Gait Characteristics of Elderly Women : The Role of Age and Speed Modification

DONG-A UNIVERSITY

Ga-Been Lee[1], Chang-Hong Youm* [1, 2], Young-Hwa Sin[1]

[1] Biomechanics Laboratory, University of Dong-A, Busan, Republic of Korea

[2] Department of Health Care and Science, College of Health Sciences, Dong-A University, Busan, Republic of Korea

KOREAN SOCIETY OF SPORT BIOMECHANICS

Introduction

Change in gait characteristics become more marked with aging, and gait disorders tend to be more prevalent in the elderly women than in the men. Previous studies on gait analysis based on the age of the elderly women have used average data by repeated measurements on a walkway of 10 m. There is a lack of research that evaluates gait characteristics and gait adaptation process of the elderly women at various speeds.

Purpose

The purpose of this study was to investigate gait characteristics of elderly women based on age by using continuous steps when walking on the ground with varying speeds such as self-preferred, faster(120% of preferred speed), and slower(80% of preferred speed) speed.

Methods

◆ Subjects

A gait test was conducted on **147 healthy elderly women aged over 65** (Group Ⅰ:52 women aged 65~69, GroupⅡ:46 women aged 70~74, and GroupⅢ:49 women aged 75 and over).

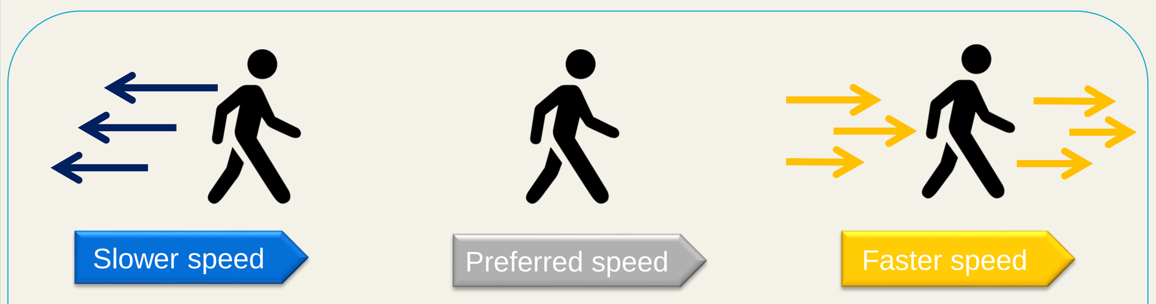
Table 1. Demographic and physical characteristics of the participants

	Total (n=147)	Group Ⅰ (n=52)	Group Ⅱ (n=46)	Group Ⅲ (n=49)
Age (yrs)	72.31±4.82	67.11±1.28	72.13±1.31	77.98±2.30
Height (cm)	152.64±5.18	153.29±5.37	152.38±5.53	152.18±4.63
Body mass (kg)	59.10±7.72	58.58±7.36	58.37±7.74	60.34±8.08
BMI (kg/m²)	25.41±3.14	25.08±3.14	25.12±3.00	26.05±3.24
BFP (%)	36.11±5.11	34.96±5.53	36.66±4.86	36.82±5.02
SBP (mmHg)	133.76±15.84	131.00±16.14	133.57±14.73	136.86±16.27
DBP (mmHg)	80.69±10.58	81.10±9.57	80.04±10.22	80.88±12.04
K-MMSE (score)	26.04±2.83	26.90±2.30	25.93±2.13	25.22±3.60
IPAQ-SF (Mets/Week)	1810.60±1231.42	2111.80±1243.66	1967.74±1319.03	1343.43±996.58

All data are shown as means and standard deviations, BMI: Body Mass Index, BFP: Body Fat Percentage, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, K-MMSE: Korean-Mini-Mental State Examination, IPAQ-SF: International Physical Activity questionnaire-short form.

◆ Measurements

✓ All participants walked along a straight 19 m walkway at their preferred speed. Slower speed and faster speed were calculated the preferred speed.



