

# Postural stability during tiptoe standing with pointe shoes in professional and advanced amateur female dancers

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## Summary

The purpose of this study was to investigate the postural stability during tip-toe standing with pointe shoes in professional and advanced amateur dancers by the center of pressure (COP) and the center of mass (COM) sway and joint kinematics by a motion capture system. We found some differences between professional and advanced amateur female dancers although both had high postural stability.

## Introduction

Previous studies have shown that dance training affects postural control, particularly during challenging tasks [1]. However, it is still unknown how skilled dancers maintain their posture, especially on the limited support base during wearing pointe shoes. Therefore, the purpose of this study was to investigate both COP and COM sway and inter-joint coordination during tiptoe standing with pointe shoes by professional and advanced amateur dancers.

## Methods

Eighteen healthy female ballet dancers who had ballet experience of more than ten years participated in our study. Eight were professional dancers (PRO) and the rest ten dancers were advanced amateur dancers (AMA). They were asked to perform double-leg tiptoe standing with pointe shoes for fifteen seconds. Three trials were analyzed. Regarding the coincidence rate of the time-series changes in COM and kinematic variables such as the position of the sternum, the hip flexion angle, and the ankle plantar flexion angle, we used cross-lagged correlation analysis on the time series data of the anteroposterior component displacement of the COM, that of the sternum, the hip flexion angle displacement, and the ankle plantarflexion angle displacement using SPSS software.

## Results and Discussion

For COP and COM sway, there was no significant difference in the path length and rectangular area of COP and COM sway between the two groups. In the cross-lagged correlation coefficient between the ankle joint angular displacement and the anteroposterior component of COM, a significant negative correlation was observed in PRO, whereas a significant positive correlation was observed in AMA (Table 1.). PRO showed a significant positive correlation between hip angle displacement and COM displacement, while AMA showed a significant negative correlation. Both groups showed a significant positive correlation between the ankle joint angular displacement and the sternum displacement and also showed a significant negative correlation between the hip angle displacement and the sternum displacement. It was indicated that PRO would modify their ankle joint and hip joint angular displacement to the COM displacement differently compared to AMA. From the results of this study, it is suggested that AMA's postural adjustments showed similar time-spatial characteristics of ankle/hip angular displacement for the upper trunk displacement, whereas PRO adjusted the angular displacement of the ankle/hip joint to the COM displacement with different time-spatial characteristics.

## Conclusions

From the results of this study, it is indicated that both professional and advanced amateur dancers showed similar postural stability evaluating by COP and COM sway, while professional dancers would show different inter-joint coordination compared to the advanced amateur dancers.

## References

[1] Rein S et al. (2011). *Clin. Neurophysiol*, 122(8): 1602-10.

Table 1: The cross-lagged correlation coefficient between time series of COM and other displacements for PRO and AMA group

Leading index	Lagging index	Cross-correlation coefficient	
		PRO	AMA
HIP FL (+) EX (-)	STERNUM AN (+) PO (-)	-0.81 *	-0.59 *
ANKLE PF (+) DF (-)	STERNUM AN (+) PO (-)	0.98 *	0.99 *
HIP FL (+) EX (-)	COM AN (+) PO (-)	0.77 *	-0.72 *
ANKLE PF (+) DF (-)	COM AN (+) PO (-)	-0.93 *	0.92 *

\*: p<0.05.