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THE IMPACT OF A HIGH/LOW FULCRUM ROTATING BALANCE PLATFORM ON STANDING POSTURAL STABILITY IN HEALTHY YOUNG ADULTS

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ABSTRACT

Back or lower limb pathology may interfere with standing balance. Knowing the impact of high and low fulcrum balance platforms on tracking rotational activities could tailor stability training interventions. Purpose: To determine the influence of a low and high fulcrum balance platform combined with tracking tasks on postural sway while standing. Method: Twenty-five participants performed seven activities at two difficulty levels. The total sway area and medial-lateral (ML) and anterior-posterior (AP) sway direction, velocity, and distance were measured during balance activities with various tracking platforms with a fixed middle fulcrum. Results: MANOVA revealed that postural sway area (m^2/s^4) with a high fulcrum decreased in front to back, rear twist, and front twist ($p = 0.05$) balance activities. The Mean velocity (m/s) analysis showed that tasks with a high fulcrum elicited slower velocities in the ML direction than those with low fulcrum activity ($p < 0.05$). Velocity also had more significant differences between tasks than any other variable (p < or =.05). Sway on the high fulcrum platform showed a longer length or distance in the AP direction ($p < 0.05$). Conclusion: Young, healthy adults, adjusted to more challenging balance tasks, such as when BoS is elevated, or rotational perturbations are added, by increasing sway velocity in the ML direction and sway distance in the AP direction. Clinicians and researchers should consider the height of the balance platforms and add rotation disturbances to increase the balance system's demands on different populations and pathologies.

Contribution/Originality: The paper's primary contribution is finding the detailed postural adaptation of young, healthy adults on a rotating balance platform. These adaptations will provide a stepping stone to establish targeted intervention in a population with balance impairments.

1. INTRODUCTION

According to the World Health Organization (WHO), falls are a significant health issue worldwide. Falls can be catastrophic, accounting for one of the two primary risk factors associated with death worldwide. The risk of falls and the severity of the effects of falls increase with age, with the greatest percentage of falls occurring among adults aged 60 years and older (www.WHO.org).

One main alternative to reduce the risk of falling is to promote and maintain equilibrium. Balance is the ability to preserve the center of gravity (CoG) within the area of the base of support (BoS). In humans, the CoG is broader than the BoS in the standing position, requiring the employment of several postural control mechanisms (PCM) elicited by muscle activity to preserve balance (Pollock, Durward, Rowe, & Paul, 2000). Whether in a static or dynamic posture, PCM includes the ankle, hip, and stepping strategies. The balance strategy is chosen depending on the magnitude of the perturbation or the difficulty of the tasks. For instance, the ankle strategy is sufficient for lower-amplitude perturbations, and the stepping method is suitable for higher-amplitude perturbations. The muscular activity patterns used in these mechanisms vary from the trunk muscles to the distal segments of the body. However, proximal muscles are adopted within all postural control mechanisms. When the CoG travels beyond the BoS, it requires using one of these postural balance strategies to regain the CoG position and avoid falling. Therefore, falls occur when an individual cannot adapt to a disturbance and perform such actions (Shumway-Cook & Woollacott, 2007).

Failure to accommodate a disturbance using a PCM may derive from deficits in the visual, somatosensory, or vestibular networks, which are the balance system's critical components. Abnormal function in any of these systems leads to postural instability and an increased risk of falling. Concepts such as dynamic system theory (DST) attempt to explain the interplay between these sensory networks. The DST suggests that the three balance networks must integrate sensory information synchronously to maintain balance, particularly when the balance is significantly challenged (Shumway-Cook & Woollacott, 2007) by a perturbation. When this collaboration occurs, humans can avoid falls while navigating various surfaces and environments because of sensory modification or sensory reweighting. Sensory reweighting fails when two or more balance networks are contested or diminished, enhancing the body's reliance on other systems to preserve balance (Shumway-Cook & Woollacott, 2007).

