# KINETIC CHARACTERISTICS OF MIDDLE-AGED AND OLDER ADULTS DURING WALKING

[1] Hidetaka Okada, [2]Shinya Kuno, [2]Mitsuo Matsuda and [2]Michiyoshi Ae
[1]The University of Electro-Communications, Japan; e-mail: hidetaka@e-one.uec.ac.jp
[2]University of Tsukuba, Japan

## INTRODUCTION

The ability to walk is one of the most important factors for us to live actively. It may be a strong determinant for independent daily living, especially for elderly people. Unfortunately, the ability of the elderly to walk seems to deteriorate with aging. However, we can find the biomechanical causes of that deterioration and show how the elderly can maintain the ability to walk from the results of kinetic analyses of their motion.

The purpose of this study is to clarify the kinetic characteristics for middle-aged and older adults during walking and to present findings useful for maintaining or enhancing their ability to walk.

## METHODS

The subjects were 326 healthy Japanese adults, including 49 middle-aged, 265 elderly and 12 young adults (Table 1). They were instructed to walk about 10m as they usually did in their daily lives. In order to analyze the motion in the sagittal plane, we videotaped them during walking with a digital VTR camera at 60fps. The ground reaction forces on the right foot were measured by a force platform installed below the walkway. Two-dimensional coordinates of the eight body landmarks were obtained by using a video digitizing system (Frame-DIAS, DKH Co., Ltd.). The coordinates were smoothed by a fourth-order, zero-phase-shift Butterworth digital filter at the optimal cut-off frequencies that were derived from residual analysis (Winter, 1990). After synchronizing the smoothed coordinate data and ground reaction forces, we calculated joint torques at the ankle, knee and hip using a link-segment model based on the inverse dynamics method. Joint torque powers were next calculated by multiplying the joint torque by the joint angular velocity. Finally, joint mechanical work was calculated by integrating the joint torque power over time.

## RESULTS AND DISCUSSION

Figure 1 depicts the joint mechanical work of the ankle, knee and hip during normal walking for each age group. From these results, it appeared that positive work of ankle and knee and negative work of each joint for M, E1, E2 and E3 were smaller than those for Y. The positive ankle work was remarkably smaller in older groups. In contrast, the positive hip work was larger in older groups than the younger group.

**Table 1 Subjects and age groups**

| Group | Abbr. | n | Age (yr.) | |
|---|---|---|---|---|
| | | | Mean±SD | Range |
| Young | Y | 12 | 24.5±1.8 | 22.02–27.54 |
| Middle-aged | M | 49 | 59.7±4.8 | 45.30–64.97 |
| Elderly 1 | E1 | 97 | 67.6±1.3 | 65.14–69.99 |
| Elderly 2 | E2 | 109 | 72.5±1.4 | 70.05–74.98 |
| Elderly 3 | E3 | 59 | 77.7±2.2 | 75.31–86.32 |

Positive ankle power is exerted only in the second half of the stance phase (push-off phase) in walking. In this phase, positive power is generated by concentric contraction of the ankle plantar flexors, in which plantar flexion torque is exerted as the joint moves in the direction of plantar flexion. We therefore believe that the function of plantar flexors during walking deteriorates with aging and the hip joint must then exert more power to compensate for the decline in ankle function.

## CONCLUSIONS

The most remarkable characteristic of walking kinetics for middle-aged and older people is the decrease in positive ankle work. Therefore, preventing the decline in ankle plantar flexor function during walking may be the key for maintaining or enhancing the ability of the elderly to walk.

## REFERENCES

1. Judge, JO, et al.. *J Geront* **51A**, M303-M312, 1996.
2. Okada H, et al.. *Proceedings of ISB XIX*, Dunedin, New Zealand, Abstract 303, 2003.
3. Winter, DA, et al.. *Phys Ther* **70**, 340-347, 1990.

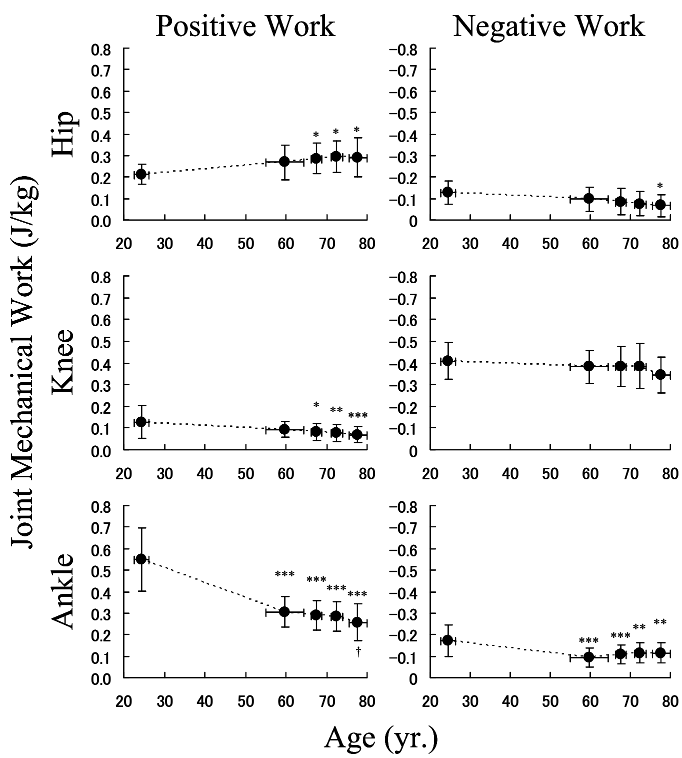


**Figure 1 Joint mechanical work of lower limb during normal walking**

Asterisks mean significant differences from the YOUNG in the multiple comparison (Scheffe's method) after ANOVA (* p<.05, **p<.01, ***p<.001). Crosses mean significant difference from the MIDDLE-AGED in the multiple comparison (Scheffe's method) after ANOVA († p<.05).