

# DYNAMIC POSTURAL STABILITY DURING SIT-TO-WALK TRANSITIONS IN THE HEALTHY YOUNG AND HEALTHY ELDERLY

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## INTRODUCTION

The study of transitional movements such as gait initiation (GI) and sit-to-stand (STS) has provided valuable insights into the control of dynamic postural stability in the elderly. The study of GI and STS has clearly been valuable in understanding dynamic postural stability within common activities of daily living (ADL); however, little attention has been paid to the functional task of initiating gait from the seated position, or Sit-to-Walk (STW). This is surprising since the initiation of gait from a seated position is a common ADL and it represents a complex transitional task that imposes challenges to both the locomotor and postural control systems.

In healthy young adults (HYA), STW is a merged task based on the coincidental timing of seat-off and gait initiation (Magnan 1996, Kerr 2004). Healthy older adults (HOA) perform STW slower than HYA (Kerr 2006), however no detailed biomechanical analysis of STW in the elderly has been performed. Thus, the purpose of this study was to biomechanically evaluate STW in the HOA population and compare the performance of the HOA to the HYA.

## METHODS

Twelve healthy older adults (age:  $63 \pm 8$ y.o., ht:  $169.8 \pm 10$ cm, wt:  $79.2 \pm 15.5$ kg, BMI:

$25.5 \pm 3.4$ ) and twelve healthy young adults age:  $29 \pm 3$ y.o., ht:  $170.6 \pm 7.6$ cm, wt:  $76 \pm 14.8$ kg, BMI:  $25.9 \pm 3.1$ ) participated in this study. Kinematic data was collected at 120Hz with 41 retro-reflective markers attached. Kinetic data from 2 forceplates were sampled at 1560Hz.

Each subject performed 5 trials of STW. Trials began with the subject seated on a backless and armless adjustable height stool (40 – 58cm) such that the subject's knees were flexed to approximately 105°. In the initial starting position, subjects were seated so that their greater trochanter was located near the front edge of the stool. The feet were placed comfortably on the force platforms and the position was recorded and subsequently standardized throughout the experiment by placing tracings on the force platform. Potential intersubject differences due to movement of the upper limbs were minimized by requiring the subjects to sit with the palmar aspect of their hands resting on their stomach, just inferior to the xiphoid process.

Phases of STW were identified as previously described (Kerr 2004). In addition, spatiotemporal characteristics, COP-COM separation, and COM momentum were calculated. In pilot work we were unable to replicate Kerr's (2004) definition of GI, therefore initial swing leg heel-off was used as a marker to identify the initiation of gait within STW.

Three separate MANOVA's were used to analyze the STW task. A 2 (group) x 2 (task) repeated measures ANOVA was used to compare between tasks.

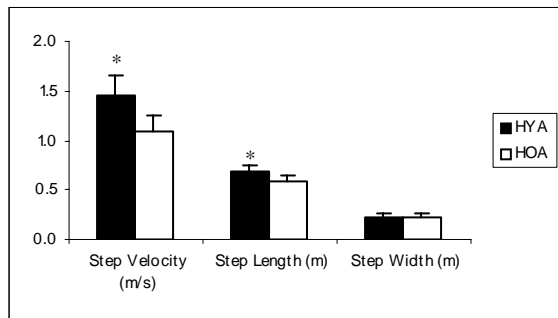
## RESULTS AND DISCUSSION

The HYA moved quicker through each phase of STW except phase I as seen in the table below.

Phase	Description	HYA (s)	HOA (s)	p-value
I	Mvmt initiation to seat off	0.48	0.50	0.389
II	Seat-off to peak vertical velocity	0.39	0.51	0.022
III	Gait initiation to swing toe off	0.12	0.16	0.006
IV	Swing Toe Off to Stance Toe Off	0.47	0.54	0.007
Total	Total Task Time	1.46	1.82	0.001

**Table 1. Temporal durations of each phase of the STW task.**

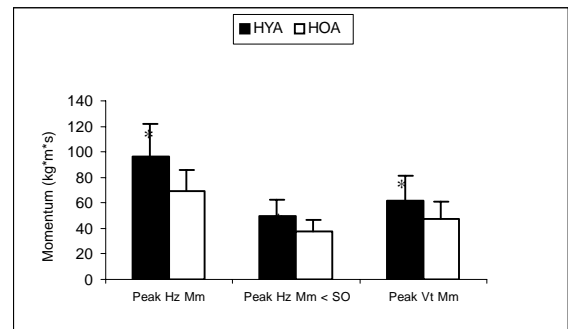
The HYA took significantly longer steps ( $p < 0.001$ ) at significantly faster velocities ( $p < 0.001$ ) than the HOA. There was no difference in the initial step width between groups.



**Figure 1. Spatiotemporal characteristics of the groups during the STW task. \* indicates significant difference between groups**

The HOA initiated gait after a significantly longer delay from seat-off ( $p < 0.001$ ) and while standing significantly more erect ( $p = 0.002$ ) than the HYA. While the HYA merged the two tasks shortly after seat-off, the HOA delayed the initiation of gait until they were nearly fully upright.

Additionally, the HYA produced significantly greater peak horizontal momentum ( $p = 0.005$ ), peak horizontal momentum prior to seat-off ( $p = 0.020$ ), and peak vertical momentum ( $p = 0.044$ ) during STW. It is likely this increased generation of momentum resulted in the HYA having a greater COP-COM separation ( $p = 0.001$ ) at the conclusion of the single support phase of the initial step during STW.



**Figure 2. Horizontal and Vertical momentum generated during the STW task. \* indicates significant difference between groups**

## CONCLUSIONS

HOA are unable to successfully fully merge the STW task around seat-off, however the tasks were not distinct as the initiation of gait occurred while still rising. This suggests the HOA utilized a more conservative postural strategy of performing STW. Conversely, and in agreement with previous literature (Magnan 1996, Kerr 2004), the HYA successfully merged the two tasks around, or shortly after, the point of seat-off.

## REFERENCES

- Kerr A, et al. (2006) *Gait Posture*, epub August.
- Kerr A, et al. (2004) *Clin Biomech* (19), 385-390.
- Magnan A, et al. (1996) *Gait Posture* (4), 232-241.