Balance has many components, any of which can be distorted in distinct ways. Balance training is an effective technique for improving stability. Balance training can be allocated to static, standing, or dynamic walking (Shumway-Cook & Woollacott, 2007). Static balance typically involves standing with both feet on the ground while performing various activities to challenge the visual, vestibular, or proprioceptive systems. There are numerous approaches for eliciting different systems. The visual input can be canceled by closing the eyes, shifting the role of balance to the other two components, vestibular and proprioceptive. In addition, with eye-tracking target activities, the visual system can be engaged in provoking distinct adaptations. Vestibular input can be challenged by activities that employ head movements. Head movements engage the semicircular canals, which are related to the inner ear. Associated with the proprioceptive input, tasks that alter the floor surface, such as an unstable foam surface, can dispute this system. Individually or a combination thereof will lead to distinct postural strategies requiring correction to maintain adequate balance (Rosario, Bowman, & Jose, 2020). A classic example of dynamic balance is walking (Shumway-Cook & Woollacott, 2007). Gait, especially while changing surfaces (for instance, even surface to stairs), will challenge the different balance components. During gait, balance training can take various configurations depending on the patient or client's requirements. For example, for a person with vestibular issues, the treatment aims are to turn the head while walking to induce sensory reweighting towards the other balance systems and adapt to the activity (Shumway-Cook & Woollacott, 2007).

Considering the above, the current study intends to answer the following questions: What impact does tracking provided during equilibrium activities on a low and high fulcrum balance platform have on posture? How can we determine postural patterns that could then be applied for further inquiries regarding balance training programs? This research seeks to accomplish this purpose by selecting young adults' postural patterns during balance activities on a low and high fulcrum balance platform in response to distinct tracking tasks. We predicted that tasks with different tracking activities would prompt specific sway patterns and postural compensation. These arrangements will reveal which tracking activity elicits the greatest sway response, indicating that particular tasks are most challenging and require the most postural control. The investigation will also identify which variable of postural sway, direction, distance, or velocity is affected most during the particular balance movements.

2. METHODS

Participants were enrolled in the Dallas Campus at Texas Woman's University through a research team member. All participants signed the approved informed consent form after being informed of their involvement in the study by a research team member. One interview was conducted to gather demographic information on the subjects, including age, gender, weight, and height.

This study's inclusion criteria required that adults be 18 to 45 years of age to avoid common age-related differences in balance and posture commonly observed in older adults. The exclusion criteria developed to address any confounding features that might distort the results were as follows: 1. Significant balance issues, including a lack of ability to maintain balance for 30 seconds, 2. Untreated severe visual acuity, 3. Body mass index (BMI) > 40, classified as morbidly obese according to the BMI classification Table 4. Hypertension; 5. Surgeries or injuries to the trunk or lower extremities in the previous six months, and 6. Drugs that induce sleepiness 24 h before study participation; and 7. Pregnant women and women who think they are pregnant

2.1. Instrument and Balance Assessment

Data were gathered using Mobility Lab APDM (APDM Inc., http://apdm.com). Mobility Lab is a portable walking and balance lab that is used for motion analysis. The system uses a set of gyroscopic motion sensors and accelerometers positioned using straps to estimate the spatial and temporal parameters of walking and stability. This instrument is designed to quantify kinematics from the trunk and lower and upper extremities. However, in the present study, the lumbar sensor was used alone to calculate the oscillation velocity, direction, median-lateral (ML), and anterior-posterior (AP) distances.

As mentioned, the Mobility Lab was utilized to assess postural strategies during 14 activities on the M-pad balance platform, a fixed middle fulcrum (to allow rotational movements) that is adjustable to various heights to change the amount of difficulty. The balance platform's height, referred to as the fulcrum, allowed the increment of balance difficulty while engaging in the tracking movements. Each participant performed all seven tasks on two levels of difficulty (seven for each task), obtained with two fulcrum heights. The balance platform's low fulcrum is approximately 3 inches from the ground, whereas the high-fulcrum platform is 6 inches from the floor. The fulcrum feature allows the user to rotate (clockwise or counter-clockwise) or tilt (antero-posterior and left-right) the balance platform according to the tracking tasks projected on a screen by following a target (dot seen on the screen). The projected tasks were located ten feet away and 6 feet from the ground on a TV screen in front of the participants.

The 25 participants were randomly allocated into 12 participants performing level one (lower fulcrum height) first and 13 starting with level three (higher fulcrum height). Once the starting height was determined, each participant was asked to remove their footwear to perform the task. Each task resulted in different tracking activities and lasted 17 s, with a 10-second practice interval before each task. The screen projection tracking feature was provided by the M-pad balance platform mobile phone application. It consisted of a bullseye, side-to-side, front-to-back, clockwise, counter-clockwise, and front-to-rear twist. Depending on the specific tasks, as the target moved on the screen as mentioned above, we instructed each subject to track or follow the screen target by rotating or tilting the balance platform.

