

INVESTIGATION OF THE EFFECTS OF POSTURE AND BALANCE CHARACTERISTICS ON LOWER EXTREMITY AND CORE STRENGTH RATIOS IN SEDENTARY INDIVIDUALS AGED 30–50 YEARS

INVESTIGAÇÃO DOS EFEITOS DAS CARACTERÍSTICAS DE POSTURA E EQUILÍBRIO NAS PROPORÇÕES DE FORÇA DOS MEMBROS INFERIORES E DO TRONCO EM INDIVÍDUOS SEDENTÁRIOS COM IDADE ENTRE 30 E 50 ANOS

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Abstract

Objective: The aim of this study was to investigate the effects of posture and balance characteristics on lower extremity and core strength ratios in sedentary individuals aged 30–50 years. **Methods:** A total of 30 sedentary individuals (15 females and 15 males) aged between 30 and 50 years voluntarily participated in the study. Participants with any physical or metabolic disorders or high physical activity levels were excluded. Physical measurements included height, body weight, and body mass index. Dynamic posture was assessed using overhead squat and single-leg squat analyses. Maximal isometric strength of the lower extremity and core region (flexion, extension, and lateral flexion) was measured using Leg-Check and Back-Check devices. Balance performance was evaluated using the Balance-Check system. Statistical analyses were conducted using SPSS 26. Independent samples t-test and Pearson correlation analysis were applied, with significance set at $p < 0.05$. **Results:** Male participants exhibited significantly greater height, body weight, and body mass index compared to females ($p < 0.05$), whereas female participants demonstrated significantly higher core strength ratios ($p = 0.037$). Significant correlations were identified between knee valgus movement and balance performance in both genders. Additionally, notable relationships were observed between postural deviations, balance scores, and strength ratios of the lower extremity and core region. **Conclusion:** The findings

Resumo

Objetivo: O objetivo deste estudo foi investigar os efeitos das características de postura e equilíbrio nas relações de força dos membros inferiores e do núcleo em indivíduos sedentários com idades entre 30 e 50 anos. **Métodos:** Um total de 30 indivíduos sedentários (15 mulheres e 15 homens) com idades entre 30 e 50 anos participaram voluntariamente do estudo. Participantes com qualquer distúrbio físico ou metabólico ou altos níveis de atividade física foram excluídos. As medidas físicas incluíram altura, peso corporal e índice de massa corporal. A postura dinâmica foi avaliada usando análises de agachamento com barra acima da cabeça e agachamento com uma perna. A força isométrica máxima dos membros inferiores e da região central (flexão, extensão e flexão lateral) foi medida usando dispositivos Leg-Check e Back-Check. O desempenho do equilíbrio foi avaliado usando o sistema Balance-Check. As análises estatísticas foram realizadas usando o SPSS 26. Foram aplicados o teste t para amostras independentes e a análise de correlação de Pearson, com significância definida em $p < 0,05$. **Resultados:** Os participantes do sexo masculino apresentaram altura, peso corporal e índice de massa corporal significativamente maiores em comparação com as participantes do sexo feminino ($p < 0,05$), enquanto as participantes do sexo feminino demonstraram índices de força do núcleo significativamente mais elevados ($p = 0,037$). Foram identificadas correlações significativas



suggest that postural deviations, particularly inward knee movement and excessive lumbar lordosis, may negatively influence balance and lower extremity mechanics in sedentary individuals. These results highlight the importance of postural assessment and targeted strength interventions in sedentary populations.

Keywords: Physical Fitness, Balance, Posture, Strength, Sedentary Individuals.

entre o movimento valgo do joelho e o desempenho do equilíbrio em ambos os sexos. Além disso, foram observadas relações notáveis entre desvios posturais, pontuações de equilíbrio e índices de força da região inferior do corpo e do tronco. Conclusão: Os resultados sugerem que desvios posturais, particularmente o movimento do joelho para dentro e a lordose lombar excessiva, podem influenciar negativamente o equilíbrio e a mecânica da região inferior do corpo em indivíduos sedentários. Esses resultados destacam a importância da avaliação postural e de intervenções específicas de força em populações sedentárias.

Palavras-chave: Aptidão física. Equilíbrio. Postura. Força. Indivíduos sedentários.

