 0.54 | 1.431 | 0.160 | 0.021 |
| Jump to the left | EG | 139.38 | 49.12 | 7.77 | 123.66 | 155.09 | 17.94 | <0.001 | 2.96 |
| | CG | 1.67 | 1.44 | 0.21 | 0.01 | 0.88 | 2.072 | 0.044 | 0.050 |

EG = experimental group; CG = control group; Diff = mean difference (FT − IT); SD = standard deviation; SEM = standard error of the mean; CI = confidence interval; p = level of statistical significance.

Between-group comparisons are shown in Table 6. At baseline, statistically significant differences were already present between the EG and CG for both jump directions (right: t = 4.248, $p < 0.001$, mean diff. = 20.375°, d = 0.90; left: t = 2.968, p = 0.004, mean diff. = 16.43°, d = 0.64), reflecting pre-existing baseline advantages in the EG for rotational coordination. These differences, likely attributable to self-selection bias inherent in the non-randomized design, constitute an important caveat in interpreting between-group post-intervention comparisons and underscore the need for within-group analyses — which are unaffected by this confound — as the primary evidence of intervention efficacy. At final testing, the performance gap between groups widened dramatically. The mean difference for the right-side jump reached 128.73° (95% CI: [118.95; 138.49]; t = 26.212; $p < 0.001$; d = 5.66), and for the left-side jump 121.27° (95% CI: [106.19; 136.37]; t = 15.984; $p < 0.001$; d = 3.41). The increase in effect sizes from baseline to final testing — from d = 0.90 to d = 5.66 for the right jump, and from d = 0.64 to d = 3.41 for the left jump — demonstrates that the intervention produced a divergence in group performance of exceptional magnitude, far exceeding the pre-existing baseline differences. The significant Levene's test for the left-side jump at final testing (F = 16.919; p < 0.001) further indicates that the assumption of homogeneity of variance was violated, consistent with the greater inter-individual variability in adaptation observed on the non-dominant side of the EG. Taken together, the within-group and between-group results converge to confirm that the 14-week functional training program was the primary driver of the observed coordination improvements in the experimental group.

**Table 6**. Independent-samples t-test for the Matorin test (EG vs. CG)

| Parameters | Test | Levene F | Levene p | t | p | Mean Diff. | SED | 95% CI LL; UL | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|
| Jump to the right | IT | 1.032 | 0.313 | 4.248 | <0.001 | 20.375 | 4.916 | 10.83; 29.92 | 0.90 |
| | FT | 0.815 | 0.396 | 26.212 | <0.001 | 128.73 | 4.910 | 118.95; 138.49 | 5.66 |
| Jump to the left | IT | 2.279 | 0.315 | 2.968 | 0.004 | 16.43 | 5.535 | 5.42; 27.44 | 0.64 |
| | FT | 16.919 | <0.001 | 15.984 | <0.001 | 121.27 | 7.587 | 106.19; 136.37 | 3.41 |

IT = initial test; FT = final test; Levene F = Levene's test statistic; SED = standard error of the difference; CI = 95% confidence interval for the difference between means, LL- lower level, UL – upper level.

## 4. Discussion

The present study investigated the effects of a 14-week functional training program using inflatable equipment on the balance and general coordination of 40 university students, comparing outcomes with a control group of 45 students attending standard physical education classes. The results demonstrated statistically significant and practically meaningful improvements in all assessed parameters within the EG, with very large effect sizes across all balance and coordination measures. These findings are consistent with and extend the existing literature on functional training interventions.

Regarding balance, the observed gains align with evidence of previous study, who demonstrated the efficacy of functional balance training on a sample of 11 collegiate volleyball players using unstable surfaces, including balance boards, foam rollers, and Swiss balls [24]. Similarly, another study confirmed the positive effects of functional exercise on balance and vestibular function in a narrative review [15]. Compared with these studies, the present program is distinctive for its use of inflatable implements that create hydraulic instability, a property not achievable with conventional equipment, which may have further challenged the neuromuscular control systems underpinning postural stability [23,34,35].

