Efficient running requires an optimum exchange of potential and kinetic energy. The measurement of ground reaction forces (GRFs) during running has allowed examination of this interchange and permits the comparison of energy exchange patterns between athletes of different ability. The comparison of athlete’s force application has been centred on the estimation of leg stiffness from the GRFs. There is some evidence to suggest that leg stiffness can predict running economy, since the stiffness of a spring significantly influences its energy storage and recovery properties. It is still not clear how force application changes over a range of running velocities, how runners of varying stiffness apply GRFs, or whether force application patterns can predict running economy.

Two consecutively-placed force platforms were positioned flush with the running surface of an indoor athletics track. Twenty well-trained runners (VO2max=68.6±6.9 mlO2.kg.min) ran over the force platforms at velocities ranging from 14 to 20 km.h-1. GRFs were recorded of the right leg impacting on either force platform. Contact time (Tc), maximum vertical force (Fmax), maximal vertical loading rate (Gzi), total vertical impulse (Jv), braking impulse (Jb), propulsive impulse (Jp), vertical stiffness (kvert) and leg stiffness (kleg) were calculated from the GRFs. Running economy (RE) was measured using a standardised treadmill protocol.

kvert, Fmax, LR, Jv, Jb, Jp, increased with running velocity, while Tc decreased (p<0.05). kleg and RE did not change with velocity. kleg (12.5±3.0 kN.m) and kvert (52.91±11.07 kN.m) were found to be slightly higher than those reported previously. Tc and vertical displacement of the centre of mass were found to be significantly different between the stiffest and most compliant runners (p<0.05), and there was a trend for Gzi to be greater in the stiffer runners (p=0.089). Tc was significantly and negatively related to kvert (p<0.05). There was no difference in running economy between the stiff and compliant groups.

All runners altered their force patterns as velocity increased, while stiffer runners displayed shorter contact times and less vertical displacement. However, neither kvert or kleg, or other kinetic variables were predictive of running economy in these well-trained runners. It is possible that these runners adopt a kinetic pattern that is optimum for their own muscle-tendon properties. Further study is required to investigate the relationship between muscle-tendon unit properties and running kinematics of stiff and compliant runners.

Keywords: Running, Ground Reaction Forces, Stiffness