EFFECT OF GAIT VELOCITY ON HUMAN GASTROCNEMIUS FASCICLE BEHAVIOR DURING STAIR ASCENT
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INTRODUCTION
Muscle tendon interaction is often associated with efficiency of movement. In a recent paper [1], we showed that gastrocnemius medialis (GM) muscle fascicles hardly shortened at the push-off phase during stair ascent at a self-selected pace. This seems to be an efficient use of muscle force. Changing the demands of the task, might change this efficient usage of the muscle. Therefore, in the present study, fascicular shortening of the GM muscle is investigated at different gait velocities. Ankle joint moment would be expected to increase with increasing gait velocity, hence it is hypothesized that GM muscle fascicles will shorten more at a higher gait velocity.

METHODS
Ten young adult male subjects performed stair ascent at 3 different velocities (63, 88 and 116 step/min, controlled using a metronome). Kinematics and kinetics of the lower legs were measured using a 9-camera VICON system and a 4-step staircase with embedded forceplates. Ultrasound was used to determine muscle fascicle behavior; a linear- array probe (60mm probe width) was placed at the mid-sagittal plane of the left GM muscle, and tightly secured with a custom build fixation device. GM muscle fascicle length and pennation angle were measured for every frame in the stride from the first to the third step. To account for inter-individual fascicle length differences, values were calculated relative to a reference length, which was measured when standing upright. Influence of velocity was investigated for the stride period in which the muscle was active (assessed from Electrical activity (EMG) measurements): during the push-off phase, from peak EMG until lift-off. General Estimated Equations (GEE) were used for statistical analysis.

RESULTS AND DISCUSSION
During push-off, the ankle plantar-flexed caused by GM muscle fascicle shortening. At higher velocities, GM EMG was higher and peaked relatively earlier, while lift-off was also relatively early at higher velocities. Fascicle shortening increased in magnitude (1.3, 2.3 and 4.2 cm [mean] for resp. 63, 88 and 116 st/min, p<0.05) and shortening velocity (p<0.05) with increasing gait velocity. The increased shortening at higher velocities caused a higher ankle moment (p<0.05), however, the ankle moment did not increase any further beyond 88 st/min (p=0.628). Therefore, the increase in GM muscle fascicle shortening beyond 88 st/min can be explained by the shorter MTC length at 116 compared to that at 88 st/min (p<0.05), there was no difference in MTC length between 63 and 88 st/min (p=0.241). The results of the present study indicate that increases in fascicle shortening can occur in situations where the kinematics are fairly similar (stair ascent is a very constrained task, in terms of step length), but where increases in gait demands cause the fascicles to shorten more.

REFERENCES
Keywords: Stair Use / Stair Climbing, Muscle fibres