- Preferred speed – 20%
- Ex: 3.2 km/h

- Self-preferred speed
- Ex: 4 km/h

- Preferred speed + 20%
- Ex: 4.8 km/h

◆ Data collection and analyses

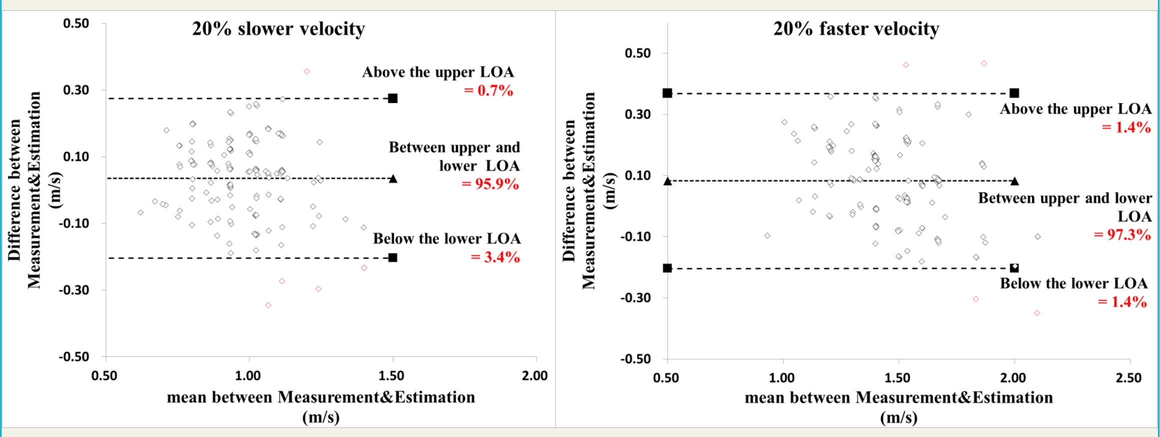
- ✓ The shoe-type data logger included an **inertial measurement unit(IMU) sensor in the each left and right outsoles**, and the data were transmitted wirelessly to a data acquisition system(DynaStab™, USA) via Bluetooth®.
- ✓ Sampling frequency for IMU: 100 Hz
- ✓ Butterworth low-pass filters 2nd-order Cut-off frequency 10Hz
- ✓ The Variables included physical characteristics, spatiotemporal variables, and the coefficient of variances of the spatiotemporal variables.

◆ Statistical analyses

- ✓ Mean & Standard deviation of all data
- ✓ The normality test: *Shapiro-Wilk* test → **Normal distribution**
- ✓ **Z-normalization** (value-mean/ standard deviation) was performed to normalize the tested variables.
- ✓ To verify slower and faster speed estimations, an **ICC (2,1) analysis** assessed the reliability of the estimated and measured speeds.
- ✓ **Multinomial logistic regression analysis** was conducted to determine the age classifiers for all participants aged 65–69 years under each walking speeds that contained all confounder(BMI, K-MMSE, IPAQ-SF, Number of fall).
- ✓ **Multiple regression analysis** was conducted to identify the factors that the variable affects the age.
- ✓ SPSS 22.0
- ✓ Significance level was set at < 0.05.

Results

◆ Bland Altman plots of the total participant



◆ Multinomial logistic regression analysis results for groups during overground walking

✓ **Difference between the 65~69 years and the 70~74 years groups**

- ➢ **Slower speed stance phase variability**
- ➢ **Stride length, step length at preferred speed**
- ➢ **Walking speed, stride time, step time, left single support phase, and right double support phase at faster speed**

✓ **Difference between the 65~69 years over 75 years groups**

- ➢ **Walking speed, total steps, stride length, step length at all speeds**
- ➢ **Right stance phase at faster speed**
- ➢ **Right stance phase variability at slower and faster speed**
- ➢ **Left stance phase variability at preferred and faster speed**
- ➢ **Gait asymmetry at slower speed**