The subjects were allowed a two-minute rest period between each series of seven trials to adjust the pivot height and prevent fatigue. Over this period, participants were asked to rate each task's perceived difficulty on a scale of 0 to 100, with zero being easy and 100 being the hardest. After a two-minute rest period, the participants completed the second round of seven trials using the other fulcrum height.

2.2. Data Analysis

The variables of interest in the current investigation were the direction, velocity, and sway distance during both fulcrum heights among all tasks. All of the above variables were associated with two major anteroposterior and mediolateral movements. A MANOVA analysis with SPSS version 25 was used to compare low-and high-balance platforms between tasks and variables. A P-value of ≤ 0.05 was significant in this study.

3. RESULTS

Table 1 shows the demographic data of all the participants. Of the 25 participants, four males and 21 females between the ages of 22 and 32 (average age 24.64 ± 2.34 SD) completed this study. Their average BMI was 24.40 ± -2.71. Table 1 shows the demographic profiles of the participants. Two of the 25 subjects were left-leg dominant, and the remaining 23 were right-leg dominant. Additionally, two were left-hand dominant, and the remaining 23 were right-hand dominant.

Table 2 illustrates the comparison of sway area (m^2/s^4) during low and high fulcrum activities. The results showed a significant difference in the total sway area during front-to-back, front twist, and rear twist activities ($p = 0.05$). Front-to-back sway with a low fulcrum produced the smallest sway area (14.48 ± 20.78), followed by the rear twist with a low fulcrum (15.02 ± 12.58), and front twist with a low fulcrum (16.11 ± 17.43). Similar results were obtained during the high fulcrum activities with front-to-back eliciting the smallest sway area (21.52 ± 17.46), followed by rear twist (28.37±12.42) and front twist (28.37 ± 12.42). No significant differences in sway area were observed during bullseye, side-to-side, clockwise, or counter-clockwise activities.

Table 3 depicts the association between postural sway in the ML direction (coronal) (m^2/s^5) and the AP direction (Sagittal) (m^2/s^5) during activities with both low and high fulcrum. The sway direction is also referred to as the sway jerk in the table. There was no significant difference in the amount of sway between the AP direction ($p = 0.42$) and the ML direction ($p = 0.47$) during any activity at either fulcrum height.

Table 4 shows a comparison of the mean velocity of postural sway in the ML direction (coronal) (m/s) and AP (sagittal) (m/s) directions during low and high fulcrum activities. Results show a significant difference between all of the following activities with a low fulcrum: ML mean velocity during front-to-back elicited the fastest velocity (0.30 ± 0.29), followed by clockwise (0.49 ± 0.16), front twist (0.51 ± 0.21), and rear twist (0.51 ± 0.27) activities respectively. The results from the highest fulcrum activities showed faster overall ML velocities. Still, velocities from fastest to slowest followed the same pattern as the low fulcrum activities. They were as follows: front-to-back elicited the fastest velocity (0.56 ± 0.30), followed by clockwise (0.74 ± 0.33), front twist (0.78 ± 0.22), and rear twist (0.84 ± 0.53) activities, respectively. No significant difference was observed in the mean AP velocity during any activity at fulcrum height. ($p = 0.53$).

Table 5 describes the path length or distance in the ML direction (Coronal) (m/s^2) and AP (Sagittal) (m/s^2) directions during low and high fulcrum activities. The results showed a significant difference in AP distance side-to-side with a low fulcrum compared to the same activity with a high fulcrum, shorter during the low fulcrum trial (49.81 ± 24.22) compared to the high fulcrum examination (69.45 ± 31.63).

4. DISCUSSION

This investigation assessed the balance of young, healthy adults and the effect of tracking on postural control at two fulcrum levels on a balance platform. Our outcomes illustrate that postural recruitment differs between activities conducted at a low fulcrum height compared to a high fulcrum height, as shown by the total sway area. Second, the results demonstrated that they utilize AP balance strategies more than ML balance strategies regarding sway velocity, but they used ML strategies more than AP strategies regarding sway distance. However, high variability was observed among participants who referred to how these strategies differed between balancing tasks, as demonstrated by the large standard deviation values in Tables 4 and 5. Third, the results indicated that the sway distance traveled during different tasks was comparable, regardless of the fulcrum height. Finally, the results determined that tracking balance tasks provoked the most considerable postural adjustments within the velocity component. These changes were proportional to the extent of the challenge that a task entailed.

