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Original Article

Variation in Dynamic Postural Control with Hip Strength Deficit in Young Adults

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ABSTRACT

Background: Balance is a critical component of human movement and stability, particularly in young adults. The relationship between hip muscle strength and dynamic postural control, as measured by the Y Balance Test (YBT), has been the subject of various studies, yet the extent of this correlation remains not fully understood.

Objective: The aim of this study was to investigate the variation in dynamic postural control with hip strength deficits in young adults. It sought to understand the correlation between hip muscle strength and dynamic balance, as well as to explore gender differences in balance performance.

Methods: This cross-sectional study involved 60 medical students from Akhtar Saeed Medical and Dental College, Lahore, aged 18-35 years. Participants with no lower extremity ailments or general health issues were included. The Y Balance Test and Manual Muscle Testing (MMT) were used for data collection. Strength was graded manually, and balance was assessed through the YBT, which involved forward, medial backward, and lateral backward movements. Data analysis was performed using SPSS version 25.0, with the Mann-Whitney U test applied to assess significant differences.

Results: The study revealed significant gender differences in YBT scores, with males showing greater composite reach distances in both dominant (Mean Rank: Males = 46.05, Females = 23.29, P = .00) and non-dominant sides (Mean Rank: Males = 44.95, Females = 23.80, P = .00). However, no significant differences were observed in the YBT scores across grades 4 and 5 in various hip muscle groups (P > 0.05 in all comparisons).

Conclusion: The study confirms significant gender differences in dynamic postural control but does not establish a strong correlation between hip muscle strength and balance performance. These findings suggest that other factors, such as training and physical attributes, may play a more significant role in balance. This research contributes to the understanding of balance dynamics in young adults and can guide the development of targeted training and rehabilitation programs.

Keywords: Dynamic Postural Control, Hip Muscle Strength, Y Balance Test, Manual Muscle Testing, Gender Differences, Young Adults.

INTRODUCTION

Balance, defined as the ability to maintain the center of gravity over a supporting base, plays a crucial role in human movement and stability (1). This concept is critically examined through the Y-Balance Test, an established tool for assessing balance and posture and predicting potential lower limb injuries. However, the direct correlation between hip muscle strength and performance on the Y Balance Test remains unclear (2).

Hip muscles are pivotal in maintaining balance during static and dynamic activities. They are particularly engaged during the Y Balance Test, which involves standing on one leg and reaching in three directions: anterior (ANT.), posteromedial (PM), and posterolateral (PL). This test highlights the role of hip muscles in dynamic balance (2, 3).

The study of fall risks in various populations has underscored the importance of understanding the relationship between lower limb strength and balance. This knowledge is vital for therapists and practitioners, aiding in the design of injury prevention and rehabilitation programs (4).

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In daily activities, such as walking, the hip muscles perform complex tasks to maintain balance in both static and dynamic postures. The Y Balance Test, incorporating elements of the Star Excursion Balance Test (SEBT), is a valuable tool for measuring active balance and assessing fall risk. This test evaluates range of motion (ROM), flexibility, and strength (7).

Manual Muscle Testing (MMT) and dynamometry are essential in assessing skeletal muscle strength. MMT, a manual assessment technique, categorizes muscle strength on a scale of 0 to 5, where 0 indicates no muscle contraction, and 5 represents active movement against gravity with maximum resistance (8, 9).

The Y Balance Test is not only a research tool for diverse populations, including athletes, but it also offers insights into injury recovery and dynamic balance in healthy individuals, such as volleyball players (10).

This research aims to explore the relationship between hip strength and dynamic balance control in young adults, utilizing MMT and the Y Balance Test. It investigates whether there is a significant variation in dynamic postural control associated with hip strength deficits. The null hypothesis posits no significant variation in dynamic postural control with hip strength deficits, while the alternate hypothesis suggests a significant variation.

MATERIAL AND METHODS

In this cross-sectional study, conducted at Akhtar Saeed Medical and Dental College, Lahore, between July and December 2022, medical students aged 18-35 years were the subjects. This age range was chosen to represent young adults. Participants were selected based on their absence of lower extremity ailments or general health issues, alongside negative results for the Head Impulse Nystagmus Test of Skewness (HINTS) Exam (11, 12) and Distal Proprioception Test (DPT) (13). The ethical review committee of the Akhtar Saeed College of Rehabilitation Sciences, Lahore, granted approval for the study.