1 INTRODUCTION

The relationship between sedentary behavior and adverse health outcomes was first described in the early 17th century and has since been substantiated by extensive scientific evidence demonstrating its association with increased morbidity and mortality risk (Andrew *et al.*, 2012; Tremblay *et al.*, 2010, Karaca, & Ilkim, 2021). Sedentary behavior is currently defined as low-energy–expenditure activities performed while sitting, reclining, or lying down, characterized by minimal physical activity levels (Tremblay *et al.*, 2010). Modern lifestyle conditions have led individuals to spend a substantial proportion of their daily lives in sedentary positions, resulting in adverse musculoskeletal and neuromotor adaptations (do Rosário, 2014).

A sedentary lifestyle has been shown to negatively affect the musculoskeletal system, particularly through prolonged sitting and sustained static postures that increase mechanical loading on the cervical and lumbar spine (McGill, 2001; Panjabi, 1992, Ilkim *et al.* 2021). These biomechanical stresses may facilitate the development of postural impairments, weaken postural control mechanisms, and compromise balance performance (Winter, 1995; Nalçakan & Yol, 2020).

Posture refers to the spatial alignment of the body against gravity and is regulated by a complex central nervous system mechanism that integrates visual, vestibular, and somatosensory inputs (Gurfinkel *et al.*, 1988; Cordo & Nashner, 1982, Gürer *et al.* 2024, Yurtseven *et al.* 2024). Impairments in any of these sensory systems may result in balance

deficits and functional movement limitations. Previous research has demonstrated that impaired postural control is associated with an increased risk of falls and reduced lower extremity function (Baczkowicz *et al.*, 2008; Winter, 1995).

Balance is a fundamental component of human movement and is essential for the safe and effective performance of daily living activities. In sedentary individuals, reduced balance performance has been associated with postural deviations and muscle strength deficiencies, particularly in the lower extremity and core musculature (Bulbulian & Hargan, 2000; de Noronha *et al.*, 2006). Insufficient strength in these muscle groups may diminish the effectiveness of balance strategies and functional movement control.

Core strength and stability play a critical role in spinal control and force transfer between the extremities (Kibler *et al.*, 2006; Hibbs *et al.*, 2008). Inadequate core stability may lead to compensatory movement patterns, impaired trunk control, and movement instability (Hodges *et al.*, 2004; Akuthota & Nadler, 2004, Şahin *et al.* 2025). In sedentary populations, weakening of the core musculature is considered a major contributing factor to the development of postural dysfunctions and balance impairments (McGill, 2001; Arab *et al.*, 2007).

In this context, investigating the effects of posture and balance characteristics on lower extremity and core strength ratios in sedentary individuals aged 30–50 years is essential for the development of both preventive and rehabilitative exercise strategies aimed at improving postural control, balance performance, and functional movement quality.

2 METHODOLOGY

2.1 Study design

This study was conducted using a cross-sectional and correlational research design to investigate the effects of posture and balance characteristics on lower extremity and core strength ratios in sedentary individuals aged 30–50 years. All measurements were performed in a controlled laboratory environment in accordance with standardized protocols and employed a cross-sectional and correlational research design to investigate the relationships between posture, balance, and strength parameters in sedentary adults (Winter, 1995).

2.2 Participants

A total of 30 sedentary volunteer participants (15 females and 15 males), aged between 30 and 50 years, who applied to a fitness center located in the Beşiktaş district of Istanbul, were included in the study. Individuals with high physical activity levels or with any physical or metabolic disorders were excluded. All participants were informed in detail about the study procedures, and written informed consent was obtained prior to participation. Thirty sedentary adults aged 30–50 years participated voluntarily. Sedentary status was confirmed using the Physical Activity Readiness Questionnaire (PAR-Q), consistent with ACSM guidelines (ACSM; Tremblay *et al.*, 2010).

2.3 Assessment of physical activity level

To determine the sedentary status of the participants, the Physical Activity Readiness Questionnaire (PAR-Q) was administered. This questionnaire was developed to assess pre-exercise health risks and is widely used in accordance with American College of Sports Medicine (ACSM) standards. Participants who responded “no” to all questions were included in the study.

2.4 Anthropometric measurements

Body weight was measured in kilograms using a Tanita HD-366 digital scale, and height was measured in centimeters using a wall-mounted stadiometer. Measurements were performed barefoot and with light clothing. Body Mass Index (BMI) was calculated using the obtained data.

2.5 Dynamic postural analysis

Dynamic postural assessment was conducted in accordance with the evaluation protocols developed by the National Academy of Sports Medicine (NASM). During the tests, participants were observed from both anterior and lateral views, and postural deviations related to the feet, knees, hips, trunk, and shoulder complex were recorded. Observational findings were documented using a standardized postural analysis chart.

