Discussion
The displacement method was unable to detect any differences between conditions, contrary to the findings of De Wit et al. (2000). However, the accelerometry technique revealed significantly higher acceleration peaks for barefoot running compared to shod, confirming the trends observed by McNaig and Marshall (1994) for axial, tibial shock. The lack of difference between shod conditions reflects differences in individual adaptation strategies. The accelerometry approach allowed both groups and individual changes to be clearly identified.

References

Table 1: Peak shank kinematics (AV-angular velocity) and MPF.

P618
Effects of the telescope-style running poles on the foot-ground interaction
Y. Kwon, L.R. Bolt, J. Shim, B.K. Doan, E.M. Popper, R.A. Rogers, Ball State University (Muncie, USA)

To determine the effects of the new telescope-style running poles on the foot-ground interaction during running in subjects with chronic knee problems, 10 male recreational runners with history of chronic knee problems were recruited as subjects. The poles used in this study consisted of the aluminum main poles that freely slide over the plastic upper poles attached to the upper-body vest through hinge mechanisms located under the armpit.

The design of the handles was such that they were approximately 75 degrees relative to the pole, instead of the typical ski pole handles. The poles were individually fitted to the subjects in terms of the pole length and the handle height and the pole-running trials of the subjects were compared with their normal running trials after a 4-week familiarization period with the poles. The running velocity was maintained at 3.5-3.7 m/s for both conditions. The ground reaction forces were measured during the normal and pole-running trials. The leg joint angles and their ranges of motion were quantified through 2-D motion analysis to evaluate the change in running kinematics due to the use of the running poles.

The ground reaction force data revealed a consistent trend of decrease with significant decreases in the peak vertical propulsive force (11.4%; 2.46 to 2.18 BW) and the vertical Impulse (11.4%; 0.35 to 0.31 BW-s) due to the use of the poles. The peak vertical impact force showed a non-significant decrease of 9.4% (2.12 to 1.92 BW). The maximum knee flexion angle during the swing phase significantly decreased by 10.9 degrees while the maximum hip hyperextension angle increased significantly by 4.0 degrees. In the correct pole-running technique, it was observed that the forward/backward arm-pole swing was generated more by the trunk rotation and lateral flexion than by the shoulder flexion and extension, with the shoulder range of motion kept minimal, which caused the upper body, including the stretched arm-pole complex, to move in one unit with an increased moment of inertia. The need to keep the running balance by increasing the lower body moment of inertia appeared to be the main reason for the reduced knee flexion during the swing phase in pole-running. The counter-rotation of the pelvis against the upper trunk in this process appeared to contribute to a more trailing position of the ipsilateral leg, causing increased maximum hip hyperextension angle at toeoff.

From the data analysis it was concluded that the telescope-style running poles significantly reduced the foot-ground interaction and demonstrated a potential to reduce the burden on the knee and, thus may benefit runners with chronic knee problems. For runners with a history of previous injury, the poles might provide enough protection to allow them to continue their running program without a high risk for further injury.

P619
Structure of locomotion and neuromuscular activity of lower extremity muscles during non-fatigued and fatigued running
K. Hottemrott, O. Hoos, H.-M. Sommer, Philipps-University of Marburg (Marburg, D)

Introduction
Neuromuscular and metabolic fatigue are important factors to assure adaptations in a training process. On the other hand, fatiguing exercises increase the load on the musculo-skeletal system and thus bear the risk of overload (3). The aim of the study was to assess the effects of fatigue on the structure of locomotion and neuromuscular activity in running.

Methods
24 well-trained endurance athletes performed two standardized running-tests of graded speed levels on a treadmill, before (pre: 3.3 m/s to 5.5 m/s) and after (post: 3.3 m/s to 4.4 m/s) a fatiguing bicycle exercise. Muscle activity of 6 primarily propulsive lower limb muscles (TA, GA, BF, VM, VL, RF) were recorded at each level in running. Simultaneously, kinematics (goniometry, inertia switch) of the lower limb were obtained.

Results
A comparing of the third speed level of pre- and post-test (v = 4.4 m/s) yielded the following significant results:

Structure of locomotion
- decrease of stride frequency, increase of stride length and stance time (p < 0.01)
- increased knee flexion during initial ground contact, decreased knee extension during toe off (p < 0.05)
- higher knee extension velocities in the eccentric phase and lower knee extension velocities during early swing (p < 0.05)

Neuromuscular activity
- increase in muscle activation time (> 30% of Peak EMG-value) of M. tibialis anterior (TA) and M. biceps femoris (BF) (p < 0.05)
- earlier EMG onset of BF and TA (left-shift), later EMG onset of M. rectus femoris (RF) (right-shift) (p < 0.05)
- increase in AEMG values of leg extensors (VM, VL, RF, GA) during preactivation and eccentric phase (p < 0.01) and unchanged AEMG values of leg flexors (TA, BF)
- decrease in AEMG values of leg extensors (VM, VL, RF) in concentric phase (p < 0.01).

Discussion
Our results support the thesis that changes in foot contact timing are typical consequences of increasing fatigue in running (1,2). Stability of initial ground contact is altered by a much higher incline in EMG-activity (AEMG) for the leg extensors in preactivation and eccentric phase in comparison to the antagonistic flexor muscles. This dysbalance disturbs an optimal tension ratio between flexor and extensor muscles in order to stabilize the joints during initial ground contact. The non-optimal tension ratio is supported by the fact of increasing knee extension velocities, stance times and decreased EMG-activity of leg extensors during the concentric phase.

In conclusion, neuromuscular fatigue alters motor control, leads to unfavorable lower limb kinematics, supports the development of muscular dysbalance and therefore increases the risk of musculo-skeletal overload.

References