Table-1. Demographic data of all participants.

Characteristics	Study Participants n= 25
Age	24.6 +/- 2.3 years
Gender	Male= 4; Female = 21
Height (inches)	M= 66.4+/-3.7
Weight (pounds)	151.8+/-28.6
BMI	24.4± 2.7 kg/m^2

Table-2. Comparisons of Postural Sway - Acc – Sway. Area (m^2/s^4) during the high and low base of support variables. Results of MANOVA were performed comparing sway variables. Significance level set at p≤0.01.

N=	Low BOS Means and SD	High BOS Means and SD	P-Value
Bullseyes	5.41 ± 10.34	10.49 ± 11.16	0.17
Front to Back	14.48 ± 20.78	21.52 ± 17.46	0.05
Side to Side	8.22 ± 8.86	13.86 12.90	0.13
Front Twist	16.11 ±17.43	28.37 ± 12.42	0.05
Back Twist	15.02 ± 12.58	25.53 ± 12.73	0.05
Clockwise	18.72 ± 13.47	23.20 ± 13.85	0.33
Counter Clockwise	19.56 ± 14.30	22.93 ± 16.46	0.52

Note: S.D.=Standard Deviation.

Table-3. Comparisons of Postural Sway - Acc - Jerk (Coronal-ML) (m^2/s^5) Postural Sway - Acc - Jerk (Sagittal-AP) (m^2/s^5) during the high and low base of support variables. Results of MANOVA were performed comparing sway variables. Significance level set at p≤0.01.

N=	Low BOS Means and SD	High BOS Means and SD	P-Value
AP Bullseyes	46.22 ± 91.49	106.86 ± 105.10	0.62
AP Front to Back	345.51 ± 335.94	338.85 ± 231.48	0.9
AP Side to Side	103.27 ± 131.97	148.10 ± 123.71	0.30
AP Front Twist	506.95 ± 472.85	761.88 ± 582.34	0.16
AP Back Twist	592.88 ± 387.78	731.19 ± 642.94	0.44
AP Clockwise	210.10 ± 177.15	276.11 ± 192.28	0.30
AP Counter Clockwise	266.61 ± 279.58	283.15 ± 195.76	0.84
ML Bullseyes	138.78 ± 277.82	329.35 ± 303.61	0.78
ML Front to Back	399.42 ± 857.21	755.32 ± 822.82	0.21
ML Side to Side	561.67 ± 606.37	571.24 ± 604.25	0.96
ML Front Twist	1829.16 ± 1542.19	2779.25 ± 2087.03	0.13
ML Back Twist	2288.28 ± 1962.64	2390.18 ± 1549.50	0.87
ML Clockwise	429.23 ± 372.25	569.75 ± 485.99	0.34
ML Counter Clockwise	505.59 ± 489.77	688.51 ± 522.10	0.29

Note: S.D.=Standard Deviation.

Table-4. Comparisons of Postural Sway - Acc - Mean Velocity (Coronal-ML) (m/s) and Postural Sway - Acc - Mean Velocity (Sagittal-AP) (m/s) during the high and low base of support variables. Results of MANOVA were performed comparing sway variables. Significance level set at p≤0.01.

N=	Low BOS Means and SD	High BOS Means and SD	P-Value
AP Bullseyes	0.53 ± 0.73	0.51 ± 0.41	0.87
AP Front to Back	0.85 ± 0.44	0.95 ± 0.78	0.53
AP Side to Side	0.41 ± 0.32	0.63 ± 0.64	0.19
AP Front Twist	0.68 ± 0.53	0.77 ± 0.33	0.65
AP Back Twist	0.60 ± 0.36	0.93 ± 0.63	0.06
AP Clockwise	0.96 ± 0.46	0.95 ± 0.51	0.94
AP Counter Clockwise	0.96 ± 0.64	0.93 ± 0.56	0.90
ML Bulls eyes	0.24 ± 0.30	0.55 ± 0.31	0.001
ML Front to Back	0.30 ± 0.29	0.56 ± 0.30	0.01
ML Side to Side	0.59 ± 0.39	0.63 ± 0.30	0.74
ML Front Twist	0.51 ± 0.21	0.78 ± 0.22	0.001
ML Back Twist	0.51 ± 0.27	0.84 ± 0.53	0.05
ML Clockwise	0.49 ± 0.16	0.74 ± 0.33	0.05
ML Counter Clockwise	0.52 ± 0.25	0.68 ± 0.28	0.08

Note: S.D.=Standard Deviation.

