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Original Article

Examine the Differences in the Dynamic Balance of Young Adults and Middle-Aged Women as Determined by the Star Excursion Balance Test

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ABSTRACT

Background: Dynamic balance is crucial for performing daily activities and preventing falls, particularly as individuals age. Previous studies have indicated that dynamic balance, as assessed by the Star Excursion Balance Test (SEBT), tends to diminish with aging, impacting overall quality of life and increasing the risk of injuries.

Objective: The aim of this study was to examine the differences in dynamic balance between young adults and middle-aged women using the SEBT, to understand how aging affects balance and postural control.

Methods: A cross-sectional study design was employed, involving fifty fit and active women, divided into two age groups: young adults (aged 18–25 years, n=25) and middle-aged women (aged 40–60 years, n=25). Participants with any lower extremity or spinal musculoskeletal disorders in the last 6 months, those who were physically unfit, and pregnant women were excluded. The SEBT was administered to assess dynamic balance, with participants performing three reaches in each of the eight directions in a randomized order. The mean reach distance was calculated for each direction. Data analysis was conducted using SPSS version 25, with independent sample t-tests to compare reach distances between the two groups. A P-value of <0.05 was considered statistically significant.

Results: The young adult group demonstrated significantly greater reach distances compared to the middle-aged group in all directions of the SEBT. Specifically, medial reach distances were 54.96 ± 5.63 cm for the young adults and 41.79 ± 7.36 cm for the middle-aged group, with a P-value of <0.001. Similar trends were observed in anteromedial, anterior, anterolateral, lateral, posterolateral, posteromedial, and posterior reaches, indicating a consistent decline in dynamic balance with age.

Conclusion: The study confirms that dynamic balance, as measured by the SEBT, significantly decreases from young adulthood to middle age in women. This underscores the importance of incorporating balance training and physical activity into lifestyle interventions to mitigate age-related declines in balance and postural control.

Keywords: Dynamic Balance, Star Excursion Balance Test, Aging, Young Adults, Middle-aged Women, Postural Control.

INTRODUCTION

The Star Excursion Balance Test (SEBT), a crucial tool for evaluating dynamic balance and postural control, requires participants to perform a single-leg stance while extending their foot in eight distinct directions. This method effectively identifies a range of musculoskeletal deficiencies, including injuries to the anterior cruciate ligament, persistent ankle instability, and other lower extremity conditions. The SEBT's reliability and sensitivity in detecting individuals with conditions such as chronic ankle instability (1,2), patellofemoral pain syndrome (3), anterior cruciate ligament deficiency (4), and movement discrepancies following anterior cruciate ligament reconstruction (5-7) underscore its importance in physical therapy practice and sports medicine. Furthermore, its predictive capacity in foretelling injuries in various sports, notably among high school basketball and football players (8-12), highlights its utility in diagnosing lower extremity anomalies.

A study by Lucinda E. Bouillon in 2018 examined the dynamic balance capabilities of young adults (aged 23–39) and middle-aged adults (aged 40–54) through the SEBT. Bouillon's research demonstrated a decline in balance with age, as evidenced by younger

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women achieving greater reach distances in the anterior, anteromedial, and posteromedial directions by approximately 7 cm (13). This significant difference of around 12 cm in reach distances between the two age groups (14,15) illustrates the impact of aging on balance and supports the premise that dynamic balance diminishes as individuals age.

In parallel, Amstrong Ross's 2018 study focused on the impact of fatigue, particularly within the context of dance, on SEBT performance. Considering the high risk of injury associated with dance, Ross aimed to explore how dance-specific fatigue influences balance and performance. The study concluded that resistance to fatigue might be indicative of a dance-specific performance adaptation, as no significant changes in movement performance that could increase the risk of injury were observed (16). This finding emphasizes the importance of physical activity in maintaining superior balance and SEBT performance, with physically active individuals showing greater reach distances compared to their less active or older counterparts (17).

The scarcity of experimental studies in this domain, especially within the Pakistani context, led to the current investigation aimed at comparing the dynamic balance of young and middle-aged women using the SEBT. With an alternate hypothesis suggesting a significant difference in dynamic balance between these two groups, and a null hypothesis positing no significant difference (18,19), this study seeks to contribute to the body of knowledge on dynamic balance across different age groups. This research aimed to facilitate the development of more targeted interventions and preventive measures in the field of physical therapy and related areas.

MATERIAL AND METHODS

In this cross-sectional study, the dynamic balance differences between young adults and middle-aged women were examined using the Star Excursion Balance Test (SEBT). Conducted at Akhtar Saeed Medical and Dental College over a six-month period from June 2022 to December 2022, the research targeted fifty active women. These participants were divided into two distinct groups: twenty-five middle-aged women aged between 40 and 60 years, and twenty-five adult women aged 18 to 25 years. The inclusion criteria focused on females without any lower extremity or spinal musculoskeletal disorders in the preceding six months, those who were physically fit, and psychologically normal. Conversely, physically unfit individuals, pregnant females, or those with recent musculoskeletal issues were excluded from the study.