Dynamic postural assessments were conducted using Overhead Squat and Single-Leg Squat tests following NASM protocols (Clark & Lucett, 2011; Clark *et al.*, 2012). These tests are widely used to identify functional movement impairments and compensatory strategies (Ageberg *et al.*, 2005).

2.6 Maximal isometric lower extremity and core strength measurements

Lower extremity and core muscle strength measurements were performed using the Dr. Wolff Back-Check and Leg-Check systems. The measurements were recorded via software capable of evaluating results according to international norms based on age, sex, height, and body weight.

The Leg-Check measurement was conducted bilaterally in a seated position, with the knee angle set at 45°. Participants performed three trials, applying maximal isometric force for 3–5 seconds during each trial.

Using the Back-Check system, maximal isometric muscle strength for trunk flexion, extension, and right–left lateral flexion was measured in a standing position. Device settings were adjusted according to participant anthropometrics to prevent compensatory movements. Each measurement was performed in three repetitions, and the highest values were included in the analysis. Maximal isometric strength assessment has been shown to be a reliable indicator of neuromuscular capacity and postural control (Berger, 1962; Frontera *et al.*, 1991).

2.7 Balance assessment

Balance performance was assessed using the Dr. Wolff Balance-Check device. Participants were instructed to maintain balance for 30 seconds on an unstable platform at a predefined difficulty level. Measurements were conducted in two trials, and numerical data were obtained through the device software. Instrumented balance assessments provide objective indicators of postural stability and neuromotor control (Winter, 1995; Baczkowicz *et al.*, 2008).

2.8 Statistical analysis

The statistical analyses of the data were performed using the SPSS software package (version 26.0). Descriptive statistics were presented as mean and standard deviation values. Independent samples *t*-tests were used for comparisons based on sex, and Pearson correlation analysis was applied to determine relationships between variables. The level of statistical significance was set at $p < 0.05$.

3 RESULTS

3.1 Demographic, anthropometric, and physical characteristics of the participants

An examination of the descriptive statistics related to the demographic, anthropometric, and physical characteristics of the participants revealed no statistically significant difference between male and female groups in terms of age ($p > 0.05$). However, height and body weight values were significantly higher in male participants compared with female participants ($p < 0.01$). In addition, body mass index (BMI) values in the male group were found to be significantly higher than those in the female group ($p < 0.05$).

Table 1

Descriptive Statistics of Demographic, Anthropometric, and Physical Characteristics of the Participants (CSR: Core Strength Ratio, LESR: Lower Extremity Strength Ratio, BL: Balance, BMI: Body Mass Index, BW: Body Weight)

Gender	Age	Height (cm)	BW (kg)	BMI	CSR	LESR	BL
Males (n=16)	41.44±6.48	174.0±0.09	82.89±15.17	27.28±3.90	1.58±0.90	2.71±2.46	2.73±0.90
Females (n=15)	42.60±6.62	161.0±0.08	59.3±11.00	22.71±3.72	2.70±1.82	3.45±1.96	2.48±1.04
Difference (p-value)	p=0.625	p=0.001	p=0.001	p=0.002	p=0.037	p=0.363	p=0.477

When evaluated in terms of core strength ratios, the mean values of the female participants were found to be statistically significantly higher than those of the male

participants ($p = 0.037$). No statistically significant differences were observed between the groups with respect to lower extremity strength ratios or balance scores ($p > 0.05$).

3.2 Postural assessment findings

An examination of the dynamic postural assessment results of all participants revealed that anterior foot flattening or external foot rotation during movement was observed in 25% of male participants and 20% of female participants. Medial knee displacement during movement was observed at similar rates in both sexes, occurring in 56.25% of males and 55.33% of females.

In the lateral view assessment, excessive forward trunk lean during movement was observed in 68.75% of male participants, whereas this rate was 46.67% in female participants. Excessive lumbar lordosis was identified at low frequencies in both sexes. Forward arm displacement was observed more frequently in female participants compared with male participants.