The sample size was determined using the formula $N = [(Z\alpha+Z\beta)/C] 2 + 3$ (2). Participants were included through non-probability convenience sampling and provided informed consent before participating. Data were collected using both the Y Balance Test (YBT) and Manual Muscle Testing (MMT).

Two therapists conducted six readings for each participant. The YBT required participants to move forward, medially backward, and laterally backward, maintaining balance on the right foot while standing on the left foot, to assess hip musculature strength and balance. Each reach direction was tested three times, alternating limbs to reduce fatigue. Participants had a maximum of six attempts to complete three effective tests for each reach direction, in a predetermined order (14-16).

Muscle strength was graded by manually applying resistance in the muscles' respective positions (17). For the hip abductors, participants, while standing and holding an object for support, elevated the leg sideways against moderate resistance applied by the researcher at the end of the active range of motion (AROM). This method was used to assess muscle strength in five grades (18). Hip extensor strength was tested similarly, with participants raising their leg backward against resistance (19). The strength of hip external rotators was assessed with the participant in a short sitting position on an examination couch or stool, with the foot off the ground. The participant externally rotated the hip against moderate to maximum resistance applied at the end of AROM (20).

Data analysis was performed using SPSS version 25.0. Quantitative variables from the Y balance test, such as age and scores, were presented as medians and standard deviations. Group variables, including muscle strength, were represented as frequencies, percentages, and bar charts. The relationship between the strength of hip extensor, external rotator, and abductor muscles and changes in Y balance test scores was analyzed using the Mann-Whitney U test, due to the non-normal distribution of data. A p-value of 0.05 or less was considered statistically significant.

RESULTS

In the presented study, the demographic characteristics of the participants were closely examined (Table 1). The gender distribution among the 60 participants showed a higher proportion of females, with 41 participants (68.3%), compared to 19 male participants (31.7%). Regarding marital status, the majority of the participants were unmarried, accounting for 96.7% (58 participants), while only 3.3% (2 participants) were married. The dominant side was predominantly right among the participants, with 56 individuals (93.3%) identifying as right-handed, while only 4 participants (6.7%) were left-handed.

The comparison of Y-Balance Test scores between male and female adults revealed significant findings (Table 2). In the dominant (D) side assessment, the mean rank for male participants was notably higher at 46.05, with a sum of ranks at 875.00, compared to the female participants who had a mean rank of 23.29 and a sum of ranks of 955.00. This difference was statistically significant, as indicated by a p-value of .00 in the Mann-Whitney U Test. A similar pattern was observed in the non-dominant (ND) side, where male participants had a mean rank of 44.95 and a sum of ranks of 854.00, in contrast to the female participants' mean rank of 23.80 and a sum of ranks of 976.00, also yielding a significant p-value of .00.

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Further analysis was conducted to compare the Y-Balance Test scores across Grades 4 and 5 of Manual Muscle Testing in different muscle groups of the hip region (Table 3). For the hip abductors on the dominant side, the mean rank for participants with weaker muscle strength was 29.61, with a sum of ranks of 1125.00, while for those with stronger muscle strength, the mean rank was slightly higher at 32.05 with a sum of ranks of 705.00. However, the difference was not statistically significant, as indicated by a p-value of 0.60. On the non-dominant side, the mean ranks were 30.23 and 31.05 with sums of ranks of 1209.00 and 621.00 for weaker and stronger muscle strengths, respectively, yielding a p-value of 0.86.

Table 1 Demographic Characteristics of the Participants

Characteristic	Response	Frequency	Percent
Gender	Male	19	31.7%
	Female	41	68.3%
	Total	60	100.0%
Marital Status	Unmarried	58	96.7%
	Married	2	3.3%
	Total	60	100.0%
Dominant Side	Right	56	93.3%
	Left	4	6.7%
	Total	60	100.0%

Table 2 Comparison of Y-Balance Test Scores Between Male and Female Adults

Composite Reach Distance	Gender	N	Mean Rank	Sum of Ranks	P-value (Mann-Whitney U Test)
D (Dominant)	Male	19	46.05	875.00	.00
	Female	41	23.29	955.00	
ND (non-dominant)	Male	19	44.95	854.00	.00
	Female	41	23.80	976.00	

Table 3 Comparison of Y-Balance Test Scores Across Grades 4 and 5 of Manual Muscle Testing in Different Muscle Groups of the Hip Region

Composite Reach Distance					
Muscle Strength	Side	N	Mean Rank	Sum of Ranks	P-value (Mann-Whitney U Test)
Hip Abductors	D	38	29.61	1125.00	0.60
		22	32.05	705.00	
	ND	40	30.23	1209.00	0.86
		20	31.05	621.00	
Hip Extensors	D	32	29.06	930.00	0.49
		28	32.14	900.00	
	ND	31	28.32	878.00	0.32
		29	32.83	952.00	
Hip External Rotators	D	39	30.28	1181.00	0.89
		21	30.39	649.00	
	ND	40	30.01	1200.50	0.76
		20	31.48	629.50	

Note: D = Dominant, ND = Non-dominant.