From a physiological standpoint, the balance improvements observed in the EG are consistent with neuromuscular adaptations resulting from repeated exposure to unstable loading conditions. Inflatable equipment, due to dynamic water displacement within its interior, generates unpredictable reactive forces that require continuous sensorimotor integration across the vestibular, visual, and proprioceptive systems [23,29]. This multisystem challenge aligns with the principle that balance training on unstable surfaces yields greater improvements than training on stable surfaces alone [12,36]. A modest asymmetry in balance gains was observed between the right and left unilateral stances, consistent with the known influence of limb dominance on postural control [2,3,37]. The increase in CV% for left unilateral stance at final testing reflects greater inter-individual variability in adaptation for the non-dominant limb, a pattern documented in laterality research [2,37]. The mechanisms underlying these inter-limb differences remain to be clarified in future studies with explicit laterality-focused designs.

Regarding coordination, the improvements align with previous research that reported enhanced coordination and movement speed in athletes after functional training, with early gains evident in the first weeks of intervention [38,39]. Wang et al. (2024) likewise observed significant coordination improvements across a 12-week functional training program in a large sample of martial arts practitioners (n = 474). The present study extends these findings to a non-athlete university population, demonstrating that functional training with inflatable equipment yields very large coordination gains in this context [26]. The greater improvement in coordination on the left-side jump compared to the right is noteworthy. The lower pre-test performance on the left-sided jump reflects a pre-existing non-dominant side deficit, and the larger absolute and relative gains on this side are consistent with the generally greater trainability of lower-performing limbs [2,37]. Whether this pattern reflects differential neural plasticity, greater room for improvement, or both, cannot be determined from the present data and warrants investigation in future laterality-focused studies.

Regarding inflatable equipment specifically, researches demonstrated that an inflatable bag significantly increased trunk muscle activation during bicep curl exercises in 20 participants, while another reported improvements in balance, proprioception, and stabilizer muscle activation following squat exercises with an inflatable bag in 18 football players [28,29]. The present study complements and extends these findings by showing that a comprehensive program combining multiple types of inflatable implements (bags, balls, kettlebells, and dumbbells) produces substantial functional benefits across two distinct motor qualities, balance and coordination, in a medical student population.

### 4.1. Limitations of study

Several limitations should be acknowledged. First, the quasi-experimental design without randomization limits causal inference and may have introduced selection bias; future studies should adopt randomized controlled designs. Second, the sample was restricted to medical students aged 19–23 years at a single institution, limiting the generalizability of the findings to other university populations, age groups, and cultural contexts. Third, the program duration was limited to 14 weeks, and long-term retention of the observed gains was not assessed. Fourth, no control was implemented for physical activity performed outside study sessions, which may have introduced confounding variation. Fifth, blinding of assessors was not possible given the nature of the assessment protocols.

### 4.2. Practical implications of study

The findings of the present study have direct implications for physical education practice in higher education. The significant improvements in balance and general coordination achieved by a 14-week functional training program using inflatable equipment, conducted in two weekly sessions within the standard physical education schedule, demonstrate that this approach is feasible and effective for non-sport university students. The progressive adjustability of inflatable equipment through variable water filling enables systematic load progression without additional apparatus, making it an accessible and cost-efficient training modality. Furthermore, the concurrent development of two distinct motor capacities within a single program supports its integration into university curricula, particularly for student populations with limited time for structured physical activity. A 14-week inflatable equipment-based functional training program conducted within standard university physical education classes produced very large improvements in postural balance and rotational coordination in medical students, motor capacities directly relevant to clinical tasks requiring sustained posture, precise manual control, and rapid sensorimotor adjustment. Given the sedentary demands of medical education, integrating structured functional training with inflatable equipment into compulsory physical education curricula represents a low-cost, timeefficient strategy to develop the neuromuscular foundations that underpin safe and effective clinical performance.