Table-5. Comparisons of Postural Sway Distance - Acc - Path Length (Coronal-ML) (m/s^2) and Postural Sway - Acc - Path Length (Sagittal-AP) (m/s^2) during the high and low base of support variables. Results of MANOVA were performed comparing sway variables. Significance level set at $p \leq 0.01$.

N=	Low BOS Means and SD	High BOS Means and SD	P-Value
AP Bullseyes	24.51 ± 26.39	51.47 ± 26.11	0.005
AP Front to Back	91.10 ± 39.60	100.13 ± 35.73	0.47
AP Side to Side	49.81 ± 24.22	69.45 ± 31.63	0.05
AP Front Twist	109.48 ± 44.72	139.03 ± 46.78	0.61
AP Back Twist	120.17 ± 40.67	131.95 ± 47.57	0.44
AP Clockwise	78.22 ± 35.77	88.96 ± 27.51	0.32
AP Counter Clockwise	80.42 ± 37.33	91.59 ± 31.18	0.33
ML Bullseyes	38.98 ± 49.12	91.09 ± 48.70	0.05
ML Front to Back	72.31 ± 64.89	131.30 ± 69.70	0.01
ML Side to Side	111.51 ± 54.94	115.10 ± 52.03	0.84
ML Front Twist	211.31 ± 87.40	261.37 ± 87.82	0.96
ML Back Twist	228.23 ± 92.70	239.31 ± 79.62	0.71
ML Clockwise	104.21 ± 44.95	122.10 ± 48.44	0.26
ML Counter Clockwise	106.32 ± 47.78	131.50 ± 49.69	0.13

Note: S.D.=Standard Deviation.

Our first finding confirmed that tasks with greater complexity would provoke more significant movement and sway with rotational components such as clockwise movement, in this case, on a higher fulcrum. The increase in sway can be illustrated by the fact that humans produce more movement when the BoS is raised more vertically from a stable surface. For instance, when a person performs rotational movements in a clockwise direction, such as reaching over the right shoulder during standing undertakings, the task will call for a greater postural demand or sway capacity to maintain balance than reaching during sitting activities because of the elevated BoS. Lee, Verghese, Holtzer, Mahoney, and Oh-Park (2014) explained that elevated BoS and activities with rotational components increased sway. The researchers analyzed walking speed and sway to detect associations with increased morbidity and mortality rates in older populations. Investigators noticed increased instability in elderly individuals, especially women, in AP and ML sway during gait.

Adaptation to different BoS elevations paired with rotational components is a concept with important clinical implications when training specific populations, such as athletes and geriatrics. For example, when instructing athletes, increasing the vertical displacement of their BoS from its original position would demand enhanced sway control, and most times, appropriately challenge balance per athletes' sport requirements. In contrast, a healthcare professional might refrain from implementing rotational movements and higher fulcrum activities into the plan of care for elderly patients with severely impaired balance until they have demonstrated the ability to perform preceding progressions for these complex tasks. Participants with more significant balance impairments could begin with lower fulcrum activities without a rotational component before advancing to higher fulcrum activities with rotational components for more challenging training.

The second outcome presented from this investigation demonstrated that sway distance increases in both the ML and AP directions, with heightening task difficulty. Regardless, ML velocities varied considerably between tasks, while changes in AP velocities were comparable between the fulcrums. In contrast, AP distances differed significantly between activities, whereas variations in ML distances were not significant. These earlier observations show that ML or AP strategies involve distinct components of postural sway. Clinically, this implies that functional balance strategies within the coronal and sagittal planes could improve different aspects of balance. This previous remark is partially described in a systematic review by Hwang and Braun (2015). They investigated balance distinctions between a group of dancers and inactive older adults. The investigation revealed that those who took part in the dance had a better balance than those who led sedentary lives regardless of the type. Thus, the authors' results suggest that individuals who undertake activities requiring regular balance techniques, such as dance, will employ more effective postural adjustment strategies to counteract small perturbations than their predominantly sedentary counterparts with a lack of balance training (Hwang & Braun, 2015). Likewise, it is conceivable that the participants with greater balance training in this research could adjust their posture more efficiently to overcome perturbations and avoid a critical shift in sway.