Table 2

Findings Related to Dynamic Postural Assessment Criteria in All Participants

Gender	ANTERIOR FOOT FLATURATION/OUTWARD ROTATION		ANTERIOR KNEE INWARD MOVEMENT		LATERAL LUMBO-PELVIC-HIP COMPLEX EXCESSIVE FORWARD FALL		LATERAL LUMBO-PELVIC-HIP COMPLEX EXCESSIVE LOWER BOW		LATERAL SHOULDER COMPLEX FORWARD FALL OF THE ARMS		ANTERIOR KNEE INWARD MOVEMENT RIGHT		ANTERIOR KNEE INWARD MOVEMENT LEFT	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Males (n=16)	4	12	9	7	11	5	1	15	4	12	13	3	11	5
Females (n=15)	3	12	8	7	7	8	1	14	9	16	15	0	12	3

As shown in Table 2, postural assessment of all participants aged 30–50 years revealed that anterior foot flattening or external foot rotation during movement was observed in 25.0% of male participants and 20.0% of female participants. Anterior medial

knee displacement was identified in 56.25% of males and 55.33% of females. Excessive forward trunk lean during movement was observed in 68.75% of male participants and 46.67% of female participants. Excessive lumbar lordosis during movement was detected in 6.67% of males and 7.14% of females. Forward arm displacement was observed in 25.0% of male participants and 60.0% of female participants. Anterior medial displacement of the right knee was found in 81.25% of male participants and 100.0% of female participants, whereas anterior medial displacement of the left knee was observed in 68.75% of males and 80.0% of females.

3.3 Findings related to balance and postural variables

When postural assessment results of participants with balance scores of 2.50 and above were examined, postural deviations were observed at lower frequencies in individuals with better balance performance. In particular, postural impairments such as medial knee displacement and excessive forward trunk lean were found to be associated with balance scores.

Table 3

Postural Assessment Results of Participants with Balance Scores ≥ 2.50

Gender	Anterior Foot Flattening / External Rotation		Anterior Knee Valgus		Lateral Lumbo–Pelvic–Hip Complex: Excessive Forward Lean		Lateral Lumbo–Pelvic–Hip Complex: Excessive Lumbar Lordosis		Lateral Shoulder Complex: Forward Arm Displacement		Anterior Knee Valgus (Right)		Anterior Knee Valgus (Left)	
	present	Absent	present	Absent	present	Absent	present	Absent	present	Absent	present	Absent	present	Absent
Males (n=10)	3	7	5	5	7	3	10	0	3	7	8	2	7	3
Females (n=7)	3	4	6	1	3	4	1	6	4	3	7	0	5	2

Based on the analyses presented in **Table 3**, anterior foot flattening or external rotation was observed in 30.0% of male participants and 42.86% of female participants. Anterior medial knee displacement was identified in 50.0% of males and 85.71% of females. Excessive forward trunk lean was observed in 30.0% of male participants and

42.86% of female participants. Excessive lumbar lordosis was detected in 100.0% of males and 14.9% of females. Forward arm displacement was observed in 30.0% of male participants and 57.14% of female participants. Anterior medial displacement of the right knee was found in 80.0% of male participants and 100.0% of female participants, whereas anterior medial displacement of the left knee was observed in 70.0% of males and 71.43% of females.

3.4 Relationship between lower extremity strength and posture

When postural assessment results of participants with lower extremity strength ratios of 5.00 and below were examined, postural impairments such as medial knee displacement and foot flattening were found to occur more frequently in individuals with lower lower extremity strength. In male participants, a positive correlation was identified between lower extremity strength and medial displacement of the left knee ($r = 0.525$, $p = 0.001$).

3.5 Relationship between core strength and posture

In participants with low core strength ratios, postural deviations such as excessive forward trunk lean and forward arm displacement were more pronounced. When all participants were evaluated together, a strong negative correlation was identified between excessive forward trunk lean and forward arm displacement ($r = -0.868$, $p = 0.001$).

3.6 Correlation findings by gender

Sex-specific correlation analyses revealed a positive relationship between lower extremity strength and medial displacement of the left knee in male participants. In addition, a strong negative correlation was found between excessive forward trunk lean and forward arm displacement ($r = -0.856$, $p = 0.001$).

In female participants, a negative correlation was identified between medial knee displacement and balance scores ($r = -0.661$, $p = 0.007$). Furthermore, a strong negative correlation was observed between excessive forward trunk lean and forward arm

displacement ($r = -0.873, p = 0.001$). A positive relationship was also identified between excessive lumbar lordosis and foot flattening or external rotation ($r = 0.535, p = 0.040$).

When all parameters were evaluated between sexes, no statistically significant differences were observed ($p > 0.05$).

