Gait With A Load Carriage For The Elderly Men
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Introduction
Carrying a load is one of the most basic human daily activities for men and women of all ages. On the other hand, load carriage is pointed out as one of the factors that increase the risk of falls for the elderly. Biomechanical studies on gait with a load carriage for the elderly women have revealed that (1) a slender subject with a BMI (Body Mass Index: weight/height$^2$) of 20.2 tended to walk with low toe lift during the swing phase while carrying a load (Iiboshi, 1998), (2) overweight subjects (BMI>24.1) also tended to walk with low toe lift while carrying a load at the side of their body (Iiboshi and Suenaga, 1999). Since low toe lift during the gait has been pointed out as one of the risk factors of falls for the elderly (Kaneko, 1991), the gait pattern shown by the slender or the overweight elderly may put them in danger of falling while carrying a load. These studies have been focused on the gait of the elderly women, and there is no research concerning a load carriage for the elderly men. Therefore, the purpose of this study was to investigate the effect of different type of load carriage on the gait for the elderly men living in the community, and compared the data with those of the elderly women reported previously from the viewpoint of safety.

Methods
Six healthy elderly men aged over 65 (mean age 70.0 years, height 1.65m, body weight 66.0kg, BMI 23.4) participated in the study after informed consent. They performed four tasks comprising one normal walking without a load and three load carriage conditions, which were frequently used by the elderly who fell while carrying a load (Iiboshi et al., 1995). These load carriage conditions were: (a) load at the side of the body in the dominant hand (side carriage), (b) load at the front of the body held with two hands and elbows bent at approximately 90 degree (front carriage), and (c) load on the back (back carriage). The load was a 4kg medicine ball put into a backpack. Therefore, the total amount of the load was 4.25kg, and equivalent to 6.5% (ranging from 5.7% to 7.9%) of the body weight of the subjects. The subjects walked over a 15m distance under each condition, and their gaits during the movement period over middle 6m of the distance were filmed by two video cameras operating at 60 fields/sec from frontal and sagittal plane views of the subjects. Videotape recordings of the gait patterns of the subjects were analyzed using the FRAME DIAS system (DKH Co., Japan). Values for several variables, which are frequently used in describing the temporal and kinematic characteristics of gait, were quantified from the film. These variables were step length, step frequency, walking velocity, and the maximum toe height during the swing phase. Step length represented the distance between the right heel and the left heel at the contact point of each foot. Step frequency was calculated as the number of steps completed per minute. Walking velocity was the product of the step length and the step frequency. Angle of the thigh, shank and ankle for the push-off leg and the contact leg, and the inclination of the trunk were also analyzed.

Results & Discussion
Mean gait speed of the normal walking without a load was 86.1m/min, with a step length of 0.72m and a step frequency of 120.8 step/min. These values are greater than those of the elderly
women reported previously (Iiboshi, 1998).

Figure 1 showed that the change in the step length and the maximum toe height during the swing phase with load carriage based on normal walking. There were no significant differences but the maximum toe height during the swing phase in the front carriage tended to increase in spite of shorter step length compared to the normal walking without a load. Same pattern was observed in the front load carriage of the elderly women (Iiboshi & Suenaga, 1999). Since the short step length generally involves the low toe lift during the swing phase, a higher toe lift with a shorter step length observed in the front carriage is interesting and desirable pattern to avoiding falls during load carriage. On the contrary, the maximum toe height during the swing phase in the side carriage tended to decrease. Especially, in case of the most slender elderly with BMI of 20.8 among the subjects, the maximum toe height during the swing phase in the side carriage decreased by 12.6% compared with that of the normal walking in spite of the same step length. Such a low toe lift was also observed in the slender elderly women with BMI of 20.2 (Iiboshi, 1998), and pointed out as one of the factors that increases the risk of falls for the elderly (Kaneko, 1991). Therefore, the elderly men, especially slender type, have to pay attention to avoid falls while carrying a load in the side carriage.

![Figure 1](image_url)

**Figure 1** The change in the step length and the maximum toe height during the swing phase with load carriage based on normal walking (n = 6)

**References**


