

HIP, KNEE, ANKLE KINEMATICS AND KINETICS DURING STAIR ASCENT AND DESCENT IN HEALTHY YOUNG INDIVIDUALS

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Introduction There is a great deal of research into human walking on level ground. Fewer reports on stair negotiation are evident in the literature, yet we frequently encounter steps/stairs during our daily activities (Renier et al., 2002). Understanding lower limb kinetics and kinematics during stair activities is important to further our understanding of lower extremity function and the pathogenesis of lower extremity disorders. The purpose of this ethically approved study was to identify normal functional parameters of the lower limb during stair ascent and descent in young healthy individuals.

Methods Eighteen subjects, (8 M, 10 F, range 20-39 years) with no history of lower limb injuries, pathology of the back or pelvis, or systematic or neuromuscular disease were included into the study. The laboratory staircase consisted of 4 steps (rise height 18 cm, tread length 28.5 cm). To estimate lower limb kinematics and kinetics, Vicon 3D motion analysis was used (Oxford Metrics Ltd, UK). Temporal gait cycle data and ground reaction forces were recorded using a force platform (Model 4020H, Bertec Corporation, Columbus Ohio). Kinetic data were standardized to body mass and height.

Results Paired t-tests showed significantly ($p=0.0001-0.023$) greater hip, knee angles and hip, knee and ankle moments were found during stair ascent compared to descent (Table 1). Significantly ($p=0.0001$) greater ankle dorsi and plantar flexion angles were found during stair descent compared to ascent. Note from table 1 the greater change in hip flexion during stair ascent compared to stair descent (difference 29°) compared with knee flexion (difference 4°).

Table 1. Means (\pm SD) of the variables tested during stair ascent and descent

Mean (\pm SD)	Stair Ascent	Stair Descent
Max hip flexion (°)	63.4 (\pm 6.86)***	33.92 (\pm 7.53)
Max knee flexion (°)	93.0 (\pm 7.53)*	88.61 (\pm 6.44)
Max dorsi flexion (°)	10.8 (\pm 3.20)***	20.98 (\pm 4.76)
Max plantar flexion (°)	30.8 (\pm 5.71)***	39.89 (\pm 4.56)
Ext hip flexion moment (Nm/Kg)	0.66 (\pm 0.14)***	0.52 (\pm 0.17)
Ext knee flexion moment (Nm/Kg)	0.43 (\pm 0.20)**	0.31 (\pm 0.19)
Ext dorsi flexion moment (Nm/Kg)	1.44 (\pm 0.09)	1.32 (\pm 0.17)

* $p<0.05$ ** $p<0.01$ *** $p<0.0001$

Discussion Stair ascent was shown to be the more demanding task when compared to stair descent for healthy young subjects. Our interest lies in the differences of these parameters during ageing and the possible implications of those who have sustained lower limb injuries. The findings from the current study could be used as baseline measures for pathological studies, theoretical joint modelling, and for mechanical joint stimulators.

References

Riener, R., Rabuffeti, M., Frigo, C. (2002). Stair ascent and descent at different inclinations. *Gait and Posture*, 15, 32-44.

Where were the force plates positioned, ?? In the stair tread