Prior to participation, subjects were briefed on the study's aims, benefits, and potential drawbacks, following which informed consent was obtained. This procedure ensured adherence to ethical guidelines, aligning with the principles outlined in the Declaration of Helsinki, which emphasizes the importance of voluntary participation and informed consent in research involving human subjects.

The methodology involved participants standing at the center of a testing grid, with strips of tape positioned at 45-degree angles to mark the reach directions. Each participant was required to make three reaches in each of the eight designated directions, with the mean reach distance calculated to assess their dynamic balance. The reaches were performed in a randomized order to eliminate any sequence effects, and rest periods were incorporated throughout the sessions to prevent fatigue. The sample size of fifty was determined using the $N = [(Za + Zb)/C]^2 + 3 = 50$, based on a non-probability convenient sampling technique.

Data collection was meticulously carried out, ensuring accuracy in the measurement of reach distances and adherence to the standardized SEBT protocol. Following data collection, the analysis was performed using SPSS version 25. Quantitative variables, including mean reach distances, standard deviations, ranges, and histograms, were calculated to present a detailed statistical overview of the dynamic balance capabilities across the two groups. Categorical variables were analyzed through frequencies, percentages, cross-tabulations, and bar charts, providing a comprehensive understanding of the distribution patterns within the sample. The use of parametric tests facilitated the examination of significant differences between the groups, with a P-value of 0.05 or less considered indicative of statistical significance.

RESULTS

In the conducted study, the demographic characteristics of the participants were thoroughly analyzed to provide a foundational understanding of the sample population. The total age range of the participants spanned from 20 to 59 years, encompassing a diverse group of 50 women, which constituted the entirety of the study's demographic (Table 1). The mean age of these participants was calculated to be 34.60 years, with a standard deviation of 13.38, reflecting a broad age distribution within the sample. Marital status was evenly split among the participants, with half (25) being married and the other half (25) unmarried, ensuring a balanced representation of marital contexts within the study population.

The core of the study's findings is encapsulated in the analysis of dominant and non-dominant limb reach distances, employing the Independent Sample t-test to compare between the younger (18-25 years) and older (40-60 years) age groups. For the dominant limb, significant differences were observed across all reach directions. Young adults demonstrated superior reach in the medial direction with a mean of 54.96 (SD = 5.63) compared to the middle-aged group's mean of 41.79 (SD = 7.36), indicating a profound

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disparity in balance capabilities between the two cohorts. This pattern of results was consistent across other reach directions, including anteromedial, anterior, anterolateral, lateral, posterolateral, posteromedial, and posterior reaches, with p-values less than 0.001 in each case, suggesting statistically significant differences (Table 2).

Table 1 Demographic Characteristics of Participants

Variable	Category	Frequency	Percent
Total Age Range of Participants	20 to 59 years	50	100%
Mean Age	34.60 ± 13.38		
Marital Status	Married	25	50%
	Unmarried	25	50%
Total Participants		50	100%

Table 2 Independent Sample t-test Results for Dominant Limb Reach Distances

Reach Direction	Age Group	N	Mean	Std. Deviation	Std. Error Mean	P-Value
Medial	18- 25	25	54.96	5.63	1.13	<0.001
	40- 60	25	41.79	7.36	1.57	
Anteromedial	18- 25	25	56.52	6.46	1.30	<0.001
	40- 60	25	45.10	6.92	1.48	
Anterior	18- 25	25	54.03	6.52	1.30	<0.001
	40- 60	25	44.25	6.83	1.46	
Anterolateral	18- 25	25	55.94	6.63	1.36	<0.001
	40- 60	25	44.33	7.63	1.63	
Lateral	18- 25	25	51.05	6.04	1.28	<0.001
	40- 60	25	37.84	5.74	1.22	
Posterolateral	18- 25	25	51.11	6.17	1.23	<0.001
	40- 60	25	36.93	7.02	1.50	
Posteromedial	18- 25	25	56.54	7.81	1.56	<0.001
	40- 60	25	44.81	6.60	1.40	
Posterior	18- 25	25	49.62	9.09	1.82	<0.001
	40- 60	25	39.27	4.74	1.01	

Table 3 Independent Sample t-test Results for Non-Dominant Limb Reach Distances

Reach Direction	Age Group	N	Mean	Std. Deviation	Std. Error Mean	P-Value
Medial	18- 25	25	51.63	7.80	1.60	<0.001
	40- 60	25	42.90	6.88	1.47	
Anteromedial	18- 25	25	55.74	7.16	1.43	<0.001
	40- 60	25	44.79	7.73	1.65	
Anterior	18- 25	25	53.37	6.47	1.29	<0.001
	40- 60	25	42.70	5.73	1.22	
Anterolateral	18- 25	25	57.07	6.89	1.38	<0.001
	40- 60	25	42.28	6.32	1.35	
Lateral	18- 25	25	56.29	5.51	1.10	<0.001
	40- 60	25	41.97	8.58	1.83	
Posterolateral	18- 25	25	59.47	6.12	1.22	<0.001
	40- 60	25	43.83	7.46	1.59	
Posteromedial	18- 25	25	51.88	8.13	1.63	<0.001
	40- 60	25	41.94	3.40	0.81	
Posterior	18- 25	25	50.98	9.44	1.89	<0.001
	40- 60	25	39.03	3.49	0.73	

