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Immediate Acute Effects of a Single Core Muscle Strengthening Exercise on Balance in Sedentary Adults

Wasin Kraisuriyawong
E-mail: 6652003286@lamduan.mfu.ac.th
Master of Science in Anti-Aging and Regenerative Science
School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University
Asst. Prof. Sumate Kunching, Ph.D.
E-mail: sumate.kun@mfu.ac.th
School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University

Abstract

The objectives of this research were to investigate the immediate acute effect of a single session of core muscle strengthening exercise on both static and dynamic balance capabilities in sedentary adults.

A quasi-experimental pre-test/post-test design was conducted on 27 sedentary volunteers aged 25–30 years living in Bangkok. Participants were randomly allocated into the Experimental Group (EX, n = 14) or the Control Group (CTRL, n = 13). Inclusion criteria required a sedentary lifestyle (> 6 hours/day sitting or < 150 mins/week moderate exercise), passing the PAR-Q Plus screening, and exhibiting low muscle strength (handgrip strength < 37.7 kg for males, < 25.6 kg for females). The EX group performed 2 sets of 8 repetitions of two core exercises: the Bird-Dog and the Plank with Arm Lift, with a 30-second rest between sets. The CTRL group rested for 15 minutes. Static balance was evaluated using the Modified Romberg Test (MRT), and dynamic balance was assessed via the Y-Balance Test (YBT) before and 15 minutes after the intervention.

The EX group demonstrated a highly significant immediate increase in the YBT Composite Reach Score (+5.04%, p < .001) with a large effect size, while the CTRL group showed no significant change. In static balance, the EX group achieved a remarkable increase in single-leg stance duration with eyes closed (+8.18 seconds, p <

.001), successfully mitigating postural deficits under sensory deprivation. Furthermore, independent t-tests on Gain Scores confirmed that the EX group's dynamic balance magnitude of improvement (10.41%) was approximately 25 times greater than that of the CTRL group (0.42%, $p < .001$).

Keywords: Core Stability, Acute Effects, Postural Control, Sedentary Behavior, Neuromuscular Coordination, Anti-aging, Active micro-break

Introduction

Prolonged sedentary behavior has emerged as a pervasive global public health crisis, severely affecting student and working-age populations in Thailand. Extended periods of sitting mechanically unload postural stabilizer muscles, inducing skeletal muscle atrophy, weakness of the core musculature, and impaired proprioceptive re-weighting. These functional deficits shift human movement into a reactive state, increasing the ultimate risk of falls, occupational injuries, and chronic musculoskeletal pain.

From an Anti-Aging and Regenerative Science perspective, a sedentary lifestyle accelerates biological aging through "Inflammaging"—a sterile, low-grade chronic systemic inflammation that triggers cellular senescence and multi-organ dysfunction. This is driven by a "myokine deficit"; chronically under-contracted skeletal muscles fail to secrete anti-inflammatory signaling proteins such as Interleukin-6 (IL-6), allowing pro-inflammatory cytokines like TNF-α and C-reactive protein to remain chronically elevated. While long-term exercise guidelines are well established, research regarding the immediate, short-term benefits of brief physical interventions is limited. Therefore, this study explores whether a single 15-minute micro-bout of targeted core stability exercise can act as a neuromuscular catalyst to immediately reverse these functional deficits and enhance body balance.

Research Methodology

Research Design

A Quasi-Experimental (Pre-test/Post-test) design comparing an exercise intervention group against a non-exercise control group.

Participants & Sample Size

27 low-strength, sedentary young adults (aged 25–30; normal BMI of 18.5–22.9 kg/m^2) recruited around the Asok BTS station in Bangkok. Sample size was validated using a standard sample calculation formula with a 95% confidence level.

Screening Instruments

Physical Activity Readiness Questionnaire Plus (PAR-Q Plus) and a Camry Digital Hand Dynamometer to verify low baseline muscle strength.

Assessment Tools

Seiko Stopwatch for the Modified Romberg Test, Tape-based Y-Balance Test Kit, and an AIREX Balance Pad for unstable surface testing.

Intervention Protocol:

1. Standardized Warm-up: All participants performed a structured routine consisting of 5 stretching exercises (Hip Flexor, Hamstring, Figure-Four, Quadriceps, and Side Trunk stretches), held for 10 seconds, 3 times per side.
2. Randomization: Programmed via random.org into Experimental (n = 14) and Control (n = 13) groups.
3. Exercise Execution: The Experimental group executed 2 sets of 8 repetitions of the Bird-Dog Exercise and the Plank with Arm Lift, with a 30-second rest between sets. The movement tempo for each repetition was strictly controlled at a 4-second pace (2 seconds for the concentric/upward phase and 2 seconds for the eccentric/downward phase) to ensure optimal stimulation of neuromuscular coordination. The Control group sat and rested for 15 minutes.

Data Analysis

Executed via IBM SPSS Statistics Version 28.0. Normality was verified via the Shapiro-Wilk test ($p > .05$). Homogeneity was assessed via independent t-tests, and a 2x2 Repeated Measures ANOVA was applied to evaluate Group x Time interaction effects ($p < .05$).

Results

Demographic characteristics showed baseline homogeneity between the groups with respect to age, BMI, and sitting time (≈7.5 hours/day).