In the assessment of hip extensors, participants with weaker muscle strength had a mean rank of 29.06 and a sum of ranks of 930.00 on the dominant side, compared to those with stronger muscle strength who had a mean rank of 32.14 and a sum of ranks of 900.00, resulting in a p-value of 0.49. On the non-dominant side, the mean ranks were 28.32 for weaker strength (sum of ranks 878.00) and 32.83 for stronger strength (sum of ranks 952.00), with a p-value of 0.32.

For the hip external rotators, the dominant side's mean ranks were 30.28 for weaker muscle strength (sum of ranks 1181.00) and 30.39 for stronger muscle strength (sum of ranks 649.00), yielding a p-value of 0.89. On the non-dominant side, the mean ranks

were 30.01 and 31.48 with sums of ranks of 1200.50 and 629.50, respectively, for weaker and stronger muscle strengths, resulting in a p-value of 0.76. These results suggest that the differences in muscle strength of the hip extensors and external rotators did not significantly affect the Y-Balance Test scores.

DISCUSSION

In this study, significant gender differences in dynamic postural control were identified, as evidenced by the composite reach distances in both dominant and non-dominant extremities, using the Mann-Whitney U Test with a p-value of less than 0.05. Contrarily, when comparing the composite reach distance of Y Balance Test scores across grades 4 and 5 in various hip muscle groups, no significant differences were observed. This finding contrasts with a study by Wilson et al. in 2018, which established a significant positive correlation between hip abduction strength and Y Balance Test outcomes, highlighting hip abduction as a key predictor of Y Balance Test performance (2). The discrepancy between these findings underscores the importance of quantitative evaluation, as Wilson et al. employed, and suggests that subjective measures like grades 4 and 5 may not fully capture the nuances of muscle strength assessment.

Furthermore, this research reveals considerable differences between males and females in terms of reach distance in the Y Balance Test, aligning with other studies which suggest age and gender differences in balance. For instance, research indicated that older males (16–17 years) generally outperformed younger groups, and younger females (10–11 years) scored higher than those in the 12–13 year age bracket (21). These findings could imply that factors such as age, gender, height, and weight play significant roles in balance and should be further investigated.

Additionally, the impact of training on balance was highlighted in a 2020 study by Schwiertz et al., where youth athletes showed superior performance in the YBT-LQ and YBT-UQ compared to untrained peers, suggesting a 74% probability of distinguishing between young athletes and controls based on these tests (22). This indicates that balance is not only a physical attribute but can be enhanced through training, an aspect that merits further exploration in relation to muscle strength and motor control.

The current study, however, has its limitations. The sample was confined to a specific region due to financial constraints and limited resources, affecting the generalizability of the findings. Additionally, the absence of standardized equipment, such as the specific setup for the Y Balance Test, might have influenced the results. This highlights the need for more comprehensive research with broader demographic coverage and better-equipped facilities.

In conclusion, while this study contributes valuable insights into the relationship between muscle strength and dynamic postural control, its findings should be interpreted with caution due to the limitations mentioned. Future research should aim to include a more diverse sample, consider additional variables that may affect balance, and utilize standardized testing equipment to validate and expand upon these findings.

CONCLUSION

The study concludes that significant gender differences exist in dynamic postural control among young adults, as evidenced by the varied composite reach distances in the Y Balance Test. However, the correlation between hip muscle strength and postural control was less pronounced, indicating a need for further investigation. This research underscores the importance of considering gender and physical training in the assessment and enhancement of balance and postural control. The findings have practical implications for designing targeted balance training programs, especially in rehabilitation and sports settings, where understanding the nuances of balance and strength can aid in injury prevention and performance optimization. Future research should expand upon these findings, taking into account a wider range of variables and utilizing more sophisticated testing methods.

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