Center of Mass Trajectory in ADHD Adults during a Precision Stepping Task

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Summary

Individuals diagnosed with ADHD (Attention-deficit/hyperactivity disorder) demonstrate irregular gait characteristics in complex walking tasks compared to typically developing controls. This study aimed to investigate how these previously identified gait changes are related to center of mass (COM) control. We hypothesized that the ADHD population will exhibit balance impairments. Our results indicate that ADHD individuals, faced with a challenging gait task, demonstrate a conservative gait strategy by reducing forward COM and increasing mediolateral COM velocities. Combined with reduced stability margins suggest that this strategy increases fall risk in ADHD adults.

Introduction

Individuals with ADHD face an increased risk of injury compared to typically developing individuals, primarily due to increased fall risk [1]. Investigation into ADHD gait has revealed several atypical gait characteristics have been associated with ADHD, including faster self-selected walking pace, irregular stepping rhythm and impairment of balance when walking compared to controls [2]. When faced with increasingly complex walking tasks, ADHD individuals reduce gait velocity [2,3]. While this conservative strategy has been measured through gait characteristics, the COM trajectory remains uninvestigated during gait tasks. This study aimed to determine the effect of a complex stepping task on COM trajectory in ADHD adults. We also examined the effects of visual distraction (VD) and delayed visual information (DI) to challenge gait behavior.

Methods

Fifteen young adults aged 18-35 with ADHD (10 F; 21.8±1.9yrs) and 15 without ADHD (12 F; 21.6±1yrs) walked along a 10-meter walkway with projector-produced stepping targets. Participants were instructed to step as accurately as possible on the target midpoints. Target size and spacing was adjusted to individual gait patterns and the forward half of the walkway was modified to assess task completion under normal (NW), VD, and DI conditions (Figure 1). In total 36 randomized trials were performed. Kinematic data was collected with an Optotrak system to determine COM and foot location. Analysis included COM velocity mean and maximum in the mediolateral (ML) and antero-posterior (AP) directions across a gait cycle, initiated at contact with the first force plate (Figure 1b). Margin of stability (MOS) was measured as the mediolateral distance between the BOS and the COM to estimate stability, only during contact on 2nd force plate, one stride after a possible pathway changes.

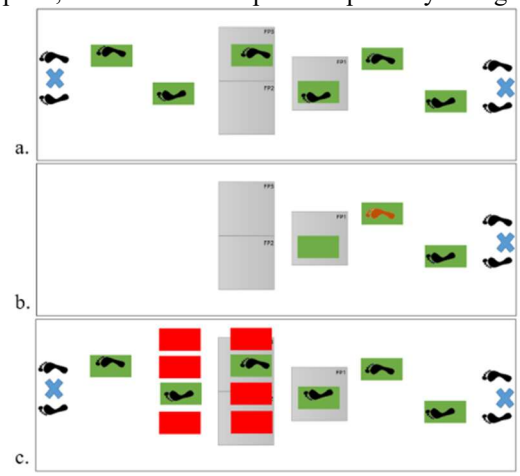

Figure 1: Target-stepping task (a), trigger step (orange) for delay condition (DI) (b), and distractive targets (VD) (c).

Results and Discussion

ADHD participants had a smaller MOS when compared across all conditions ($p=0.002$), specifically during NW trials ($p=0.04$) and DI trials ($p=0.04$), indicating greater instability compared to the control group. The ADHD group had significantly reduced anteroposterior mean velocity overall ($p<0.001$), specifically within NW ($p<.001$) and DI ($p<.001$) conditions. Mediolaterally, the ADHD group differed only within double stance, where greater mean ($p<.001$) and maximum ($p<.001$) COM velocities were found overall, as well as within NW (mean: $p=0.006$, max: $p=0.01$) and DI (mean: $p<0.001$, max: $p<0.001$) conditions.

Conclusions

Young adults with ADHD are at greater risk for falls and subsequent injury compared to controls when performing tasks with a precision stepping component. This suggests that the ADHD strategy to control COM trajectory is different from typically developing controls and may be a contributor to increased falls risk as indicated by a reduced MOS.

References

[1] Kaya et al. (2007). *J. Int. Medical Res*, **36**(1): 9-16.
[2] Buderath et al. (2009) *Gait & Posture*, **29**(2): 249-254
[3] Möhring et al. (2018). *Human Mov. Sci.*, **62**: 48-57.

Table 1: Balance and COM Velocity results for normal walking condition only (DS-double stance).

Group	MOS (mm)	Mean AP COM vel (m/s)	Mean ML COM vel (DS) (m/s)	Max ML COM vel (DS) (m/s)
ADHD	93.1±17	1.26±0.19	0.16±0.05	0.19±0.07
Control	97.9±19.8	1.32±0.25	0.13±0.05	0.17±0.08