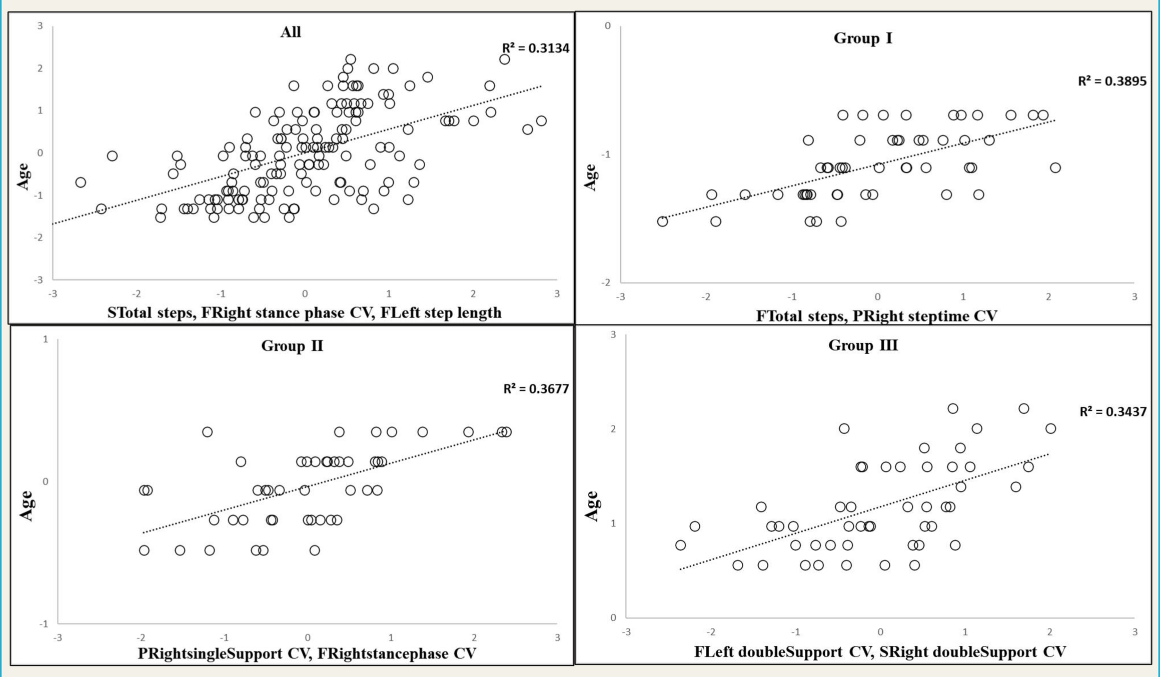
◆ Multivariable linear regression analysis results of gait parameters affects on the age at three different speeds

- ➢ **Total steps(p<0.001) at slower speed**
- ➢ **Right stance phase variability(p=0.006) and left step length(p=0.026) at faster speed**

Table 2. Results of multivariable linear regression analysis of gait parameters with age at three different speeds in the elderly women

	Variables	β	SE	t-value	p-value	VIF	Tolerance limit
		Stepwise multivariable linear regression analysis					
All participants (n=147)	Constant	2.889	0.070				
	S total steps	0.304	0.074	4.128	**<0.001**	1.096	0.913
	F Right stance phase CV	-0.195	0.070	-2.766	**0.006**	1.006	0.994
	F Left step length	-0.170	0.076	-2.247	**0.026**	1.165	0.859
	R^2=0.313, adjusted R^2=0.278, F=9.049, p<0.001						
Group Ⅰ (n=52)	Constant	-1.020	0.040				
	F total steps	0.119	0.044	2.712	**0.002**	1.059	0.944
	P Right step time CV	-2.087	0.608	-2.298	**0.009**	1.130	0.885
	R^2=0.389, adjusted R^2=0.291, F=3.995, p=0.002						
Group Ⅱ (n=46)	Constant	-0.047	0.035				
	P Right single support CV	-0.124	0.041	-2.998	**0.005**	1.101	0.908
	F Right stance phase CV	-0.131	0.046	-2.866	**0.007**	1.096	0.913
	R^2=0.368, adjusted R^2=0.271, F=3.791, p=0.005						
Group Ⅲ (n=49)	Constant	1.072	0.069				
	F Left double support CV	-0.223	0.089	-2.619	**0.012**	1.220	0.820
	S Right double support CV	0.175	0.073	2.392	**0.021**	1.169	0.855
	R^2=0.343, adjusted R^2=0.249, F=3.652, p=0.005						

Model adjusted for education, BMI, fallen number and physical activity; S: slower speed; P: preferred speed; F : faster speed; CV: Coefficient of variance; SE: Standard error; R^2: R square.



Discussion & Conclusions

In this study, continuous ground walking at various speeds such as self-preferred speed(100%), faster speed(120% of the preferred speed), and slower speed(80% of the preferred speed) condition for the elderly women aged 65~69, 70~74, and over 75 is useful in evaluating the difference according to the change of walking ability according to the increase of age. It also contributes to reducing the risk of falling and the functional regression of the elderly.

Future studies may examine gait characteristics during speed changes and turning movements when walking in daily life using wearable sensors.

References

- Herssens, N., Verbecque, E., Hallemans, A., Vereeck, L., Van Rompaey, V., & Saeys, W. (2018). Do spatiotemporal parameters and gait variability differ across the lifespan of healthy adults? A systematic review. *Gait & Posture*, 64, 181-190.
- Nascimbeni, A., Minchillo, M., Salatino, A., Morabito, U., & Ricci, R. (2015). Gait attentional load at different walking speeds. *Gait & posture*, 41(1), 304–306.

Acknowledgments

- **This study was supported by The Sports Promotion Fund of Seoul Olympic Sports Promotion Foundation From Ministry of Culture, Sports and Tourism.**
- **Department of Health Sciences, The Graduate School of Dong-A University.**