Table 4

Pearson Correlation Matrix Between Core Strength, Lower Extremity Strength, Postural Variables, and Balance

No	Variables	1	2	3	4	5	6	7	8	9	10
1	Core Strength Ratio	1	-0.0006	-0.028	0.104	0.079	-0.341	-0.062	-0.203	-0.029	-0.271
2	Lower Extremity Strength Ratio	1	0.1199	-0.092	-0.091	0.254	0.285	0.125	0.292	-0.305	
3	Anterior Foot Flattening / External Rotation	1	0.1180	-0.323	0.172	0.323	0.177	0.142	-0.285		
4	Medial Knee Displacement	1	0.280	-0.289	-0.280	0.141	0.057	-0.172			
5	Excessive Forward Trunk Lean	1	-0.309	-0.868	-0.057	-0.053	0.017				
6	Excessive Lumbar Lordosis	1	0.086	0.155	0.405	0.238					
7	Forward Arm Displacement	1	0.057	0.202	-0.017						
8	Medial Knee Displacement (Right)	1	0.306	0.141							
9	Medial Knee Displacement (Left)	1	0.205								
10	Balance Score	1									

Pearson correlation analysis revealed several significant relationships among core strength, lower extremity strength, postural deviations, and balance variables. A strong and statistically significant negative correlation was observed between excessive forward trunk lean and forward arm displacement ($r = -0.868, p < 0.001$), indicating that increases in forward trunk lean were associated with decreases in forward arm displacement.

Moderate relationships were also identified between postural deviations and balance-related variables; however, most correlations did not reach statistical significance ($p > 0.05$). Core strength and lower extremity strength ratios showed limited direct associations with individual postural variables, suggesting that postural control and balance performance may be influenced by multifactorial interactions rather than isolated strength parameters.

**Significant correlations are indicated in bold. Correlation analysis was performed using Pearson's correlation coefficient. Statistical significance was set at $p < 0.05$.*

As shown in Table 4, correlation analysis revealed a significant negative correlation only between postural control markers, specifically excessive forward trunk lean and forward arm displacement ($r = -0.868, p = 0.001$). No other statistically significant correlations were observed among the remaining parameters ($p > 0.05$).

Table 5

Correlation Results of Balance, Core Strength, and Lower Extremity Strength in Male Participants

No	Variables	1	2	3	4	5	6	7	8	9	10
1	Balance Score	1	-0.218	0.051	0.293	-0.218	0.101	0.051	-0.163	-0.379	
2	Anterior Foot Flattening / External Rotation	1	-0.234	-0.149	0.333	0.277	0.078	-0.177	0.068		
3	Medial Knee Displacement	1	0.493	-0.293	-0.364	0.222	0.019	-0.029			
4	Excessive Forward Trunk Lean	1	-0.383	-0.856	0.022	0.230	0.038				
5	Excessive Lumbar Lordosis	1	0.447	0.124	-0.389	0.294					
6	Forward Arm Displacement	1	-0.092	-0.243	0.365						
7	Medial Knee Displacement (Right)	1	0.367	-0.209							
8	Medial Knee Displacement (Left)	1	0.525*								
9	Core Strength Ratio	1									
10	Lower Extremity Strength Ratio	1									

Core Strength Ratio; Lower Extremity Strength Ratio * $p < 0.01$, $p < 0.05$

When the correlation results of all male participants were examined, a statistically significant positive correlation was identified between lower extremity strength and medial displacement of the left knee ($r = 0.525$, $p = 0.001$). In addition, a statistically significant negative correlation was found between excessive forward trunk lean and forward arm displacement ($r = -0.856$, $p = 0.001$). The detailed correlation coefficients and significance values are presented in Table 5.

Table 6

Pearson Correlation Matrix of Balance, Core Strength, Lower Extremity Strength, and Postural Variables in Female Participants (N = 15)

No	Variables	1	2	3	4	5	6	7	8	9
1	Balance Score	1	-0.354	-0.661*	0.094	0.189	0.000	0.354	-0.249	-0.137
2	Anterior Foot Flattening / External Rotation	1	0.134	-0.468	0.535*	0.408	0.250	0.009	0.374	
3	Medial Knee Displacement	1	0.071	-0.286	-0.218	-0.468	0.152	-0.193		
4	Excessive Forward Trunk Lean	1	-0.250	-0.873	-0.200	-0.121	-0.351			
5	Excessive Lumbar Lordosis	1	0.218	0.134	-0.379	0.219				
6	Forward Arm Displacement	1	0.272	0.239	0.397					
7	Medial Knee Displacement (Left)	1	0.142	0.005						
8	Core Strength Ratio	1	-0.188							
9	Lower Extremity Strength Ratio	1								

According to Table 6, correlation analysis of female participants revealed a statistically significant negative correlation between medial knee displacement and balance scores ($r = -0.661$, $p = 0.007$). In addition, a strong negative correlation was identified between excessive forward trunk lean and forward arm displacement ($r = -0.873$, $p = 0.001$). A statistically significant positive correlation was also found between

excessive lumbar lordosis and anterior foot flattening or external rotation ($r = 0.535$, $p = 0.040$). No other statistically significant correlations were observed among the remaining parameters ($p > 0.05$).

