Assessing Hip Joint Angle Changes in Young and Older Adults During Multidirectional Steps: A Pilot Study

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Summary

This study compares hip joint angle changes in the sagittal and frontal planes during voluntary stepping in the lateral, forward, and backward directions between young and older adults. Our findings suggest that age-related changes in hip joint angles could reflect reduced dynamic stability in older populations.

Introduction

Stepping is a critical motor response to prevent falls, particularly in older adults, making it essential to understand how stepping mechanics change with age. This complex action requires coordinated movements across multiple joints, with the hip playing a central role due to its involvement in weight transfer, balance, and limb propulsion. Age-related declines in muscle strength, joint flexibility, and neuromuscular control can alter these mechanics, potentially increasing fall risk [1]. Previous research has shown that passive hip abduction and adduction range of motion is smaller in younger individuals compared to older adults [2]. However, measurements conducted during active movement such as stepping tasks maybe more relevant to fall risk. Therefore, this pilot study aims to explore how aging impacts the hip joint range of motion in the sagittal and frontal planes during lateral, forward, and backward stepping.

Methods

We recruited 20 adults (9 older adults [OA], 4F and 5M: 74±5 years; 1.62±0.09 m; 72±12 kg and 11 young adults [YA], 9F and 2M: 27±9 years; 1.66±0.07 m; 61±8 kg; X±SD) with no lower-limb injuries, who visited the laboratory one time.

Body marker placement: Twenty-four reflective markers were placed on the body and data were recorded for 7 s at a sampling rate of 120 Hz, using a 10-camera motion analysis system (Vicon, Oxford, UK) [3]. *Stepping Task:* Participants completed 18 choice reaction step tests [3] across three directions—forward, backward, and lateral—performing 6 repetitions for each step type, evenly distributed between the right and left sides. The steps were randomized by blocks. Movement analysis was conducted using the Visual3D program. *Statistical analysis:* A general linear model univariate analyses were conducted, with step direction (lateral, forward, or backward) and age group (YA and OA) as fixed factors, and change in hip joint angle (abduction, adduction, flexion, or extension) as dependent variables. Analysis was only performed for the stepping leg. The analyses were performed using SPSS version 26, with a significance level (alpha) set at 0.05.

Results and Discussion

Hip Abduction: YA exhibited significantly greater changes in hip abduction during lateral steps compared to OA ($p=0.016$), while the opposite pattern was observed during backward steps ($p<0.001$). *Hip Adduction:* OA showed higher greater changes in joint angle during all steps compared to YA ($P\leq0.001$). *Hip Extension:* There were no differences in hip extension when comparing both groups. *Hip Flexion:* YA presented significantly larger changes in hip flexion angle during forward and backward steps.

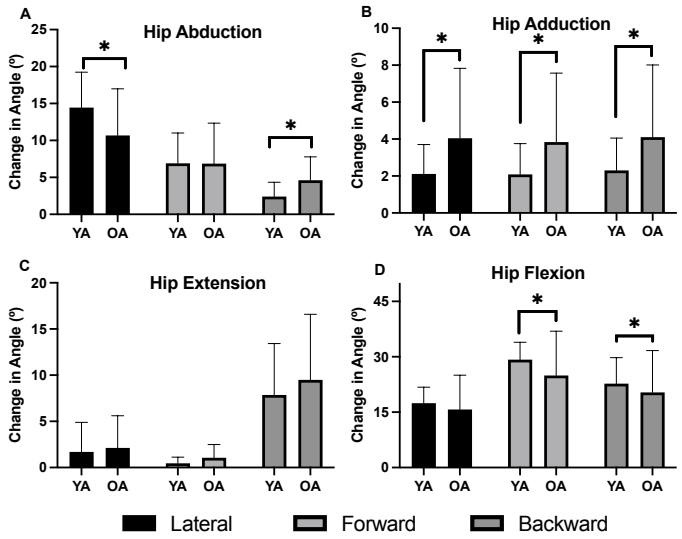

Figure1. Changes in hip joint angle across the different step types. *Indicates differences between age groups. YA= young adults; OA= older adults.

Conclusions

Our data suggest that age-related changes in movement patterns are more prominent in hip abduction, adduction, and flexion rather than hip extension. During lateral steps, OA exhibited smaller changes in hip abduction but greater hip adduction, indicating a smaller base of support, which has previously been linked to a higher risk of falls. During forward and backward steps, OA demonstrated greater hip adduction but lower hip flexion, further indicating a narrower base of support compared to YA. These findings suggest that age-related changes in hip joint angles may reflect reduced dynamic stability in older populations. Thus, there are undeniable changes in hip joint kinematics with aging that may contribute to fall risk. Future studies should further explore how these age-related differences influence stability and fall prevention strategies in older adults.

Acknowledgments

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References

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