

Po-Chih Lin¹, Yi-Ching Lee², Li-Wen Ku¹, Chih-Hsiu Cheng^{1,3}

¹School of Physical Therapy and Graduate Institute of Rehabilitation Science, Chang Gung University, Taiwan

²Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital, Taiwan

³ Bone and Joint Research Center, Chang Gung Memorial Hospital, Taiwan

E-mail: chcheng@mail.cgu.edu.tw

Introduction

- The **Sit-to-stand** (STS) movement is an **important motion task**.
- Previous studies have showed that three movement strategies are used to successfully perform the STS task with different patterns of kinematic and kinetic behaviors [1].
- This study aims to investigate whether the changes of **movement velocities** and **foot placement widths** in the frontal plane would **lead to the changes of posture control** during the STS task.

Materials and methods

- **Nineteen healthy subjects** were recruited in this study (aged 21.7±1.9 years, height 165.8±8.6 cm, weight 58.3±9.2 kg).
- The research variables are **two movement velocities**, including the self-selected velocity and fast velocity, as well as **three-foot placement widths**, including the foot placement in narrow width (FPN), foot placement in shoulder-width (FPS), and foot placement in wide width (FPW).
- **Kinematic data** were collected using an **inertial measurement unit** (IMU, laboratory-developed, sampling rate at 50Hz).
- **Kinetic data** were collected using a **force plate** (Bertec 909015, sampling rate at 1000Hz).
- **Two-way ANOVA** (two velocities and three foot placement widths) was used to examine how the changes of the main variables affect the kinematic and kinetic parameters of the subjects.
- Statistical significance was set at $p < 0.05$.

Result

- The following parameters were **significantly greater at fast velocity than at the self-selected velocity** ($p<0.05$), including the ground reaction force (GRF) increasing velocity, GRF decreasing velocity, maximal media-lateral displacement of the center of pressure (MLCOP), maximal anterior-posterior displacement of the COP (APCOP), and COP sway area.
- There was **significant main effect in terms of the width** factor on the MLCOP and COP sway area.
- Post hoc analysis showed that those parameters were the largest in FPW, followed by those in FPS, and the smallest in FPN ($p<0.05$) (Table 1).

Table 1. Kinematic and kinetic parameters under different velocities and foot placement widths

	Fast velocity			Self-selected velocity			Width p value	Velocity p value
	FPN	FPS	FPW	FPN	FPS	FPW		
Maximal hip flexion angle (degree)	103±13	106±12	103±12	105±13	107±13	105±13	p=0.215	p=0.256
GRF increasing velocity (N/ms)	2.6±0.8	2.5±0.7	2.6±0.9	1.5±0.5	1.4±0.5	1.5±0.5	p=0.598	p<0.001
GRF decreasing velocity (N/ms)	1.4±0.5	1.4±0.6	1.3±0.6	0.6±0.3	0.6±0.3	0.6±0.3	p=0.716	p<0.001
MLCOP (mm)	21±7	30±11	42±16	19±6	25±9	34±13	p<0.001	p<0.001
APCOP (mm)	64±16	63±17	61±18	53±12	48±13	49±13	p=0.198	p<0.001
COP sway area (mm ²)	1172±639	1593±870	2228±1033	848±416	1105±676	1386±805	p<0.001	p<0.001

Discussion

- STS task requires the body to move forward and upward.
- During the upward movement of the body, previous studies showed that GRF decreasing velocity is positively correlated to the upward force [2].
- Current study found both the **GRF increasing** and **decreasing velocities** were **significantly affected by the movement velocity** but not the foot placement widths.
- The results of this study found that the **MLCOP** and **COP sway area** trend to be **greater in wide foot placement width** compared to in narrow width, which may increase the energy cost of movement.
- **Decreased MLCOP** and **increased APCOP** were found **in narrow foot placement** width compared to that in wide width.

Conclusion

- The movement velocity and foot placement widths could partially affect the posture control during the STS task.
- Compared to the other examined conditions, subjects performing the STS task with self-selected velocity in FPS can help to reduce the ground reaction force, and to achieve a stable STS movement.

References

[1] Hirschfeld, H. et al., *J Neurophysiol*, 1999, [2] Demura, S. et al., *Percept Mot Ski*, 2007