## 5. Conclusions

The present study demonstrates that a 14-week functional training program incorporating inflatable equipment produced statistically significant and practically substantial improvements in both balance and general coordination among non-physical education university students, with very large effect sizes across all assessed parameters. The experimental group consistently outperformed the control group at the final assessment, confirming the intervention's efficacy relative to standard physical education classes. The bilateral stance condition showed the greatest absolute balance gain, whereas the left-side rotational jump showed the greatest coordination gain. These findings suggest that inflatable equipment, by generating hydraulic instability, provides a sufficiently challenging motor environment to stimulate neuromuscular adaptations relevant to postural control and inter-segmental coordination. Based on these results, it is recommended that inflatable equipment be integrated into university physical education curricula as a cost-effective and adaptable tool for developing balance and coordination. Future research should address the identified limitations through randomized designs, longer follow-up periods, and the inclusion of diverse student populations.

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**Data Availability Statement:** The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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**References**

1. Ghorbani, M.; Yaali, R.; Sadeghi, H.; Koumantakis, G.A. The impact of flatfeet on the correlation between functional movement scores, balance, agility, and core muscle strength in young females: A cross-sectional study. Sci. Rep. 2025, 15, 5077. https://doi.org/10.1038/s41598-025-89364-8
2. Alonso, A.C.; Brech, G.C.; Bourquin, A.M.; Greve, J.M.D. The influence of lower-limb dominance on postural balance. São Paulo Med. J. 2011, 129, 410–413.
3. Horak, F.B. Postural orientation and equilibrium: What do we need to know about neural control of balance to prevent falls? Age Ageing 2006, 35, ii7–ii11. https://doi.org/10.1093/ageing/afl077
4. Liang, B.; Wu, L. The effect of Internet+-based extracurricular running exercise on students' physical fitness. Sci. Rep. 2024, 14, 31255. https://doi.org/10.1038/s41598-024-82610-5
5. Pancio, G.; Kern, N.; Ankam, N.; Zhang, X.C. Impact of exercise prescription education on medical student confidence and knowledge in generating exercise recommendations. Cureus 2023, 15, e51396. https://doi.org/10.7759/cureus.51396
6. Gaerlan, M.G.; Alpert, P.T.; Cross, C.; Louis, M.; Kowalski, S. Postural balance in young adults: The role of visual, vestibular and somatosensory systems. J. Am. Acad. Nurse Pract. 2012, 24, 375–381. https://doi.org/10.1111/j.1745-7599.2012.00699.x
7. Magauina, G.; Tsoukatos, M.; Nikitas, C.; Papadopoulou, S.; Kikidis, D.; Utoomprurkporn, N.; Limkitisupasin, P.; Bamiou, D.E. Effects of balance physical therapy with or without cognitive training in adults with cognitive and balance impairments: A systematic review. Eur. Rev. Aging Phys. Act. 2025, 22, 16. https://doi.org/10.1186/s11556-025-00383-w