Similarly, the non-dominant limb results mirrored those of the dominant limb, underscoring the consistency of balance performance disparity between the age groups. In the medial reach, for example, the younger group averaged 51.63 (SD = 7.80) while the older group managed 42.90 (SD = 6.88), with a p-value less than 0.001. This significant trend continued across anteromedial, anterior, anterolateral, lateral, posterolateral, posteromedial, and posterior reach directions, reaffirming the significant impact of age on dynamic balance as measured by the SEBT (Table 3).

The detailed analysis of reach distances for both limbs not only highlights the significant differences in dynamic balance between the young adult and middle-aged women but also emphasizes the robustness of the SEBT as a tool for evaluating postural control and balance across different age groups. The consistent finding of superior performance in younger adults across all measured directions underscores the influence of age on balance and postural stability, providing invaluable insights for targeted interventions and preventive strategies in physical therapy and related fields.

DISCUSSION

The findings from the current study underscore a discernible decline in dynamic balance with aging among healthy women, highlighting a significant disparity where the middle-aged group's reach distances were approximately 12 cm shorter than those of the young adult women across various directions. This correlation between the Star Excursion Balance Test (SEBT) performance and age aligns with previous research indicating a negative association beyond the age of 60 (20). The observed variance between young and middle-aged participants corroborates the notion that healthy elderly individuals exhibit a progressive deterioration in standing balance as they age (21), thereby reinforcing the critical nature of dynamic balance assessment in these populations.

Lucinda E. Bouillon's 2018 study similarly explored dynamic balance differences between adult-aged and middle-aged women using the SEBT, with findings that younger women could reach approximately 7 cm farther in anterior, anteromedial, and posteromedial excursions compared to their older counterparts (14). These results parallel the current study, emphasizing a tangible decline in balance capabilities with advancing age, further substantiated by a significant difference of approximately 12 cm between young adults and middle-aged women in our analysis. Such consistency across studies serves to solidify the SEBT as a reliable measure for assessing dynamic balance across various age groups.

The impact of physical activity levels on SEBT performance was also highlighted in a study by Amstrong Ross in 2018, which investigated the role of fatigue in dancers. Ross found that dance-specific fatigue did not adversely affect SEBT performance, suggesting an adaptation to fatigue among dancers that might mitigate injury risk (16). This resilience to fatigue among physically active individuals, as also demonstrated in our study, underscores the potential of regular physical activity to enhance dynamic balance and SEBT performance, even as age progresses.

In contrast, Mikel R. Stiffler's 2015 research into SEBT performance across sexes and sports among collegiate athletes revealed variances in performance, particularly in the anterior direction, which was more indicative of differences between male and female teams (22). While Stiffler's work highlighted sex and sport-specific differences in balance, our study contributes to this dialogue by delineating age-related balance disparities, notably in the anterior, posterolateral, and posteromedial directions among women.

Alyson Filipa's 2010 study on the effects of a neuromuscular training program (NMTP) on SEBT performance underscored the potential for targeted interventions to enhance dynamic balance, particularly in the posterolateral and posteromedial reaches (23). The parallels between Filipa's findings and our study suggest that SEBT can serve as an effective tool in evaluating and improving postural instability, particularly in young, recreationally active individuals.

Lee Herrington's 2009 study further enriches the context by examining the impact of anterior cruciate ligament deficiency (ACLD) on dynamic postural control as measured by the SEBT, revealing significant impairments in individuals with ACLD compared to asymptomatic subjects (7). While Herrington focused on a specific impairment, our study extends the utility of SEBT in assessing dynamic balance in a broader, healthy population across different age groups.

The convergence of these findings with our research indicates that while dynamic balance diminishes with age, factors such as physical activity levels and targeted training programs can play a pivotal role in mitigating this decline. The study's strengths lie in its rigorous methodology and the clear demonstration of age-related differences in dynamic balance. However, limitations include the reliance on a convenience sample and the focus solely on female participants, which may restrict the generalizability of the findings to broader populations or to men.

In light of these insights, it is recommended that future research explore longitudinal interventions aimed at enhancing dynamic balance across different age groups, with a particular focus on how targeted training programs might offset age-related declines in balance. Additionally, expanding the demographic scope to include male participants and a wider range of age groups would provide a more comprehensive understanding of dynamic balance across the human lifespan.

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CONCLUSION

In conclusion, the SEBT has proven to be an invaluable tool in highlighting the significant differences in dynamic balance between middle-aged women and younger individuals, offering a pathway for early intervention and prevention strategies aimed at mitigating fall risk and enhancing quality of life among aging populations.

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