4 DISCUSSION

The present study demonstrated that posture, balance, and strength parameters are closely interrelated in sedentary individuals aged 30–50 years, highlighting the multidimensional effects of a sedentary lifestyle on postural control and neuromuscular function. These findings are consistent with previous research indicating that prolonged sedentary behavior adversely affects postural regulation, balance performance, and movement quality (do Rosário, 2014; Tremblay *et al.*, 2010).

Sex-related differences observed in the present study revealed that male participants exhibited significantly higher height, body weight, and body mass index values, whereas female participants demonstrated higher core strength ratios. This finding may be attributed to sex-specific biomechanical and neuromuscular characteristics. Previous studies have suggested that females may exhibit relatively greater endurance and stabilization capacity in certain core muscle groups, which may contribute to improved trunk control despite lower absolute strength levels (Hibbs *et al.*, 2008; McGill, 2009).

Postural assessment outcomes indicated a high prevalence of medial knee displacement, foot flattening, and excessive forward trunk lean in both sexes, suggesting compromised lower extremity and trunk stabilization in sedentary individuals. Among these deviations, medial knee displacement has been widely recognized as a critical postural impairment associated with balance deficits and an increased risk of lower extremity injuries (Ageberg *et al.*, 2005; de Noronha *et al.*, 2006). The significant association identified between medial knee displacement and balance performance further supports the role of lower extremity alignment as a key determinant of effective balance strategies (Baczkowicz *et al.*, 2008; Winter, 1995).

Additionally, the strong negative correlation observed between excessive forward trunk lean and forward arm displacement suggests the concurrent emergence of postural compensation mechanisms during movement. Similar patterns of trunk–upper extremity coordination have been reported in studies examining anticipatory and compensatory

postural adjustments, indicating that postural deviations rarely occur in isolation (Cordo & Nashner, 1982; Hodges *et al.*, 2004).

Evaluation of strength-related parameters revealed that postural deviations were more pronounced in individuals with lower lower extremity strength ratios. The positive association between lower extremity strength and medial knee displacement observed in male participants suggests that insufficient stabilization during force production may adversely influence postural control. This finding aligns with previous evidence indicating that neuromuscular adaptations related to strength capacity play a crucial role in joint alignment and movement quality (Balshaw *et al.*, 2017; Jaric, 2003).

Overall, the findings of the present study indicate that impairments in posture, balance, and strength parameters are interdependent in sedentary individuals and may collectively contribute to reduced functional movement quality. These results underscore the importance of integrated assessment and intervention strategies targeting postural alignment, balance control, and both lower extremity and core strength in sedentary populations.

5 CONCLUSION AND RECOMMENDATIONS

The findings of the present study indicate that postural impairments in sedentary individuals aged 30–50 years are significantly associated with balance and muscle strength parameters. In particular, postural deviations such as medial knee displacement, excessive lumbar lordosis, and forward trunk lean appear to adversely affect balance performance and functional movement control.

Sex-specific analyses revealed distinct patterns in the relationships between posture, balance, and strength parameters. In male participants, significant associations were observed between lower extremity strength and medial knee displacement, whereas in female participants, postural deviations were more strongly related to balance performance. These findings suggest that exercise interventions designed for sedentary individuals should consider gender-related biomechanical and neuromuscular characteristics when targeting postural control and movement quality.

Based on the present results, it is recommended that postural assessments be systematically incorporated into exercise programs for sedentary individuals. Interventions prioritizing improvements in lower extremity and core strength, combined

with core stabilization and balance-enhancing exercises, may provide meaningful functional benefits and contribute to improved postural control and balance performance (Kibler *et al.*, 2006; McGill, 2001).

Future research should include larger sample sizes, different age groups, and longitudinal exercise interventions to further elucidate causal relationships between posture, balance, and strength parameters. Such studies may also help to determine the long-term effectiveness of targeted exercise strategies in sedentary populations.

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All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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