8. Rogge, A.-K.; Röder, B.; Zech, A.; Nagel, V.; Hollander, V.; Braumann, K.-M.; Hötting, K. Balance training improves memory and spatial cognition in healthy adults. Sci. Rep. 2017, 7, 5661. https://doi.org/10.1038/s41598-017-06071-9
9. Conner, B.C.; Petersen, D.A.; Pigman, J.; Tracy, J.B.; Johnson, C.L.; Manal, K.; Miller, F.; Modlesky, C.M.; Crenshaw, J.R. The cross-sectional relationships between age, standing static balance, and standing dynamic balance reactions in typically developing children. Gait Posture 2019, 73, 20–25. https://doi.org/10.1016/j.gaitpost.2019.07.128
10. Ilie, M. Similarities and differences concerning the balance capacity of sport faculty students. Eur. Proc. Soc. Behav. Sci. 2019. https://doi.org/10.15405/epsbs.2019.08.03.143
11. Malek, N.F.A.; Nadzalan, A.M.; Tan, K.; Nor Azmi, A.M.; Krishnan Vasanthi, R.; Pavlović, R.; Badau, D.; Badau, A. The acute effect of dynamic vs. proprioceptive neuromuscular facilitation stretching on sprint and jump performance. J. Funct. Morphol. Kinesiol. 2024, 9, 42. https://doi.org/10.3390/jfmk9010042
12. Prasetyo, H.; Siswantoyo, Y.; Prasetyo, Y.; Hartanto, A. Circuit training BOSU ball: Effect on balance and accuracy of archery athletes. Pedagogy Phys. Cult. Sports 2023, 27, 229–234. https://doi.org/10.15561/26649837.2023.0307
13. Blasco, J.M.; Domínguez-Navarro, F.; Tolsada-Velasco, C.; de Borja-Fuentes, I.; Costa-Moreno, E.; García-Gomáriz, C.; Chiva-Miralles, M.J.; Roig-Casasús, S.; Hernández-Guillen, D. The effects of suspension training on dynamic, static balance, and stability: An interventional study. Medicina 2024, 60, 47. https://doi.org/10.3390/medicina60010047
14. Bozic, D.; Karisik, S.; Przulj, R.; Joksimovic, M.; Muntean, R.I.; Valentina, S.; Popovic, A. Efectos de un programa de entrenamiento de balonmano playa en las características morfológicas de jugadores juveniles de élite de balonmano masculino durante la pretemporada. Int. J. Morphol. 2025, 43, 1771–1778.
15. Bunnell, E.; Stratton, M.T. The impact of functional training on balance and vestibular function: A narrative review. J. Funct. Morphol. Kinesiol. 2024, 9, 251. https://doi.org/10.3390/jfmk9040251
16. Morina, B.; Georgiev, G.; Hadzic, R. Algunos indicadores de obesidad y estado físico en adolescentes de Kosovo y Montenegro. Int. J. Morphol. 2018, 36, 864–870. DOI: 10.4067/S0717-95022018000300864
17. Boyle, M. Advances in Functional Training: Training Techniques for Coaches, Personal Trainers and Athletes; On Target Publications: Aptos, CA, USA, 2010.
18. Li, L.; Meng, F.; Yao, S.; Shi, Q.; Luo, C. The effects of an 8-week functional training program on functional movement and physical fitness in male university students: A randomized controlled trial. Front. Public Health 2025, 13, 1641590. https://doi.org/10.3389/fpubh.2025.1641590
19. Lu, Y.; Wiltshire, H.D.; Baker, J.S.; Wang, Q. The effects of running compared with functional high-intensity interval training on body composition and aerobic fitness in female university students. Int. J. Environ. Res. Public Health 2021, 18, 11312. https://doi.org/10.3390/ijerph182111312
20. Cao, S.; Liu, J.; Wang, Z.; Geok, S.K. The effects of functional training on physical fitness and skill-related performance among basketball players: A systematic review. Front. Physiol. 2024, 15, 1391394. https://doi.org/10.3389/fphys.2024.1391394
21. Burgatti, J.C.; Lacerda, R.A. Professional gym fitness equipment aerobic pump barbell set L-311. Rev. Esc. Enferm. USP 2009, 43, 237–244.
22. Nessler, J.A.; Hastings, T.; Greer, K.; Newcomer, S.C. Wearing an inflatable vest alters muscle activation and trunk angle while paddling a surfboard. J. Appl. Biomech. 2017, 33, 282–287. https://doi.org/10.1123/jab.2016-0248
23. Wezenbeek, E.; Verhaeghe, L.; Laveyne, K.; Ravelingien, L.; Witvrouw, E.; Schuermans, J. The effect of aquabag use on muscle activation in functional strength training. J. Sport Rehabil. 2022, 31, 420–427. https://doi.org/10.1123/jsr.2021-0245
24. Oliver, G.D.; Brezzo, R.D. Functional balance training in collegiate women's volleyball. J. Strength Cond. Res. 2009, 23, 557–564. https://doi.org/10.1519/JSC.0b013e31818f02f8
25. Yildiz, S.; Pinar, S.; Gelen, E. Effects of 8-week functional vs. traditional training on athletic performance and functional movement on prepubertal tennis players. J. Strength Cond. Res. 2019, 33, 651–661. https://doi.org/10.1519/JSC.0000000000002956
26. Wang, X.; Soh, K.G.; Deng, N.; Zhang, D.; Cao, S.; Samsudin, S. Effects of functional training on muscle strength, jumping, and functional movement screen in wushu athletes: A systematic review. Heliyon 2024, 10, e24087. https://doi.org/10.1016/j.heliyon.2024.e24087
27. Xiao, W.; Soh, K.G.; Wazir Norjali Wazir, M.R.; Talib, O.; Bai, X.; Bu, T.; Sun, H.; Popovic, S.; Masanovic, B.; Gardasevic, J. Effect of functional training on physical fitness among athletes: A systematic review. Front. Physiol. 2021, 12, 738878. https://doi.org/10.3389/fphys.2021.738878
28. Glass, S.C.; Blanchette, T.W.; Karwan, L.A.; Pearson, S.S.; O'Neil, A.P.; Karlik, D.A. Core muscle activation during unstable bicep curl using a water-filled instability training tube. J. Strength Cond. Res. 2016, 30, 3212–3219. https://doi.org/10.1519/JSC.0000000000001418
29. Ditroilo, M.; O'Sullivan, R.; Harnan, B.; et al. Water-filled training tubes increase core muscle activation and somatosensory control of balance during squat. J. Sports Sci. 2018, 36, 2002–2008. https://doi.org/10.1080/02640414.2018.1431868
30. Kljajević, V.; Stanković, M.; Đorđević, D.; Trkulja-Petković, D.; Jovanović, R.; Plazibat, K.; Oršolić, M.; Čurić, M.; Sporiš, G. Physical activity and physical fitness among university students—A systematic review. Int. J. Environ. Res. Public Health 2021, 19, 158. https://doi.org/10.3390/ijerph19010158