One of the many altered components that people with gait abnormalities exhibit is a reduction in walking distance and increased ML sway length as a compensatory mechanism for postural instability (Lee et al., 2014). In our study, the compensatory mechanism for the elevated balance platform and the diverse tracking tasks is an increase in sway distance, mainly in the ML direction. We postulated that considering the findings of this investigation, individuals with an unhealthy balance system would show an unusual increase in ML distance at different BoS heights and tracking activities. Further research should be conducted to obtain greater clarity regarding the above remark. If ML sway distance is one of the components with more alterations with balance instability, perhaps it could be utilized as a predictive tool and intervention strategy for balance training.

This study's final critical development underlined the difference in velocity between the low and high fulcrum platforms. Velocity demonstrated a more significant difference between activities than distance or direction of sway, suggesting that it is the key component utilized to adapt to balance perturbations. This difference was more distinct in the ML direction than in the AP direction. This variation can be attributed to an increment in the challenge implemented by elevating the BoS with a higher fulcrum. The participants of this study demonstrated faster ML sway velocities to adjust to a higher fulcrum. This ML increased sway velocity indicates that rapid movements elicited by more challenging tasks will increase instability, requiring more considerable postural adjustments to avoid falls (Blaszczyk, Lowe, & Hansen, 1994).

5. CONCLUSION

This study aimed to determine postural control during two fulcrum heights associated with standing on a balance platform with tracking tasks. Young, healthy adults adapted to more challenging balance tasks, such as when BoS is elevated, or rotational perturbations, by slowing sway velocity in the ML direction and increasing sway distance in the AP path. These results suggest that lower platform training should be used in patients with balance deficits. Activities at lower BoS heights generated fewer radical responses from postural sway control mechanisms. On the other hand, higher platform heights should be used for athletes or those with greater balance functions to challenge balance systems.

This analysis showed that all components of the sway increased with rotational movement. This concept needs to be viewed in light of the results of a study conducted by Almajid, Goel, Tucker, and Keshner (2020), who found a direct relationship between reduced time during rotational features of gait turning, and dynamic postural stability. A more in-depth analysis may examine the effects of rotational balance training on a balance platform on walking speed parameters during turns in persons with dynamic postural instability. In further research and clinical assessments of balance, we suggest implementing clockwise and counter-clockwise tracking tasks to explore the rotational component and its impact on postural control. This rotational integration would challenge individuals to shift towards their dominant and non-dominant sides, simulating the need to turn in both directions during gait. This additional research could help clinicians understand how to treat people with specific deficits in the dynamic aspects of balance.

Another element that could be considered with more in-depth consideration is the underlying mechanism of trunk musculature involvement in postural control. As noted above, three postural mechanisms – ankle, hip, and step – were identified as strategies used to maintain postural stability. The technique adopted by the participants in this study to meet the challenge of a high BoS was primarily the hip strategy. However, an increase in trunk musculature recruitment with side-to-side movements was observed, suggesting that the fourth strategy, the "trunk" method, may be a significant player during BoS height variation tracking activities. Further investigation should examine trunk biomechanics and electromyography (EMG) of the trunk musculature during an elevated BoS balance platform to characterize the proposed trunk strategy.

Based on the outcomes of this study, we suggest that balance training in individuals with significant deficits follow this progression, as determined by this study's results: 1. Lower BoS heights and small, non-rotational external perturbations to train adjustments in postural sway velocity incrementally; 2. Higher BoS heights and larger rotational perturbations enable more efficient control mechanisms and sway velocities to improve balance.

One last note, a limitation of this investigation is the lack of male participants. Lee et al. (2014) revealed that females had increased difficulty balancing activities compared to males. This study's sample consisted mainly of females, preventing the ability to accurately discern whether an actual difference exists between the two genders regarding balance mechanisms related to balance platform heights and tracking activities. Nonetheless, future studies should emphasize postural gender distinction.

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