1. Dynamic Balance Performance (YBT)

As shown in Table 1, the experimental group achieved highly significant functional gains across all directional vectors following the intervention, while the control group remained stagnant.

Table 1 Normalized Y-Balance Test Scores (%)

Direction	Group	Pre-test	Post-test	Mean Diff	*p*-value
Anterior (ANT)	EX	67.54 ± 1.61	72.59 ± 2.23	+5.05	**<.001***
	CTRL	67.46 ± 1.71	68.02 ± 1.68	+0.56	.210
Posteromedial (PM)	EX	66.49 ± 1.55	71.53 ± 2.16	+5.04	**<.001***
	CTRL	66.45 ± 1.62	67.02 ± 1.58	+0.57	.230
Composite Score	EX	67.02 ± 1.58	72.06 ± 2.20	+5.04	**<.001***
	CTRL	66.98 ± 1.60	67.40 ± 1.61	+0.42	.450

*Significant at $p < .05$

2. Static Balance Performance (MRT)

A ceiling effect occurred in the initial stable, eyes-open conditions (MR1, MR2), where all participants logged the maximum 60 seconds. However, as sensory inputs were removed and the base of support was minimized, significant acute improvements emerged in the EX group (Table 2).

Table 2 Comparison of Static Balance Duration (Seconds)

Test Condition	Group	Pre-test (Mean±SD)	Post-test (Mean±SD)	Mean Diff.	*p*-value
MR3: Tandem Stance (EO)	EX	54.36 ± 2.37	60.00 ± 0.00	+5.64	<.001*
	CTRL	54.08 ± 1.98	55.15 ± 1.99	+1.07	0.165
MR4: Tandem Stance (EC)	EX	49.21 ± 2.26	57.93 ± 1.49	+8.72	<.001*
	CTRL	49.08 ± 1.98	50.15 ± 1.99	+1.07	0.140
MR5: Feet Together/Foam (EO)	EX	55.14 ± 2.18	60.00 ± 0.00	+4.86	<.001*
	CTRL	54.92 ± 2.06	55.69 ± 2.10	+0.77	0.285
MR6: Feet Together/Foam (EC)	EX	48.57 ± 2.41	56.43 ± 1.91	+7.86	<.001*
	CTRL	48.31 ± 2.29	49.08 ± 2.14	+0.77	0.320
MR7: Single Leg Stance (EO)	EX	45.36 ± 3.12	54.21 ± 3.45	+8.85	<.001*
	CTRL	45.08 ± 2.96	45.62 ± 3.01	+0.54	0.480
MR8: Single Leg Stance (EC)	EX	30.22 ± 3.00	38.40 ± 3.92	+8.18	<.001*
	CTRL	29.89 ± 3.70	30.45 ± 3.67	+0.56	0.550

*Significant at $p < .05$

3. Psychological and Fatigue Outcomes

The physical improvements in the EX group were accompanied by a statistically significant increase in Self-Confidence in Balance (Δ + 2.00 ± 0.45, p < .001). Post-test Rating of Perceived Exertion (RPE) for the EX group was 3.14 ± 0.95, falling within a safe and well-tolerated "Light to Moderate" intensity range for sedentary adults.

Discussion

The empirical results confirm that short-term core interventions provide immediate physiological benefits through distinct neuromuscular pathways:

1. Refinement of Feed-forward Control: The targeted protocol primes Anticipatory Postural Adjustments (APAs), accelerating the subconscious firing of the transversus abdominis and multifidus milliseconds before limb movement occurs, allowing for cleaner dynamic extensions.
2. Proximal Stability for Distal Mobility: Isometric loading during planks increases intra-abdominal pressure, transforming the trunk into a rigid cylinder that acts as a secure mechanical anchor, minimizing micro-oscillations and Center of Pressure (COP) sway.
3. Sensory Re-weighting: When visual inputs are completely removed (as in MR8), the acute core stimulus "re-awakens" deep muscle spindles and joint receptors, enhancing proprioceptive facilitation and allowing the brain to effectively maintain stability using internal somatosensory feedback alone.
4. Reversing the Myokine Deficit: Subjective data shows 100% perceived improvement, indicating that a brief 15-minute bout serves as an effective acute metabolic stimulus to temporarily alleviate sedentary-induced neuromuscular deconditioning.

Suggestions & Limitations

1. Workplace Integration: It is highly recommended to incorporate these two specific core exercises (Bird-Dog and Plank with Arm Lift) into daily "active micro-breaks" for office employees to immediately mitigate the structural stability losses caused by sitting for more than 6 hours a day.
2. Pre-Activity Warm-up: This exact protocol should be integrated as a specific warm-up sequence prior to sports or recreational activities (e.g., Muay Thai, or traversing uneven urban terrains) to instantly optimize postural safety and lower injury rates.
3. Future Academic Research: Subsequent studies should implement electromyography (EMG) to track exact alterations in muscle firing sequences,

and explore whether a "loading dose" of consecutive daily exercise sessions establishes a permanently elevated baseline balance in sedentary cohorts.

4. A primary limitation of this study is the relatively small sample size (*n* = 27), which may limit the generalizability of the findings to a broader sedentary population; therefore, future studies with a larger calculated sample size are warranted.
5. Future academic research should investigate the exact duration of these acute benefits (effect duration) to determine how long the post-exercise balance improvements persist—such as 1 hour or 4 hours post-intervention.

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