31. Jia, P.; Zhang, M. Effects of functional training on proprioception in sport athletes. Rev. Bras. Med. Esporte 2022, 28, 672–675. https://doi.org/10.1590/1517-8692202228062022_0030
32. Thomas, J.R.; Nelson, J.K.; Silverman, S.J. Research Methods in Physical Activity, 7th ed.; Human Kinetics: Champaign, IL, USA, 2015.
33. Faul, F.; Erdfelder, E.; Lang, A.-G.; Buchner, A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav. Res. Methods 2007, 39, 175–191. https://doi.org/10.3758/BF03193146
34. Tomljanović, M.; Spasić, M.; Gabrilo, G.; Ujević, O.; Foretić, N. Effects of five weeks of functional vs. traditional resistance training on anthropometric and motor performance variables. Kinesiology 2011, 43, 145–154.
35. Cortell-Tormo, J.M.; Tercedor Sánchez, P.; Chulvi-Medrano, I.; Tortosa-Martínez, J.; Manchado-López, C.; Llana-Belloch, S.; Pérez-Soriano, P. Effects of functional resistance training on fitness and quality of life in females with chronic nonspecific low-back pain. J. Back Musculoskelet. Rehabil. 2018, 31, 95–105. https://doi.org/10.3233/BMR-169684
36. Walnik, L.; Kück, M.; Tegtbur, U.; Fischer, V.; Kerling, A. Physical fitness, nutrition and quality of life in German medical students. Nutrients 2022, 14, 5375. https://doi.org/10.3390/nu14245375
37. Erdogan, M.; Karacan, K.; Bilgic, S. Correlación de la preferencia de mano con las medidas antropométricas de la mano en estudiantes universitarios. Int. J. Morphol. 2025, 43, 554–563. DOI: 10.4067/S0717-95022025000200554
38. Veličković, S.; Kolar, E.; Paunović, M.; Veličković, P.; Pantelić, S.; Bubanj, S.; Ilić, I.; Bjelica, B.; Gašić, T.; Preljević, A.; Vulpe, A.M.; Rață, B.C.; Stoica, C.E.; Voinea, N.L.; Dobrescu, T. The impact of an acrobatics-based curriculum on motor fitness in adolescents. Life 2025, 15, 778. https://doi.org/10.3390/life15050778
39. Mountford, H.S.; Hill, A.; Barnett, A.L.; Newbury, D.F. Genome-wide association study of motor coordination. Front. Hum. Neurosci. 2021, 15, 669902. https://doi.org/10.3389/fnhum.2021.669902.